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Vol. I.

TRANSCRIPT OF RECORD.

SUPREME COURT OF THE UNITED STATES.

OCTOBER TERM, 1893.

No. ~~286~~. 44

THE CONSOLIDATED ELECTRIC LIGHT COMPANY,
APPELLANT,

vs.

THE McKEESPORT LIGHT COMPANY.

APPEAL FROM THE CIRCUIT COURT OF THE UNITED STATES FOR
THE WESTERN DISTRICT OF PENNSYLVANIA.

FILED OCTOBER 17, 1890.

(14,326.)

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INDEX.

	Original.	Print.
Caption	1	1
Docket entries	1	1
Bill of complaint	14	7
Subpoena	22	11
Marshal's return	23	12
Demurrer	24	12
Opinion on demurrer	27	13
Order overruling demurrer	28	14
Answer	29	14
Replication	42	22
Order assigning time for taking testimony and appointing H. D. Gamble an examiner	43	23
Order fixing time for taking complainant's evidence in reply	44	23
Stipulation extending time for closing complainant's proofs in reply	45	23
Proof of service of notice of motion for two months in which to take defendant's testimony	46	24
Opinion and order on motion for time to take testimony, &c.	47	24
Motion for extension of time to take defendant's testimony	48	25
Order extending time to take testimony	48	25

JUDD & DETWEILER, PRINTERS, WASHINGTON, D. C., DECEMBER 22, 1893.

	Original.	Print.
Order allowing defendant to impeach William H. Church	49	25
Stipulation for appointment of John H. Kitchen as examiner, &c.	50	26
Order appointing John H. Kitchen as examiner on part of defendant	51	26
Order appointing William T. Farnham as examiner on part of complainant	52	27
Order appointing William T. Farnham as examiner on part of defendant	53	27
Stipulation for appointment of William T. Farnham as examiner, &c.	54	28
Order appointing John A. Shields as examiner on part of complainant	56	28
Evidence-in-chief for complainant	57	29
Exhibits offered	57	30
Testimony of Franklin L. Pope	58	30
Exhibit Sawyer and Man Assignment of October 14, 1878—Assignment from Sawyer and Man to the Electro-Dynamic Light Company, October 14, 1878	113	65
Exhibit Sawyer and Man Assignment of January 9, 1880—Assignment from Sawyer and Man to the Electro-Dynamic Light Company, recorded January 9, 1880	115	66
Exhibit Electro-Dynamic Light Company Assignment of April 6, 1881—Assignment from the Electro-Dynamic Light Company to William H. Church, April 6, 1881	115	66
Exhibit Church Assignment of April 6, 1881—Assignment from William H. Church to the Eastern Electric Manufacturing Company, April 6, 1881	120	69
Exhibit Eastern Electric Manufacturing Company's Assignment of September 30, 1882—Assignment from the Eastern Electric Manufacturing Company to the Consolidated Electric Light Company, September 30, 1882	124	72
Exhibit Sawyer and Man Assignment of April 5, 1881—Assignment from Sawyer and Man to the Electro-Dynamic Light Company, April 5, 1881	130	76
Evidence for defendant	134	78
Exhibits offered	134	78
Testimony of George F. Barker	135	79
Evidence in reply for complainant	138	80
Testimony of Amos Broadnax	138	80
Exhibit Broadnax Sketch	147	86
Stipulation as to facts	242	146
Exhibits offered	243	146
Testimony of J. Edgar Bull	246	148
Exhibits offered	248	149
Evidence from interference case of Sawyer & Man *vs.* Edison	249	150
Testimony of William Sawyer	249	150
William E. Sawyer	266	161
Exhibits offered	281	170
Evidence for defendant	283	171
Notices to take testimony	283	171
Testimony of George W. Sawyer	286	173
John M. D. Keating	325	199
William Hochhausen	332	204

	Original.	Print.
Testimony of William Sharp	362	224
Exhibit Sharp Drawing, figures 1 and 2	405	254
Exhibit Sharp Drawing, figure 3	406	254
Exhibit Sharp's Diagram of Walker-street Shop	419	262
Testimony of Walter K. Griffin	432	271
John M. D. Keating	433	272
Keating Book Exhibit	435	273
Stipulation as to evidence of Thomas A. Edison	436	274
Testimony of Thomas A. Edison	437	274
Charles Batchelor	574	365
Henry E. Vineing	665	425
Cyrus F. Brackett	693	443
Exhibits offered	796	510
Testimony of George F. Barker	801	514
William P. Wilson	861	553
Exhibits offered	892	574
Testimony of William Holzer	893	574
Amos Broadnax	901	579
Jacob Hays	907	583
William Hochhausen	913	587
Albon Man	915	588
William Hochhausen (recalled)	916	589
Hugh R. Garden	917	590
Stipulation as to minutes, &c., of Electro-Dynamic Light Company	921	592
Minutes of board of trustees of Electro-Dynamic Light Company, &c.	922	593
Letter of William D. Baldwin to Thomas Wallace, January 8, 1880	962	618
Stipulation as to evidence	963	619
Evidence in Edison *vs.* Sawyer-Man interference	964	620
Testimony of Martin N. Force	964	620
Edward H. Johnson	971	624
John Kruesi	975	627
Francis R. Upton	979	630
John Kruesi (realled)	996	641
Stephen D. Field	1000	644
Thomas B. Stillman	1002	645
William Sawyer	1007	648
James A. Russell	1010	650
James D. Potter	1012	651
James E. O'Keeffe	1013	652
Francis R. Upton	1016	654
Philip S. Dyer	1021	657
Testimony of Calvin Goddard	1027	661
R. M. Galloway	1031	664
Grosvenor P. Lowrey	1033	665
James Hood Wright	1038	668
Evidence in reply for complainant	1041	670
Testimony of Albon Man	1041	672
Exhibit Man Sketch No. 1	1318	851
Exhibit Man Sketch No. 3	1349	871
Exhibit Man Drawing, December 9, 1887	1446	931

	Original.	Print.
Exhibit Man's Diagram Centre-street Shop, March 27, 1887	1449	933
Exhibit Man Sketch No. 2	1498	963
Exhibit Man,s Diagram Centre-street Shop, March 27, 1887	1651	1057
Exhibit Man's Diagram Walker and Elm Shop, March 27, 1889	1654	1059
Exhibit Man Drawing of Tulip-shaped Lamp, April 2, 1889	1699	1081
Exhibit Cheever Agreement—Agreement between the Electro-Dynamic Light Company and Charles A. Cheever, Jan. 9, 1880	1721	1094
Exhibit Lowrey Letter of October 30, 1878—Letter of G. P. Lowrey to Albon Man, October 30, 1878	1723	1095
Exhibit Man's Letter to Lowrey of October 31, 1878	1725	1096
Exhibit Lowrey Letter of November 6, 1878—Letter of G. P. Lowrey to Albon Man, November 6, 1878	1727	1097
Exhibit Sawyer's Letter, dated March 7, 1878—Letter of W. E. Sawyer, March 7, 1878	1729	1098
Exhibit Lowrey Letter of November 2, 1878—Letter of G. P. Lowrey to Albon Man, November 2, 1878	1730	1098
Testimony of Thomas B. Stillman	1731	1099
Exhibit Stillman No. 1—Drawing	1733	1100
No. 2—Drawing	1736	1100
No. 3—Drawing	1740	1103
Exhibit Stillman Record of Lamp Tests	1745	1103
Exhibit Sawyer-Stillman Letter of March 5, 1879	1765	1119
Testimony of Ida Man Ives	1766	1119
Alice J. Watkins	1772	1123
Hans J. Muller	1776	1125
Edwin L. Hays	1784	1130
David Hennessy	1794	1136
Exhibit Hennessy Memorandum, April 5, 1889	1796	1138
Testimony of Edward Rowe	1797	1138
George S. Beith	1799	1140
Exhibits offered	1803	1142
Testimony of Hugh R. Garden	1804	1143
Edward R. Knowles	1814	1149
James A. Vandegrift	1819	1152
Charles R. Cross	1825	1156
Exhibit Cut of Voltaic Arc	1829	1158
Exhibit Cut of Serrin Arc Lamp	1830	1158
Exhibit Cut of Werdermann Arc Incandescent Lamp	1831	1158
Testimony of Henry Morton	1974	1241
Oliver B. Shallenberger	2085	1313
Frank Stuart Smith	2159	1360
Thomas B. Stillman (recalled)	2172	1368
James W. Packard	2181	1375
Walter K. Griffin	2233	1409
Franklin L. Pope	2234	1410
John M. Robertson	2278	1438
William H. Church	2280	1439
Exhibit Rockwell Kent Letter—Letter of Rockwell Kent to William Church, March 26, 1879	2283	1441
Exhibit Church Statement of Facts, April 26, 1889	2315	1462
Exhibit Tomlinson Telegram—Telegram of John C. Tomlinson to William H. Church, June 28, 188-	2317	1463

	Original.	Print.
Exhibit Church's Letter to Tomlinson—Letter of William H. Church, July 1, 1887	2318	1464
Testimony of Amos Broadnax (recalled)	2319	1464
Edward Berry	2320	1465
Franklin L. Pope (cross)	2325	1468
Tillie J. Sawyer	2392	1513
Evidence for defendant	2399	1518
Testimony of Richard N. Dyer	2399	1518
John C. Tomlinson	2432	1539
Statement of John C. Tomlinson as to his acquaintance with William H. Church	2451	1552
Complainant's Exhibit Penny Encyclopedia Extract	2455	1554
Chambers' Encyclopedia Extract	2455	1554
Rees' Encyclopedia Extract	2458	1555
Ure's Dictionary Extract	2458	1556
Dictionnaire Technologique Extract	2459	1556
Engineers and Mechanics' Encyclopedia Extract	2460	1557
Nicholson's Encyclopedia Extract	2460	1557
Encyclopedia of Chemistry Extract	2461	1557
Muspratt's Chemistry Extract	2462	1558
Extract from Faraday's Lectures	2463	1559
Extract from Muller's Physics	2464	1560
The Telegraphic Journal and Electrical Review	2465	1560
Philosophical Transactions No. 1	2467	1562
Pynchon's Physics	2472	1565
Extracts from Pepper's Cyclopædic Science Simplified	2474	1566
Philosophical Transactions No. 2	2481	1571
Miller's Chemical Physics	2486	1574
Certified Copy of Dyer & Wilber Letter to Commissioner of Patents, October 4, 1880	2491	1577
Lichtenstadt U. S. Patent No. 41627, February 16, 1864	2492	1578
Heaton U. S. Patent No. 68363, Sept. 3, 1867	2494	1579
Russell & Howland U. S. Patent No. 70474, November 5, 1867	2505	1587
Robbins & Southmayd U. S. Patent No. 87295, February 23, 1869	2509	1589
Sawyer & Man Hydrocarbon Treatment Patent No. 211,262, January 7, 1879	2512	1591
Scientific American Article	2517	1594
Extract from Philosophical Magazine	2528	1599
Extract from Ganot's Physics	2532	1602
Muspratt's Chemistry Extract	2538	1606
Edison's Testimony in Swan Interference	2539	1607
Edison's File-wrapper and Contents in the Matter of Application Filed Dec. 11, 1879	2638	1671
Edison Patent No. 1—Patent No. 214,636, granted April 22, 1879	2707	1703
Edison Patent No. 2—Patent No. 214,637, granted April 22, 1879	2710	1705

	Original.	Print.
Complainant's Exhibit Edison Patent No. 3—Patent No. 218,866, granted August 26, 1879.	2713	1707
Edison Patent No. 4—Patent No. 219,628, granted September 16, 1879	2715	1709
Edison Patent No. 5—Patent No. 224,329, granted February 10, 1880	2717	1711
Edison Patent No. 6—Patent No. 227,227, granted May 4, 1880.	2719	1713
Edison Patent No. 7—Patent No. 227,228, granted May 4, 1880.	2722	1716
Edison Patent No. 8—Patent No. 227,229, granted May 4, 1880	2725	1719
Edison Patent No. 238,868, granted March 15, 1881.	2727	1723
Edison Patent No. 248,417, granted October 18, 1881	2730	1725
Lane Fox British Patent No. 3988, October 9, 1878	2733	1727
Lane Fox British Patent No. 4043, October 12, 1878	2741	1734
Lane Fox British Patent No. 4626, November 14, 1878.	2748	1740
Lane Fox British Patent No. 1122, March 20, 1879.	2761	1750
Soapstone Switch Patent—Patent No. 229,476, granted Sawyer & Man, assignors, &c., June 29, 1880.	2766	1752
Sawyer-Man Switch Patent No. 210,152, granted November 19, 1878	2769	1755
Reissue No. 10134—Patent granted Sawyer & Man, assignors, &c., June 6, 1882.	2776	1759
Sawyer-Man Regulator Patent No. 205,305, granted June 25, 1878	2782	1768
Sawyer-Man Electric Meter Patent No. 210,151, granted November 19, 1878	2786	1773
Sawyer and Man British Patent No. 4705, of November 19, 1878.	2789	1777
No. 1—Patent No. 317,674, granted Sawyer & Man, assignors, &c., May 12, 1885	2804	1795
Patent Office Proceedings No. 1—File-wrapper and contents in matter of patent No. 317,676, granted Sawyer & Man May 12, 1885.	2811	1799
Patent Office Proceedings No. 2—File-wrapper and contents in matter of the application of Thomas A. Edison of December 11, 1879.	2829	1808
Patent Office Proceedings No. 4—File-wrapper and contents in matter of interference of Sawyer & Man *vs.* Thomas A. Edison	2848	1817
Patent Office Proceedings No. 3—Petition of Edison for permission to amend preliminary statement in interference of Sawyer & Man *vs.* Edison, &c.	2891	1835

		Original.	Print.
Complainant's Exhibit	Testimony for Sawyer & Man	2911	1843
	Testimony of Albon Man	2912	1843
	Sawyer's Exhibit No. 3—Diagram	2933	1856
	Testimony of William H. Church	2936	1858
	Sawyer's Exhibit No. 1—Diagram	2939	1860
	Sawyer's Exhibit No. 1—Diagram	2941	1860
	Sawyer's Exhibit No. 2—Diagram	2946	1863
	Testimony of William Sawyer	2958	1870
	Sawyer's Exhibit No. 4—Diagram	2966	1875
	Testimony of Amos Broadnax	2977	1880
	Sawyer's Exhibit No. 5—Diagram	2980	1883
	Testimony of Lawrence Myers	2981	1882
	Sawyer's Exhibit No. 5—Diagram	2982	1883
	Testimony of William E. Sawyer	2986	1884
	Sawyer's Exhibit No. 6—Diagram	2989	1886
	Testimony of George W. Sawyer	3003	1894
	Testimony of William H. Church	3007	1896
	Testimony of Albon Man	3025	1907
	Testimony for Edison	3032	1912
	Testimony of Thomas A. Edison	3034	1912
	Edison Exhibit 1—Diagram	3039	1916
	Edison Exhibit 2—Page of New York Herald	3046	1919
	Edison Exhibit 4—Diagram	3050	1922
	Edison Exhibit 5—Memorandum	3053	1923
	Edison Exhibit 6—Diagram	3061	1926
	Edison Exhibit 13—Diagram	3079	1937
	Edison Exhibit 14—Memorandum	3094	1945
	Edison Exhibit 9—Diagram	3096	1946
	Edison Exhibit 3—Record of lamps	3134	1968
	Edison Exhibit 7—Record of experiments	3145	1973
	Edison Exhibit 8—Extract from New York Sun	3146	1973
	Testimony of Martin N. Force	3148	1974
	Testimony of Edward H. Johnson	3155	1978
	Testimony of John Kruesi	3160	1982
	Testimony of Francis R. Upton	3165	1985
	Article of Francis R. Upton in "Scribner's Monthly" on "Edison's Electric Light"	3183	1996
	Testimony of John Kruesi (recalled)	3197	2017
	Testimony of Thomas A. Edison (resumed)	3201	2019
	Testimony of Charles Batchelor	3209	2024
	Edison Exhibit No. 4—Memorandum	3212	2026
	Testimony of Stephen D. Field	3257	2051
	Testimony of Thomas B. Stillman	3260	2052
	Edison Exhibit 23—Sawyer letter to the Sun	3262	2054
	Edison Exhibit 24—Sawyer letter to Stillman	3264	2054
	Testimony of William Sawyer	3268	2055
	Testimony of James A. Russell	3272	2057
	Testimony of James D. Potter	3274	2058
	Testimony of James E. O'Keeffe	3276	2059
	Edison Exhibit 11—Record of lamps	3280	2062

	Original.	Print.
Complainant's Exhibit Edison Exhibit 25—Sawyer letter to New York Sun	3291	2067
Decision of examiner of interferences, &c.	3292	2068
Opinion of examiner of interferences	3296	2069
Patent Office Record No. 6—Motion papers and affidavits filed in behalf of Edison on motion to reopen case in matter of the interference of Sawyer & Man *vs.* Edison	3299	2071
Patent Office Proceedings No. 7—Affidavits of W. E. Sawyer, Robert Street, *et al.*, filed April 3, 1882, in the matter of the interference of Sawyer & Man *vs.* Edison	3316	2080
Patent Office Proceedings No. 8—Decision of the Commissioner, July 24, 1882, in the matter of the interference of Edison *vs.* Sawyer & Man, &c.	3373	2111
Further evidence	3395	2123
Testimony of Alexander Welsh	3398	2124
Second deposition of Alexander Welsh	3419	2137
Testimony of Albon Man	3429	2142
Testimony of William H. Church	3458	2160
Testimony of Robert White	3471	2168
Testimony of Edward R. Knowles	3479	2173
Exhibits—Agreements and assignments	3488	2178
Patent Office Proceedings No. 5—Certified copy of papers in the matter of the interference of Sawyer & Man *vs.* Edison, &c.	3518	2194
Testimony of Francis R. Upton	3521	2195
Testimony of Philip S. Dyer	3526	2198
Decision of examiner	3537	2203
Index	3544	2208
Patent Office Proceedings No. 9—File-wrapper and contents in the matter of the appeal to the examiners-in-chief by Thomas A. Edison	3546	2209
Patent Office Proceedings No. 10—File-wrapper and contents in the matter of the appeal to the Commissioner by Sawyer and Man	3565	2220
Complainant's Exhibit No. 16—Assignment of William H. Church, trustee, to the Eastern Electric Manufacturing Company, April 6, 1881	3667	2274
No. 17—Assignment of the Eastern Electric Manufacturing Company to the Consolidated Electric Light Company, September 30, 1882	3673	2277
No. 18—Certificate of incorporation of the Electro-Dynamic Light Company, July 8, 1878	3682	2281
No. 19—Certificate of incorporation of the Eastern Electric Manufacturing Company, January 15, 1880	3685	2283

		Original.	Print.
Complainant's Exhibit	No. 20—Certificate of incorporation of the Consolidated Electric Light Company, September 7, 1882	3688	2285
	No. 22—U. S. patent No. 341,644, granted Thomas A. Edison May 11, 1886	3692	2288
	No. 23—U. S. patent No. 263,878, granted Thomas A. Edison Sept. 5, 1882	3697	2291
	No. 24—U. S. patent No. 264,657, granted Thomas A. Edison Sept. 19, 1882	3701	2293
	No. 25—Canadian patent No. 11968, granted Thomas A. Edison Nov. 11, 1880	3707	2295
	No. 27—Agreement between William E. Sawyer and Albon Man, March 19, 1878	3757	2322
	No. 28—Agreement between William E. Sawyer and Albon Man, May 11, 1878	3759	2323
	No. 30—Canadian patent No. —, granted Thomas A. Edison Jan. 10, 1880	3763	2325
Defendant's Exhibit	"Interference Stipulation"—Stipulation of counsel as to evidence	3778	2332
	"Arnoux-Hochhausen Letter"—Letter from Arnoux & Hochhausen to Charles A. Cheever, January 9, 1880	3786	2336
	Broadnax-Cheever Letter—Letter of Amos Broadnax to Charles A. Cheever, January 8, 1888	3787	2336
	Man-Cheever Letter—Letter of Albon Man to Charles A. Cheever, December 12, 1880	3788	2337
	B—Herald article of January 5, 1880	3790	2338
	C—Herald article of January 6, 1880	3791	2338
	Sawyer-Man Scientific American Article No. 1—Article from Scientific American of November 16, 1878, entitled "Another New Electric Light"	3792	2339
	Sawyer-Man Scientific American Article No. 3—Article from Scientific American of March 8, 1879, entitled "The Sawyer-Man Electric Light"	3793	2339
	Sawyer-Man Scientific American Article No. 4—Article from the Scientific American of March 8, 1879, entitled "A New Form of Carbon"	3795	2340
	Morton Sanitary Engineer Letter—Letter of Henry Morton to the editor of the Sanitary Engineer	3796	2341
	Morton Sanitary Engineer Interview—Article from the New York Times of Dec. 28, —	3798	2342
	Article from the New York Tribune, November 25, 1880	3801	2344
	Deposition of William Sharp	3806	2347
	Collected Works of Sir Humphrey Davy, vol. II, London, 1839, pp. 211 to 213, inclusive	3814	2352

		Original.	Print.
Defendant's Exhibit	Collected Works of Sir Humphrey Davy, London, 1839, vol. II, beginning at p. 214	3817	2353
	Collected Works of Sir Humphrey Davy, vol. IV, London, 1840, pp. 109, 110, 111, 112, 221, 231, 232	3821	2355
	Collected Works of Sir Humphrey Davy, vol. V, London, 1840, pp. 172, 173	3825	2358
	Watt's Dictionary of Chemistry, vol. 1, London, 1863, pp. 759 and 760	3829	2360
	Watt's Dictionary of Chemistry, London, 1875, Second Supplement	3831	2362
	Mechanics' Magazine, vol. 44, pp. 312-316, London, 1846	3832	2362
	The Mining Journal, p. 348	3838	2366
	Philosophical Transactions, Paper No. 1—Transactions of the Royal Society of London for year 1809, vol. 9	3840	2368
	Philosophical transactions, Paper No. 2—Transactions of the Royal Society of London for year 1815	3846	2371
	Philosophical Transactions, Paper No. 3—Transactions of the Royal Society of London, vol. 20, published in 1820	3856	2377
	Philosophical Transactions, Paper No. 4—Transactions of the Royal Society of London for year 1821	3857	2378
	Philosophical Transactions, Paper No. 5—Transactions of the Royal Society of London for year 1839	3870	2386
	Philosophical Transactions, Paper No. 6—Transactions of the Royal Society of London for year 1832	3882	2393
	Published Description of Ladiguin's Electric Light—Journal of the Society of Arts, London, 1872-'73	3890	2398
	Violette Paper—American Journal of Science and Arts, vol. 16	3893	2400
Edison Exhibit No.	3—Record of lamps, Book No. 67, pp. 1 to 15, inclusive	3896	2401
No.	7—Extract from records of experiments, Book No. 85	3902	2406
No.	8—Article from New York Sun, Dec. 22, 1879	3903	2407
No.	11—Record of lamps, Book No. 74, pp. 1-14	3906	2408
No.	25—Article from New York Sun, Jan. 5, 1880	3913	2414
Defendant's Exhibit	French Patent, granted Octave Gauduin September 16, 1876	3915	2415
	Prof. Cross' Report of 1881 (No. 1)—Letter of Chas. R. Cross to F. H. Betts, June 23, 1881	3926	2420
	Prof. Cross' Report of 1881 (No. 2)—Letter of Chas. R. Cross to F. H. Betts, June 24, 1881	3929	2422
	French Patent, granted Le Molt Jan. 31, 1849	3930	2422
Complainant's Exhibit	Scientific American Article No. 2—Article from Scientific American of December 7, 1878, on the Sawyer-Man electric light	3934	2424

	Original.	Print.
Defendant's Exhibit Times Article of October 30, 1878—Article entitled "A New Electric Light"	3945	2429
Defendant's Exhibit No. 10—Article from Scribner's Magazine, entitled "Edison's Electric Light," by Francis R. Upton	3949	2431
Defendant's Exhibit Fontaine's Book—French book entitled "Eclairage L'Électricité Renseignements Pratiques, par Hippolyte Fontaine"	3963	2453
Drawing marked plate 1	4003	2476
2	4004	2476
3	4005	2476
4	4006	2476
5	4007	2476
6	4008	2476
7	4009	2476
8	4010	2476
9	4011	2476
Defendant's Exhibit 1—Drawing	4012	2476
2—Article in New York Herald of December 21, 1879, entitled "Edison's Light"	4013	2476
4—Diagram and notes	4014	2476
5—Notes	4015	2476
6—Diagram	4016	2476
9—Diagram	4017	2476
13—Diagram	4018	2476
14—Notes	4019	2476
23—Lithograph of Sawyer challenge	4020	2476
24—Lithograph of Sawyer's note to Stillman	4022	2476
Defendant's Cross-examination Exhibit Morton's Paper on Electric Light—Lecture by Professor Henry Morton before the American Gas Light Association, October 17, 1878	4023	2476
Defendant's Exhibit Sawyer and Man Specification in Parallel Columns	4040	2488
Defendant's Exhibit Higg's Translation of Fontaine's Book	4041	2489
Complainant's Exhibit Sawyer's Dynamo Machine Patent—U. S. Patent No. 237,632, granted Wm. E. Sawyer, assignor, &c., February 8, 1881	4075	2511
U. S. Patent No. 20706, granted Gardiner & Blossom June 29, 1858	4079	2514
No. 166,877, granted S. A. Kosloff August 17, 1875	4082	2516
No. 181,613, granted H. Woodward August 29, 1876	4086	2521
No. 205,144, granted Sawyer & Man June 18, 1878	4090	2523
No. 205,303, granted Sawyer & Man June 25, 1878	4096	2531
No. 210,809, granted Sawyer & Man Dec. 10, 1878	4101	2538
No. 219,771, granted Wm. E. Sawyer, Sept. 16, 1879	4107	2543
No. 223,898, granted Thomas A. Edison Jan. 27, 1880	4111	2547
No. 227,118, granted Albon Man May 4, 1880	4115	2551
No. 229,335, granted Sawyer & Man June 29, 1880	4119	2556
No. 229,476, granted Sawyer & Man June 29, 1880	4123	2559
No. 233,445, granted Joseph W. Swan Oct. 19, 1880	4127	2562
No. 251,540, granted Thomas A. Edison Dec. 27, 1881	4130	2565
No. 264,642, granted Thomas A. Edison Sept. 19, 1882	4134	2567
No. 266,793, granted Thomas A. Edison Oct. 31, 1882	4138	2572
No. 369,280, granted Thomas A. Edison Aug. 30, 1887	4145	2576
Specification of patent No. 8644, granted Henry Pinkus 1840	4150	2584

	Original.	Print.
Defendant's Exhibit Staite's English Patent—English patent No. 12212, granted Wm. E. Staite 1848	4188	2610
Defendant's Exhibit De Moleyn's English Patent—English patent No. 9053, granted Frederick De Moleyns 1841	4241	2631
Defendant's Exhibit King's English Patent—English patent No. 10919, granted Edward A. King 1845	4253	2640
Defendant's Exhibit Greener & Staite English Patent—English patent No. 11076, granted Wm. Greener and Wm. E. Staite 1846.	4260	2644
Defendant's Exhibit Shepard English Patent—English patent No. 13302, granted Edward C. Shepard 1850.	4266	2648
Defendant's Exhibit Slater & Watson English Patent—English patent No. 212, granted Thomas Slater and Joseph J. W. Watson 1852	4284	2659
Defendant's Exhibit Roberts English Patent—English patent No. 14198, granted Martyn John Roberts 1852	4310	2670
Defendant's Exhibit Binks English Patent—English patent No. 119, granted Christopher Binks 1853	4330*a*	2686
Defendant's Exhibit English Patent No. 2547 of 1856—English patent granted John Thomas Way	4330*r*	2693
Defendant's Exhibit Harrison English Patent—English patent No. 588, granted Charles W. Harrison 1857	4335	2697
Defendant's Exhibit Burleigh & Danchell's English Patent—English patent No. 3164, granted Benjamin Burleigh and Frederick L. Danchell December 24, 1857	4353	2709
Defendant's Exhibit Way English Patent—English patent No. 2841, granted John Thomas Way November 10, 1857	4361	2713
Defendant's Exhibit Konn's English Patent—English Patent No. 3809, granted Stanislas W. Konn December 16, 1872.	4376	2719
Defendant's Exhibit Konn's English Patent—English patent No. 91, granted Stanislas W. Konn January 8, 1873	4384	2723
Defendant's Exhibit Kosloff's English Patent—English patent No. 441, granted Stephen A. Kosloff February 5, 1875	4394	2727
Defendant's Exhibit Jansen (Konn's) English Patent—English patent No. 970, granted Peter Jansen March 16, 1875	4410	2734
Defendant's Exhibit Werdermann English Patent—English patent No. 4805, granted Richard Werdermann December 12, 1876	4417	2738
Defendant's Exhibit English Patent No. 4905 of 1876—English patent granted Samuel Alfred Varley December 19, 1876	4423	2742
Defendant's Exhibit Edison English Patent—English patent No. 2402, granted Thomas A. Edison June 17, 1879	4461	2759
French patent No. 97583 to Lodyguine & Co.	4481	2782
Complainant's Exhibit Cut of King Lamp	4489	2784
Stipulation as to cut of King lamp	4489	2784
Stipulation as to exhibits, &c.	4490	2785
Opinion of Mr. Justice Bradley	4492	2786
Final decree	4513	2797
Prayer for and allowance of appeal	4514	2797
Bond	4515	2797
Consent to substitution of solicitors for complainant	4517	2799
Certificates to record	4518	2799
Citation	4519	2800
Proof of service of citation	4520	2800

ANALYTICAL INDEX.

PLEADINGS, ETC.

	Original.	Print.
Equity docket entries	1	1
Bill of complaint	14	7
Chancery subpœna	22	11
Demurrer to bill	24	12
Opinion and order on demurrer	27	13
Answer	29	14
Replication	42	22
Opinion of the court	4492	2786
Final decree	4513	2797
Appeal	4514	2797
Bond on appeal	4515	2798
Citation	4519	2800

STIPULATIONS AND ORDERS, ETC.

	Original.	Print.
Order assigning time for taking testimony	43	23
Order fixing time for taking complainant's testimony in reply and appointing H. D. Gamble examiner	44	23
Stipulation extending time for closing complainant's testimony in reply	45	23
Proof of service of notice of motion for time in which to take defendant's testimony	46	24
Opinion and order on above motion	47	24
Motion for an extension of time for taking defendant's testimony and order thereon	48	25
Order permitting defendant to take testimony to impeach testimony of Wm. H. Church	49	25
Stipulation respecting appointment of John H. Kitchen examiner on part of defendant	50	26
Order appointing John H. Kitchen examiner on part of defendant	51	26
Appointment of Wm. T. Farnham examiner on part of complainant	52	27
Order appointing Wm. T. Farnham examiner on part of defendant	53	27
Stipulation respecting appointment of Wm. T. Farnham examiner on part of defendant	54	28
Appointment of John A. Shields examiner on part of complainant	56	28
Stipulation as to Herald article of December 21, 1879	134	78
Stipulation that Edison Electric Light Co. is privy to this suit	242	146
Stipulation that Wm. E. Sawyer died before the commencement of this suit	242	146
Stipulation as to deposition of Thos. A. Edison taken in interference case	436	274
Stipulation as to deposition of Charles Batchelor taken in interference case	574	365
Stipulation as to the omission of certain exhibits from the record on appeal	4490	2785
Consent of Broadnax & Bull to the substitution of Kerr & Curtis as solicitors for complainant	4517	2799

COMPLAINANT'S WITNESSES.

	Original.	Print.
Beith, George S.	1799	1140
Cross	1801	1141
Berry, Edward	2320	1465
Cross	2321	1466
Broadnax, Amos	138	80
Cross	160	94
Recalled	2319	1464
Bull, J. Edgar	246	148
Church, Wm. H	2280	1439
Cross	2288	1444
Redirect	2295	1448
Recross	2297	1450
Re-redirect	2314	1461
Cross, Charles R	1825	1156
Cross	1888	1193
Redirect	1964	1235
Garden, Hugh R	1804	1143
Cross	1810	1147
Griffin, Walter K	2233	1409
Hayes, Edwin L	1784	1130
Cross	1789	1133
Hennessy, David	1794	1136
Ives, Ida Man	1766	1119
Cross	1769	1122
Knowles, Edward R.	1814	1149
Cross	1815	1150
Man, Albon	1041	671
Deposition in New York case	1043	672
Cross	1075	692
Redirect	1571	1008
Recross	1588	1018
Re-redirect	1641	1052
Re-recross	1643	1053
Recalled	1646	1055
Cross	1701	1082
Redirect	1718	1092
Morton, Henry	1974	1241
Cross	2059	1296
Redirect	2083	1312
Muller, Hans J.	1776	1125
Cross	1781	1128
Packard, James W	2181	1375
Cross	2185	1377
Redirect	2228	1406
Recross	2231	1408
Pope, Franklin L.	58	30
Cross	67	35
Redirect	110	63
Recross	112	64
Recalled	2234	1410
Cross	2325	1468

	Original.	Print.
Redirect	2376	1502
Recross	2387	1509
Robertson, John M	2278	1438
Rowe, Edward	1797	1138
Sawyer, Tillie J	2392	1513
Cross	2397	1517
Sawyer, William (deposition in interference suit)	249	150
Cross	258	156
Redirect	264	159
Recross	265	161
Sawyer, William E. (deposition in interference suit)	266	161
Cross	273	166
Redirect	280	170
Shallenberger, Oliver B	2085	1313
Cross	2115	1332
Redirect	2157	1359
Smith, Frank Stuart	2159	1360
Cross	2168	1366
Redirect	2171	1368
Stillman, Thomas B	1731	1099
Cross	1748	1108
Redirect	1765	1118
Recalled	2172	1368
Cross	2174	1370

DEFENDANT'S WITNESSES.

Barker, George F	135	79
Continued	801	514
Cross	843	541
Recalled	852	547
Cross	857	550
Batchelor, Charles	574	365
Cross	591	377
Redirect	611	390
Recalled	613	391
Cross	638	407
Redirect	662	423
Brackett, Cyrus F	693	443
Cross	759	486
Redirect	783	502
Recalled	788	505
Broadnax, Amos	901	579
Cross	906	582
Dyre, Philip S	1021	657
Cross	1022	658
Redirect	1026	660
Dyre, Richard N	2399	1518
Cross	2415	1528
Edison, Thomas A. (deposition)	437	274
Cross	470	296
Redirect	515	326
Recross	564	359

	Original.	Print.
Re-redirect	569	362
Re-recross	569	362
Force, Martin R	964	620
Cross	966	621
Field, Stephen D	1000	644
Griffin, Walter K	432	271
Galloway, R. M	1031	664
Garden, Hugh R	917	590
Cross	925	595
Goddard, Calvin	1027	661
Cross	1031	664
Hays, Jacob	907	583
Cross	909	585
Hockhausen, William	332	204
Cross	341	211
Redirect	356	221
Recross	360	223
Re-redirect	360	224
Recalled	913	587
Recalled	916	589
Cross	917	590
Holzer, William	893	574
Cross	894	575
Redirect	899	579
Johnson, Edward H	971	624
Cross	973	626
Kruesi, John	975	627
Cross	976	628
Redirect	979	630
Recalled	996	641
Cross	998	642
Keating, John, M. D	325	200
Cross	328	202
Redirect	330	203
Recross	330	203
Recalled	433	272
Lowry, Grosvenor P	1033	665
Cross	1037	668
Man, Albon	915	588
O'Keeffe, James E	1013	652
Cross	1014	652
Redirect	1015	653
Potter, James D	1012	651
Russell, James A	1010	650
Cross	1011	651
Sawyer, George W	286	173
Cross	308	188
Sawyer, William	1007	648
Cross	1010	650
Sharp, William	362	224
Cross	386	241
Redirect	424	265
Recross	430	270

	Original.	Print.
Stillman, Thomas B.	1002	645
Cross	1005	646
Tomlinson, John C.	2432	1539
Cross	2446	1548
Upton, Francis R	979	630
Cross	990	637
Recalled	1016	654
Vineing, Henry E.	665	425
Cross	688	440
Wilson, William P	861	553
Cross	883	568
Wright, James Hood	1038	668
Cross	1040	670

COMPLAINANT'S EXHIBITS.

PATENTS.	Orig'l.	Print.	Original.	Print.
	OFFERED.		COPIED.	
Complainant's patent in suit	57	29	2804	1795
Edison patent No. 1, being No. 214,636	281	170	2706	1703
No. 2, being No. 214,637	281	170	2709	1705
No. 3, being No. 218,866	281	170	2712	1707
No. 4, being No. 219,628	281	170	2714	9
No. 5, being No. 224,329	281	170	2716	11
No. 6, being No. 227,227	281	170	2718	13
No. 7, being No. 227,228	281	170	2721	16
No. 8, being No. 227,229	281	170	2724	19
Sawyer's dynamo-machine patent No. 237,632	1666	1060	4073	2511
Sawyer-Man soapstone switch patent No. 229,476	1667	1061	2764	1752
switch patent No. 210,152	1667	1061	2768	1755
regulator patent No. 205,305	1668	1061	2781	1768
reissue patent No. 10134	1668	1061	2772	1759
electric meter patent No. 210,151	1669	1062	2785	1773
hydrocarbon treatment patent No. 211,262	1857	1174	2512	1591
Edison's patent No. 238,868	1871	1183	2727	1723
No. 248,417	1871	1183	2730	1725
Lane-Fox British patent No. 3988 of 1878	2054	1293	2733	1727
No. 4043 of 1878	2054	1294	2741	1734
No. 4626 of 1878	2054	1294	2747	1740
No. 1122 of 1879	2054	1294	2759	1745
Lichtenstadt patent (U. S.) No. 41627	2056	1295	2492	1578
Heaton patent No. 68863	2056	1295	2494	1579
Russell & Howland patent No. 70474	2056	1295	2505	1587
Robbins & Southmayd patent No. 87295	2056	1295	2509	1589
Sawyer & Man British patent No. 4705 of 1878	2378	1504	2789	1777
Comp. Ex. No. 22—Edison's patent No. 341,644		....	3692	2282
No. 23—Edison's patent No. 263,878		....	3697	2291
No. 24—Edison's patent No. 264,657		....	3701	2293
No. 25—Edison's Canadian patent No. 11968		....	3707	2295
No. 30—Edison's Canadian patent of December 17, 1888		....	3763	2325

DOCUMENTS.	Orig'l.	Print.	Original.	Print.
	OFFERED.		COPIED.	
Sawyer-Man assignment of October 14, 1878	57	29	113 3659	65 2269
January 9, 1880	57	29	115 3661	66 2270
Electro-Dynamic Light Co. assignment of April 6, 1881	58	29	115 3662	66 2271
Church assignment of April 6, 1881	58	29	120 3667	69 2274
Eastern Electric Mfg. Co. assignment of Sept. 30, 1882	58	29	124 3673	72 2277
Sawyer-Man assignment of April 5, 1881	58	29	130	76
Patent Office proceedings No. 1	243	146	2811	1799
Being file-wrapper and contents of application for patent in suit, consisting of the following:				
Petition			2812	1799
Specification			2813	1800
Oath			2816	1801
Power of attorney and associate power of attorney			2818	1802
Office letter *in re* amendments			2819	1803
Amended specifications and claims			2821	1804
Official letter *in re* amended claims, &c			2825	1807
Declaration of interference			2827	1807
Patent Office proceedings No. 2	243	146	2829	1808
Being file-wrapper and contents of Edison's application for a patent, as follows:				
Petition			2830	1808
Specifications and claims			2832	1809
Office letter rejecting claims			2837	1812
Letter amending claims			2838	1813
Associate power of attorney appointing Dyer & Wilbur			2839	1813
Amendments			2840	1813
Declaration of interference with Sawyer & Man's application			2841	1814
Edison's amendment dividing his application			2843	1815
Patent Office proceedings No. 3	243	146	2891	1835
Edison's petition to amend preliminary statement			2891	1835
Affidavit of Edison accompanying motion papers			2893	1836
Charles Batchelor accompanying papers			2896	1837
Z. F. Wilbur accompanying papers			2898	1838
Office letter extending time for taking testimony			2904	1858
Office letter fixing time for hearing Edison's motion for leave to amend preliminary statement			2898	1838
Office letters *in re* motion			2902	1839
Office letters extending times for taking testimony			2903	1840
Proofs on behalf of Sawyer & Man			2911	1843
First deposition of Albon Man			2912	1843
William H. Church			2936	1858
William Sawyer			2958	1870
Deposition of Amos Broadnax			2977	1880
Lawrence Myers			2981	1882

	Orig'l.	Print.	Original.	Print.
	Offered.		Copied.	
Deposition of William E. Sawyer			2986	1884
George W. Sawyer			3003	1894
Rebutting testimony on behalf of Sawyer & Man			3007	1896
Second deposition of William H. Church			3007	1896
Second deposition of Albon Man			3025	1907
Notary's certificate to testimony on behalf of Sawyer & Man			3031	1911
Exhibits introduced on behalf of Sawyer & Man, viz:				
No. 1—Drawing			2939	1860
No. 2—Drawing			2946	1863
No. 3—Drawing			2933	1856
No. 4—Drawing			2966	1875
No. 5—Drawing			2982	1883
No. 6—Drawing			2989	1886
No. 7—Drawing			2996	1890
Proofs on behalf of Edison			3032	1912
Notice to take testimony			3032	1912
First deposition of Thomas A. Edison			3034	1912
Stipulation concerning patent put in evidence			3128	1965
Deposition of Martin W. Force			3148	1974
Edward H. Johnson			3155	1978
John Kruesi			3160	1982
—— Upton			3165	1985
Second deposition of John Kruesi			3197	2017
Second deposition of Thomas A. Edison			3201	2019
Deposition of Charles Batchelor			3209	2024
Stephen D. Field			3257	2051
T. B. Stillman			3260	2052
William Sawyer			3268	2055
James A. Russell			3272	2057
James E. O'Keeffe			3276	2059
Notary's certificate			3279	2061
Exhibits introduced on behalf of Edison:				
Edison's Exhibit No. 1—Drawing			3039	1916
No. 2—New York Herald			3046	1919
No. 3—Record of lamps			3134	1968
No. 4—Drawing			3050	1922
No. 5—Drawing			3053	1923
No. 6—Drawing			3061	1926
No. 7—Note book			3145	1973
No. 8—Article from New York Sun			3146	1973
No. 9—Drawing			3096	1946
No. 10—Sheets from Scribner's			3183	1996
No. 11—Record of lamps			3280	2062
No. 13—Drawings			3079	1937
No. 14			3212	2026
No. 23—Draft of article of Sawyer sent to New York Sun			3262	2054
No. 24—Draft of note			3264	2054
No. 25—Sawyer's challenge			3291	2067
Office letter			3292	2068

	Orig'l.	Print.	Original.	Print.
	Offered.		Copied.	
Notice of decision in favor of Sawyer & Man on question of priority of invention			3293	2068
Decision of examiner of interference in favor of Sawyer & Man			3295	2069
Z. F. Wilbur appointed sole attorney			3298	2071
Patent Office proceedings No. 4	243	147	2848	1817
Being file-wrapper and contents of interference proceedings, Sawyer & Man *vs.* Edison.				
Declaration of interference			2852	1817
Drawings accompanying Edison's application			2849	1817
Drawings accompanying Sawyer & Man's application			2851	1817
Preliminary statement of Sawyer & Man			2853	1818
Preliminary statement of Edison			2855	1819
Office letter requiring Sawyer & Man to amend their statement			2856	1819
Office letter requiring Edison to amend his statement			2857	1820
Amended statement of Man			2859	1821
Amended statement of Edison			2860	1821
Official fixing of time for putting in testimony and proofs			2861	1822
Stipulation extending time for taking testimony			2863	1823
Office letter extending time, as per stipulation			2864	1823
Office letter resetting times for putting in proofs			2866	1824
Power of attorney appointing Amos Broadnax attorney for Sawyer & Man in place of Baldwin, Hopkins & Peyton			2867	1824
Office letter notifying parties of Broadnax's appointment			2868	1825
Notice of Sawyer & Man's motion to dissolve interference			2869	1825
Official letter denying motion to dissolve			2870	1826
Notice of appeal to the Commissioner in person			2872	1827
Letter setting day for hearing appeal			2873	1827
Notice of Sawyer & Man's motion to postpone times for taking testimony until after decision of Commissioner			2874	1827
Affidavit of Amos Broadnax			2875	1828
Motion to postpone times granted			2877	1829
Notice of decision by Commissioner denying motion to dissolve			2879	1829
Decision of Commissioner denying motion to dissolve			2880	1830
Letter fixing hearing			2882	1831
Notice of motion for extension of time for putting in testimony			2883	1831
Affidavit of Amos Broadnax			2884	1832
Letter granting motion for extension of time			2885	1833
Letter *in re* stipulation to extend time			2889	1834
Patent Office proceedings No. 5	243	147	3518	2194
Supplemental proofs in reply on behalf of Edison			3519	2194
Notice of taking testimony			3520	2195
Second deposition of F. R. Upton			3521	2195
Deposition of Philip S. Dyer			3526	2198
Notary's certificate			3533	2202

	Orig'l.	Print.	Original.	Print.
	Offered.		Copied.	
Notice of decision of examiner of interference in favor of Sawyer & Man as to priority of invention			3534	2203
Decision			3537	2203
Patent Office proceedings No. 6	243	147	3299	2071
Edison's motion to reopen interference.				
Notice of motion			3300	2072
Letter of S. B. Eaton to Commissioner of Patents			3301	2072
Letter of Z. F. Wilbur to Commissioner of Patents			3302	2073
Affidavit of Z. F. Wilbur			3304	2074
Affidavit of George W. Dyer			3307	2075
Exhibit A—Sawyer letter to Herald of Dec. 24, 1879			3308	2076
B—Letter of Sawyer to Herald of Jan. 5, 1880			3310	2077
C—Letter of Sawyer to Herald of Jan. 6, 1880			3311	2077
Affidavit of Thos. Johnson			3311	2078
Exhibit D—Affidavit of W. E. Sawyer			3313	2078
Affidavit of Anthony Arnoux			3313	2079
Notice of postponement of hearing			3315	2079
Patent Office proceedings No. 7	244	147	3316	2080
Affidavits read on Edison's motion to reopen interference:				
Affidavit of Wm. E. Sawyer			3316	2080
Robert Street			3318	2081
Wm. E. Sawyer			3319	2081
Rob't Street and C. S. Whitmore			3321	2082
G. C. Thatcher			3322	2083
Norvin Green			3323	2083
S. B. Eaton			3324	2084
Draft of affidavit of W. E. Sawyer and memorandum by Z. F. Wilbur			3330	2088
Letter of W. E. Sawyer			3332	2088
Affidavit of G. P. Lowry			3332	2089
Z. F. Wilbur			3337	2091
Wm. E. Meadowcroft			3338	2092
R. N. Dyer			3338	2092
Chas. E. Chinnock			3339	2092
Seigmund Bergman			3341	2093
Thos. A. Edison			3347	2097
Letter of Sawyer to Edison			3349	2098
Affidavit of E. P. Tabri			3350	2099
Calvin Goddard			3351	2099
Z. F. Wilbur			3352	2100
Philip H. Klein, Jr., and exhibits attached			3361	2105
W. E. Sawyer *in re* Bergman's offer, &c.			3371	2110
Rob't Street			3372	2111
Patent Office proceedings No. 8	244	147	3373	2111
In re decision of Commissioner of Patents granting Edison's motion to open interference			3374	2112
Letter setting time for taking testimony			3379	2115
Letter, *in re* stipulation extending time for putting in testimony			3380	2115

	Orig'l. Offered.	Print. Offered.	Original. Copied.	Print. Copied.
Notice of motion of Sawyer & Man to have deposition of A. Walsh and Rob't White received as evidence to rebut testimony on behalf of Edison under Commissioner's order to open case			3388	2119
Motion			3389	2120
Affidavit of Amos Broadnax on said motion			3389	2120
Decision of Commissioner granting motion			3390	2120
Supplemental proofs on behalf of Edison			3395	2123
Sawyer's book entitled Electric Lighting by Incandescence and three copies of New York Herald			3395	2123
Supplemental proofs on behalf of Sawyer & Man			3398	2124
First deposition of Alexander Walsh			3398	2124
Second deposition of Alexander Walsh			3419	2137
Third deposition of Albon Man			3429	2142
Offers of assignments, &c.			3442	2150
Third deposition of Wm. H. Church			3458	2160
Deposition of Rob't White			3471	2168
Edward R. Knowles			3479	2173
Agreement between Wm. E. Sawyer and A. Man			3488	2178
Agreement between Wm. E. Sawyer and A. Man			3490	2179
Assignment, W. E. Sawyer to A. Man			3493	2181
Assignment, Sawyer & Man to Electro-Dynamic Light Co.			3496	2182
Assignment, Sawyer & Man to Electro-Dynamic Light Co.			3497	2183
Agreement, Sawyer & Man and Electro-Dynamic Light Co.			3498	2183
Assignment, A. Man to Electro-Dynamic Light Co.			3499	2184
Assignment, Sawyer & Man to Electro-Dynamic Light Co.			3500	2185
Assignment, W. E. Sawyer to Electro-Dynamic Light Co.			3502	2186
Assignment, Sawyer & Man to Electro-Dynamic Light Co.			3504	2187
Assignment, W. E. Sawyer to Electro-Dynamic Light Co.			3506	2188
Assignment, Sawyer & Man to Electro-Dynamic Light Co.			3508	2189
Assignment, W. E. Sawyer to Electro-Dynamic Light Co.			3510	2190
Assignment, Sawyer & Man to Electro-Dynamic Light Co.			3512	2191
General release by W. E. Sawyer to Electro-Dynamic Light Co.			3514	2192
Assignment, W. E. Sawyer to Electro-Dynamic Light Co.			3516	2193
Assignment, Sawyer & Man to Electro-Dynamic Light Co.			3517	2193
Patent Office proceedings No. 9	244	147		
Edison's appeal to the examiners-in-chief			3546	2209
Appeal			3547	2210
Letter fixing time for hearing same			3548	2210
Decision of examiners-in-chief			3549	2211
Letter to Edison			3562	2219
Patent Office proceedings No. 10	244	147	3565	2220
File-wrapper and contents *in re* appeal of Sawyer & Man:				
Letter of W. E. Sawyer to Commissioner			3566	2221
Letter of W. E. Sawyer to Commissioner			3566	2221
Letter of Commissioner to Sawyer			3567	2221
Appeal to Commissioner			3568	2221
Notice of hearing appeal			3569	2222

	Orig'l.	Print.	Original.	Print.
	OFFERED.		COPIED.	
Notice of hearing appeal			3570	2222
Notice of decision of Commissioner			3571	2223
Decision of Commissioner			3572	2223
Brief for Edison on appeal			3594	2227
Appeal to Secretary of the Interior			3595	2227
Dismissal of appeal			3598	2239
Notice to Sawyer & Man of above			3599	2239
Motion for a rehearing before Commissioner			3600	2240
Reasons			3602	2241
Decision overruling same			3606	2243
Notice of above			3611	2246
Letter of Broadnax to Commissioner			3612	2246
Notice, Dyer to Broadnax			3614	2247
Petition of Edison			3615	2247
Affidavit			3618	2249
Stipulation for hearing on above			3619	2249
Decision on Edison's petition			3622	2250
Brief for Sawyer & Man			3624	2251
Amendment of claim of Sawyer & Man			3633	2257
Letter of examiner to Sawyer & Man			3634	2257
Amended specification			3635	2258
Amended specification			3636	2259
Letter, examiner to Sawyer & Man			3637	2259
Letter, Broadnax to examiner			3638	2259
Amendment to specification			3439	2260
Letter of examiner to Sawyer & Man			3644	2263
Amendment			3646	2264
Examiner's letter			3649	2265
Examiner's letter			3650	2266
Amendment to specification			3651	2266
Allowance			3653	2267
Deposition of William Sawyer	248	150	249	150
William E. Sawyer	248	150	266	151
Patent Office proceedings No. 1	248	150	2812	1799
Patent Office proceedings No. 2	249	150	2830	1808
Patent Office proceedings No. 4	249	150	2848	1817
Decisions in file-wrapper and contents, marked Patent Office proceedings No. 10	249	150	3572 3598 3606 3622	2223 2239 2243 2250
Sawyer's Exhibit No. 4	257	155	2966	1875
No. 6	269	163	2989	1886
Electro-Dynamic Light Co. minutes	927	596	929	597
No. 27—Agreement between Sawyer & Man, M'ch 19, '78	1056	680	3757	2322
No. 28—Agreement between Sawyer & Man, May 11, 78	1057	680	3759	2323
Cheever agreement	1646	1055	1721	1094
Sawyer's letter of March 7, 1878	1666	1060	1729	1098
Lowry's letter of October 30, 1878	1678	1067	1723	1095
Lowry's letter of November 2, 1878	1679	1068	1730	1098
Lowry's letter of November 6, 1878	1679	1068	1727	1097
Man's letter to Lowry, October 31, 1878	1681	1070	1725	1096
Stillman record of lamp tests	1741	1103	1740	1107

	Orig'l.	Print.	Original.	Print.
	OFFERED.		COPIED.	
Sawyer-Stillman letter	1747	1107	1765	1119
Hennessy memorandum	1795	1138	1796	1138
Edison, Maxim & Swan interference record	1803	1142	2539	1607
Edison file-wrapper and contents	1804	1143	2638	1671
Certified copy of Dyre & Wilbur letter	1804	1143	2491	1577
Rockwell Kent letter	2284	1441	2283	1441
Tomlinson's telegram	2314	1492	2317	1464
Church letter to Tomlinson			2318	1464
No. 18—Certificate of incorporation, Electro-Dynamic Light Co.			3682	2281
No. 19—Certificate of incorporation, Eastern Electric Manufacturing Co.			3685	2283
No. 20.—Certificate of incorporation, Consolidated Electric Light Co.			3688	3692

PUBLICATIONS.

Scientific American article	1649	1057	2517	1594
Extract from Comptes Rendus of 1844	1698	1081	1967	1237
Philosophical Transactions, No. 1	2055	1294	2467	1562
Philosophical Transactions, No. 2	2055	1294	2481	1571
Penney Encyclopedia extract	2055	1294	2455	1554
Chambers' Encyclopedia extract	2055	1294	2455	1554
Rees' Encyclopedia extract	2055	1294	2458	1555
Ures' Dictionary extract	2055	1294	2458	1555
Dictionnaire Technologique extract	2055	1294	2459	1556
Engineers' and Mechanics' Encyclopedia extract	2055	1294	2460	1557
Nicholson's Encyclopedia extract	2056	1294	2460	1557
Encyclopedia of Chemistry extract	2056	1294	2461	1557
Muspratt's Chemistry extract	2056	1294	2462 2538	1558 1606
Telegraphic Journal article	2057	1295	2465	1560
Extract from Ganot's Physics	2277	1437	2532	1602
Mullen's Physics	2277	1437	2464	1559
Miller's Chemical Physics	2277	1437	2486	1571
Pepper's Cyclopædic Science	2277	1437	2474	1566
Faraday's lectures	2277	1437	2463	1559
Pynchon's Chemical Physics	2277	1437	2472	1565
Philosophical Magazine	2382	1506	2528	1599

DRAWINGS AND SKETCHES.

Broadnax sketch, November 28, 1888	146	86	147	86
Sharp drawings, Nos. 1 and 2	407	254	405	254
Sharp drawing, No. 3	407	254	406	254
Sharp diagram of Walker-street shop	1720	419	419	262
Man's diagram of Centre-street shop	1653	1059	1449	933
Man's diagram of Walker and Elm street shop	1652	1058	1654	1059
Man's drawing of tulip-shaped lamp	1698	1081	1699	1081
Stillman No. 1 (sketch)	1734	1100	1733	1100
No. 2 (sketch)	1734	1100	1736	1100
No. 3 (sketch)	1747	1107	1740	1103
Cut of voltaic arc	1832	1158	1829	1158

	Offered. Orig'l.	Offered. Print.	Copied. Original.	Copied. Print.
Cut of Serrin arc lamp	1832	1158	1830	1158
Cut of Werdermann arc incandescent lamp	1832	1158	1831	1158
Cut of King lamp	1832	1158	1832	1158

MODELS AND SPECIMENS.

	Offered. Orig'l.	Offered. Print.
Broadnax Sawyer-Man lamp No. 1	140	81
Broadnax-Sawyer-Man lamp No. 2	148	86
Broadnax treating apparatus	148	86
No. 26—Excelsior, broom-corn, and manilla	1050	676
No. 29—Globe of lamp	1060	682
Grugru palm	1573	1009
Mangrove	1573	1009
East India cane	1585	1017
Globes with labels	1609	1032
New York Lumber Co. lamp	1800	1140
United States zig-zag lamp	1821	1153
United States M-shaped lamp	1821	1153
Thompson-Huston lamp	1853	1172
Bernstein lamp	1853	1172
Bamboo basket No. 1	2057	1295
Bamboo basket No. 2	2057	1295
Bamboo tray	2057	1295
Sawyer-Man Lamp No. 1—Paper carbon	2095	1319
No. 2—Paper carbon	2095	1319
No. 3—Willow carbon	2095	1319
No. 4—Silk carbon	2095	1319
No. 5—Silk-thread carbon	2095	1320
No. 6—Piazava carbon	2095	1320
Ash lamp	2098	1321
Hickory	2098	1321
Linwood	2098	1321
Broom-corn	2098	1321
Piazava	2098	1321
Palmetto	2098	1321
Rattan	2098	1321
Ixtli	2098	1321
Manilla fibre	2098	1321
Hemp cord	2098	1321
Linen thread	2098	1321
Bamboo paper	2098	1321
Linen-thread carbon	2106	1326
Piazava carbon	2106	1326
Linen-twine carbon	2106	1326
Silk carbon	2106	1326
Carre carbon	2106	1326
Blotting-paper carbon	2108	1327
Linwood	2114	1331
Rattan	2114	1331
Piazava	2114	1331
Ixtl or Mexican grass	2114	1331
Bamboo paper	2114	1331

	Orig'l.	Print.	Original.	Print.
	Offered.		Copied.	
Split bamboo	2114	1331		
Sawyer-Man lamp stop-cock	2157	1359		
Stillman lamp	2171	1368		
Packard-Sawyer-Man Lamp No. 1, with bamboo carbon	2183	1376		
No. 2, with paper carbon	2183	1376		
No. 3, with willow carbon	2183	1376		
Packard bulb lamp	2183	1376		
Lancewood, produced by Berry	2320	1465		
Greenheart	2320	1465		
Bamboo	2321	1466		
Sawyer-Man switch	1667	1060		

Defendant's Exhibits.

PATENTS.

Sawyer-Man patent No. 210,152	217	130	2768	1755
210,809	217	130	4100	2538
211,262	217	130	2512	1591
229,335	217	130	4119	2556
229,476	217	130	2764	1752
205,144	217	130	4088	2524
205,303	217	130	4094	2531
205,305	217	130	2781	1768
10,134	217	130	2772	1759
Edison patent No. 224,329	514	325	2716	1711
227,227	514	325	2718	1713
227,228	514	325	2721	1716
227,229	514	325	2724	1719
223,898	514	325	4110	2549
English patent 2402 of 1879	514	325	4461	2759
Sawyer-Man patent No. 205,144	514	325	4088	2524
210,152	514	325	2768	1755
210,809	514	325	4100	2538
219,771	514	325	4103	2543
211,262	514	326	2512	1591
229,335	514	326	4119	2556
227,118	514	326	4113	2553
Edison patent 223,898	529	335	4110	2549
227,229	529	335	2724	1719
Edison bamboo patent 251,540	540	342	4129	2566
Pinkus English patent No. 8644 of 1840	798	512	4150	2584
DeMoleyns English patent No. 9053 of 1841	798	512	4241	2631
King's English patent No. 10919 of 1845	798	512	4253	2640
Greener & Staite English patent No. 11076 of 1846	798	512	4260	2644
Staite English patent No. 12212 of 1848	798	512	4188	2610
Shepard's English patent No. 13302 of 1850	798	512	4266	2624
Slater & Watson English patent No. 212 of 1852	799	512	4284	2659
Roberts English patent No. 14198 of 1852	799	512	4310	2670
Binks English patent No. 119 of 1853	799	512	4330*a*	2686
Ways English patent No. 2547 of 1856	799	512	4330*e*	2693
Harrison English patent No. 588 of 1857	799	512	4335	2697

	Orig'l.	Print.	Original.	Print.
	Offered.		Copied.	
Burleigh & Danchell's English patent No. 3164 of 1857	799	512	4353	2709
Ways English patent No. 2841 of 1857	799	512	4361	2713
Konn English patent No. 3809 of 1872	799	512	4376	2719
Konn English patent No. 91 of 1873	799	512	4384	2723
Kosloff English patent No. 441 of 1875	799	512	4394	2727
Jenson's English patent No. 970 of 1875	799	512	4410	2734
Werderman's English patent No. 4805 of 1876	799	513	4417	2738
Varley's English patent No. 4905 of 1876	799	513	4423	2743
Gardiner & Blossom patent No. 20706	799	513	4078	2514
Kosloff patent No. 166,877	799	513	4081	2518
Woodward patent No. 181,613	799	513	4085	2521
Le Mott's patent No. ——— of 1849	799	513	3930	2423
Gaduin patent No. ——— of 1876	843	541	3915	2415
Gaduin patent No. ——— of 1877	843	541	3919	2417
Sawyer-Man patent No. 205,144	1139	734	4088	2524
205,303	1139	734	4094	2531
205,305	1139	734	2781	1768
210,152	1139	734	2768	1755
210,809	1139	734	4100	2538
211,262	1139	734	2512	1591
Albon Man patent No. 227,118	1140	734	4113	2553
Sawyer-Man patent No. 229,335	1140	735	4119	2556
Sawyer-Man patent No. 229,476	1140	735	4121	2559
Lodyguine French patent No. 97583	1909	1206	4481	2782
Edison's distribution patent No. 264,642	2342	1480	4131	2568
266,793	2342	1480	4137	2573
369,280	2342	1480	4141	2580
Swan patent No. 233,445	2376	1502	4125	2580

DOCUMENTS.

Herald article of December 21, 1879	135	78	4031	2482
Keating book	435	273	435	273
Edison's Exhibit No. 2—(Herald article)	447	281	3046	1808
No. 3—(Note book)	449	282	3896	2401
No. 5—(Notes)	452	284	4051	2497
No. 7—(Notes)	459	288	3902	2406
No. 8—(Sun article)	467	294	3903	2407
No. 13	519	329	4018	2476
No. 14—(Notes)	576	366	4019	2476
Batchelor Note Book No. 52 (original to be produced)	617	393		
Broadnax-Cheever letter	905	582	3787	2336
Electro-Dynamic Light Co. record	920	591	922	593
Baldwin-Wallace letter	962	619	962	618
Interference stipulation	963	619	963	619
Edison's Exhibit No. 11—(Record of lamps)	987	635	3906	2408
No. 12—(Memorandum book, original to be produced)	998	642		
No. 23—(Letter)	1004	646	4020	2476
No. 24—(Letter)	1004	646	4022	2476
No. 25—Edison's challenge to Sawyer	1005	647	3913	2414
Man-Cheever letter of January 5, 1880	1095	705	1102	709

	Orig'l.	Print.	Original.	Print.
	Offered.		Copied.	
Cheever-Man letter of January —, ——,	1114	717	1097	706
January 7, 1880	1114	717	1101	708
Second Cheever-Man letter of January 7, 1880	1114	717	1102	709
Cheever-Man letter of January 20, 1880	1114	717	1101	708
January 26, 1880	1114	717	1099	707
February 26, 1880	1114	717	1099	707
March 27, 1880	1115	717	1100	708
May 12, 1880	1115	717	1099	707
June 22, 1880	1115	717	1098	707
July 24, 1880	1115	717	1098	707
September 30, 1880	1115	717	1097	707
Baldwin-Cheever telegram, January 6, 1880	1115	718	4489	2784
Second Baldwin-Cheever telegram, January 6, 1880	1116	718	4489	2784
Baldwin, Hopkins & Peyton Cheever Telegram, January 7, 1880	1116	718	4489	2784
Baldwin-Cheever telegram, January 5, 1880	1116	780	4489	2784
Cheever-Baldwin telegram, January 6, 1880	1116	780	4489	2784
Baldwin-Cheever telegram, January 7, 1880	1116	780	4489	2784
Baldwin-Wallace letter, January 8, 1880	1116	780	962	618
Memorandum of agreement, January 8, 1880	1116	780	1721	1094
Broadnax-Cheever letter, January 8, 1880	1116	780	3787	2336
Arnoux & Hochhausen-Cheever letter, January 9, 1880	1116	780	3786	2336
Horseshoe-Cheever bill, February 1, 1880	1117	718	4489	2784
Baldwin, Hopkins & Peyton-Cheever bill	1117	719	4489	2784
Baldwin-Cheever letter, April 27, 1880	1117	719	4489	2784
April 27, 1880	1117	719	4489	2784
April 17, 1880	1117	719	4489	2784
Pope-Cheever letter, May 12, 1880	1117	719	4489	2784
Baldwin-Man letter, September 27, 1880	1117	719	4489	2784
Man-Cheever letter, December 12, 1880	1117	719	3788	2337
Herald article, December 21, 1879	1134	730	4013	2476
January 5, 1880	3781	2334	3790	2338
January 6, 1880	3781	2334	3791	2338
Dynamo bill	1154	744	4489	2784
Accounts and Jay lease	1184	762	4489	2784
Flanigan agreement of December 16, 1887	1550	994	4489	2784
Accounts of Flanigan's disbursements, December 16, 1887	1550	994	4489	2784
Sawyer-Man-Kieth record	1570	1007	4489	2784
Sawyer-Man-Maxim record	1570	1007	4489	2784
Sawyer-Man-Weston record	1570	1007	4489	2784
Man-Cheever letter of December 12, 1880	1717	1092	4490	2785
Prof. Cross' report of 1881, No. 1	1964	1235	3926	2420
No. 2	1964	1235	3929	2422
Church statement of facts	2314	1461	2315	1462
Sawyer's World letter	2374	1501	2360	1491
Bennett & Valon report			2367	1496
Sharp's statement			3806	2347

PUBLICATIONS.

	Offered.		Copied.	
	Orig'l.	Print.	Original.	Print.
Herald article, December 21, 1879	135	70	4031	2482
Keating book	435	273	435	273
Edison's Exhibit No. 2—(Herald article)	447	281	3046	1808
No. 8—(Sun article)	467	294	3903	2407
Philosophical transactions, paper No. 1	796	510	3840	2368
Paper No. 2	796	510	3846	2371
Paper No. 3	797	511	3856	2377
Paper No. 4	797	511	3857	2378
Paper No. 5	797	511	3870	2386
Paper No. 6	797	511	3882	2393
Extracts from collected works of Sir Humphrey Davy, being four offers	797	511	3814 3817 3821 3825	2352 2353 2355 2358
Violette paper	798	511	3893	2400
Sidot paper	798	511	3923	2419
Extracts from Watts' Dictionary of Chemistry	798	511	3829 3831	2360 2362
Extracts from Mechanics' Magazine of 1846	799	513	3832	2362
Published description of Ladiguin's electric light	799	513	3890	2398
Edison's Exhibit No. 10—(Article from Scribner's)	986	635	3949	2431
Herald article of January 5, 1880	3781	2334	3790	2338
Herald article of January 6, 1880	3781	2334	3791	2338
Scribner's Monthly of July 8, 1887	1134	730	3183	1996
Higgs' translation of Fontaine's book	1936	1217	4041	2489
Fontaine's book	1936	1217	3963	2453
Morton's paper on electric light, of April 24, 1889	2080	1310	4023	2559
Sanitary Engineer and interview	2082	1311	3796	2341
Morton's interview in New York Tribune, Nov. 25, 1880	2082	1311	3801	2344
Morton's Sanitary Engineer interview in New York Times	2082	1311	3798	2342
Tribune interview of January 2, 1880	2374	1501	2352	1486
Extract from Prescott's book	2374	1501	2358	1490
Du Moncel's electric lighting	2374	1501	2359	1491
Ferguson's Electricity	2374	1501	2350	1485
Preece Philosophical Magazine article	2374	1501	2366	1495
Preece Electrician extract	2375	1501	2366	1495
Tyndall extract	2375	1501	2366	1495
Bennett & Valon report	2375	1501	2367	1496
Redwood extract	2375	1501	2367	1496
Engineering extracts	2375	1502	2367	1496
Engineering extracts	2375	1502	2368	1497
Engineering extracts	2375	1502	2368	1497
Engineering extracts	2375	1502	2368	1497
Engineering extracts	2375	1502	2369	1497
Engineering extracts	2375	1502	2369	1498
Engineering extracts	2375	1502	2370	1498
Engineering extracts	2375	1502	2370	1498
Thompson extract	2375	1502	2369	1498
Weisendanger English Mechanic extract	2376	1502	2369	1498
Telegraphic Journal extract	2376	1502	2372	1500

	Offered. Orig'l.	Offered. Print.	Copied. Original.	Copied. Print.
Sawyer-Man Scientific American article, No. 1	3784	2336	3792	2339
No. 2	3784	2336	3934	2424
No. 3	3785	2336	3793	2339
No. 4	3785	2336	3795	2340
Times article of October 30, 1878			3945	5429

DRAWINGS AND SKETCHES.

	Offered. Orig'l.	Offered. Print.	Copied. Original.	Copied. Print.
Edison's Exhibit No. 1—Sketch	442	277	3039	1916
No. 4—Sketch	451	283	4014	2476
No. 6—Sketch	458	288	4016	2476
No. 9—Sketch	486	306	4017	2476
Wilson drawing No. 1	892	574	4003	2476
No. 2	892	574	4004	2476
No. 3	892	574	4005	2476
No. 4	892	574	4006	2476
No. 5	892	574	4007	2476
No. 6	892	574	4008	2476
No. 7	892	574	4009	2476
No. 8	892	574	4010	2476
No. 9	892	574	4011	2476
Man sketch No. 1	1338	864	1318	864
No. 2	1343	867	1498	963
No. 3	1350	871	1349	871
Man drawing	1499	963	1446	931

MODELS AND SPECIMENS.

	Offered. Orig'l.	Offered. Print.
Edison's Exhibit First Incandescent Lamp	450	283
Commercial Incandescent Lamp	455	286
No. 15—Model	583	371
No. 16—Specimen	590	375
No. 17—Specimen	590	376
No. 18—Specimen	590	376
No. 19—Specimen	590	376
No. 20—Specimen	590	376
No. 21—Specimen	591	376
No. 22—Specimen	591	376
Wilson rock-elm specimen	870	559
Wilson maple specimen	892	574
Sawyer Man Electric Company's lamp No. 1	1704	1083
No. 2	1704	1083
Experimental lamp	1712	1089
Specimen of lignite	2079	1309

1 Among the rolls, records, and judicial proceedings had in the circuit court of the United States in and for the western district of Pennsylvania, in equity, wherein The Consolidated Electric Light Company is complainant and The McKeesport Light Company is defendant, may be found the following words and figures, to wit:

Equity Docket Entries.

THE CONSOLIDATED ELECTRIC LIGHT COMPANY
v.
McKEESPORT LIGHT COMPANY.

Broadnax & Bull, Thos. B. Kerr, W. Bakewell & Sons, Magnus Pflaum.

Bill filed December 8, 1887.

Same day subpœna issued, returnable first Monday of January next.

1887, Dec. 9.—Subpœna served personally and by copy upon defendant company by giving a true and attested copy thereof to G. L. Reiber, sec'y and treas. thereof, and also on J. R. Gordon, sup't, by leaving a true copy at their office Mar. 5, '90.

1888, Feb'y 4.—Demurrer to bill filed. On motion of defendant's solicitor, order granted extending time for hearing on demurrer until Feb'y 29, 1888.

1888, Feb'y 29.—Demurrer argued. *C. A. V.*

1888, March 17.—Opinion of the court with order overruling demurrer and allowing defendant 30 days to answer, filed. 2

1888, April 21.—Answer of defendant filed.

Same day complainant's replication filed.

1888, April 24.—Order granted allowing complainant until May 24, 1888, to take its evidence in support of its bill; the defendant until and including Aug. 24, 1888, to take its evidence in defence, with leave to move for further time if necessary and with leave to complainant to move for time to take evidence in reply to defendant's evidence, if it so desires, and appointing H. D. Gamble an examiner to take the same, filed. Same day proof of service of notice of above motion filed.

1888, July 28.—Upon stipulation of counsel presented and filed, order granted appointing John K. Kitchen, Esq., special examiner on part of defendant; testimony taken by him in the city of New York to have like force and effect as if taken by one of the standing examiners of this court, filed. Certificate issued.

1888, September 10.—Order granted allowing complainants three months from Oct. 15 to take its rebutting testimony filed.

1888, Sept. 12.—Testimony on part of complainant taken before H. D. Gamble, examiner, and Complainant's Exhibit "Complainant's Patent" filed.

1888, Nov. 28.—William T. Farnham, Esq., notary public
3 of the city of New York, is named to take testimony on part
of the complainant by the clerk, in pursuance of the 67th
rule in equity, as amended, filed.

1889, February 6.—Stipulation extending time for closing complainant's proofs in reply until and including February 15, 1889, filed. Same day proof of service of notice that complainant will move the court on Sat., Feb'y 9, at 10 a. m., to fix a time for hearing this cause filed.

1889, Feb'y 9.—Motion to fix a time for hearing cause made and motion argued and postponed until Saturday, Feb'y 16, 1889.

1889, Feb'y 11.—Notice of application by defendant for two months' time in which to take further testimony, with proof of service of notice and exception to a part as not in accordance with leave of court, filed.

1889, Feb'y 16.—Affidavits of George F. Barker, Edward H. Johnson, Charles J. Kintner, Amos Broadnax, Frank L. Pope, Walter K. Griffin, J. Hood Wright, and Noah Davis filed on defendant's application for time to take testimony, &c., and arguments had on said motion. *C. A. V.*

1889, Feb'y 18.—Opinion and order allowing defendant 30 days to take further testimony and complainant 30 days thereafter to rebut, and that the cause be set down for hearing at the May term.

1889, February 23.—Motion on part of complainant to strike out
questions 3 to 7 from the deposition of George W. Sawyer
4 taken before William T. Farnham, Esq., and motion argued
by counsel for respective parties and the questions held under
consideration by the court. Same day, upon presentation of stipulation and on motion, order granted appointing Wm. T. Farnham, Esq., N. P. of New York city, examiner. Order made *nunc pro tunc* on motion of defendant's solicitor and same filed.

1889, March 14.—Motion on part of defendant for an extension of 10 days for taking testimony and affidavits of G. P. Lowry and W. K. Griffin for motion and T. B. Kerr in opposition thereto, and after arguments and upon consideration order granted extending defendant's time for closing its testimony until March 23, inclusive, and the period of one month heretofore assigned to the plaintiffs to take proofs in reply, to run from the date above mentioned, filed.

1889, March 26.—In pursuance of the 67 rule in equity, as amended, I hereby name Miss Carrie E. Davison, of New York city, commissioner to take testimony on part of complainants and certificate issued.

1889, April 4.—Order granted appointing John A. Shields, Esq., U. S. com. at New York city, an examiner to take testimony on part of complainant. Same day certificate of appointment issued.

1889, April 9.—Depositions taken before Wm. T. Farnham, N. P., at New York, on part of defendant, of George W. Sawyer, filed.

1889, May 4.—Defendant moves the court for an order
5 to enable it to examine John C. Tomlinson and Richard N.
Dyer, referred to in the cross-examination of the witness

William H. Church, and John Kammer and Henry Mayo, referred to in the cross-examination of the witness Packard, at such times and under such conditions as the court may see fit, etc., with affidavit of W. K. Griffin in support of said motion presented and read and proof of service of notice of said motion filed; and, after argument of counsel *pro* and *con.*, order granted allowing defendant until and including May 7 to call and examine John C. Tomlinson and Richard N. Dyer; the examination of said witnesses to be restricted to the contradiction of the answers of the witness Church on cross-examination and as to the alleged interview of said Church with said Tomlinson and Dyer and the statements by him then made, as detailed in said cross-examination.

1889, May 17.—Testimony of Tillie J. Sawyer, on part of complainant, before H. D. Gamble, examiner, at Lehighton, Pa., filed.

1889, May 21.—The following testimony and exhibits on part of *compl't* and respondent filed:

Depositions of George S. Beith, Amos Broadnax (2), J. Edgar Bull, William H. Church, Chas. R. Cross, Hugh R. Garden, Walter K. Griffin, Edward L. Hays, David Hennessy, Ida Man Ives, Edward R. Knowles, Albon Man, Albon Man (int. dep.), Henry Morton, Hans J. Muller, J. W. Packard, F. L. Pope (2), John M.
6 Robertson, Edw. Rowe, Wm. Sawyer, Wm. E. Sawyer, O. B.
Shallenberger, Frank S. Smith, Thos. B. Stillman (2), J. A. Vandergrift, Alice J. Wakins, and the following stipulations: That the Edison Electric Light Co. is privy to this suit and that Wm. E. Sawyer and Wm. Sawyer are dead; and the following exhibits: Interference proceedings and records of Edison and Sawyer & Man, dep. of Wm. E. and Wm. Sawyer in int. case, agreement between Sawyer & Man, Feb. 5, '78; same of March 19, 1878; same of May 11, '78; Cheever-Man correspondence, Ex. dynamo bill, Ex. ac. and Jay lease, Flannigan agreement, Cheever agreement, Sawyer letter of M'ch 7, 1878; Lowry letter of Oct. 30, '78; same of Nov. 2, '78; same of Nov. 6, '78; Man's letter to Lowry of Oct. 31, '78; Stillman's record of lamp tests, Sawyer-Stillman letter of M'ch 5, '79; Hennessy memorandum, Edison, Maxim, and Swan interference record, Edison's file-wrapper & contents in Edison's application, which was in interference with patent in suit; cert. copy of Dyer & Wilbur letter of Oct. 4, '80; Rockwell-Kent letter, Ap'l 9, '79; Herald article, Scientific American article, Higgs' translation of Fontaine's book, Def't's Ex. Fontaine's Book, Def't's Ex. Prof. Cross Report of 1881, Nos. 1 and 2; def't's sanitary eng., Dec. 22, '79; Def't's Ex. Morton Int. N.Y. Tribune, Nov. 25, '80; Penny Encyclopedia extract, Chambers' Encyclopedia extract, Rees' Encyclopedia extract, Ure's Dictionary extract, Dictionaire-Technologique extracts, Engineers' & Mechanics' Enc. extract, Nicholson's Enc. ext., Ency. of Chemistry ext., Muspratt's Chemistry ext., extract from Faraday's Lectures, ext. from Muller's Physics, Telegraphic Journal
7 article, Philosophical Trans. Nos. 1 & 2, extract from Pynchon's
Chemical Physics, extract from Pepper's Cyclopaedia Science, extract from Miller's Chemical Physics, extracts from Phil. Magazine, extract from Garnot's Phisics, cut of voltaic arc light, cut of

Serrin arc lamp, cut of Werdermann arc incandescent lamp, Lichtenstadt U. S. patent, Heaton U. S. patent, Russell & Howland U. S. patent, Robbins & Southmayd U. S. patent, Edison's patents 214,636, 214,637, 218,866, 219,628, 224,329, 227,227, 227,228, 227,229, 238,868, 248,417, Lane-Fox, British, 3988; same, No. 4043; same, No. 4046; same, 1122; Sawyer-Man hydrocarbon treatment patent 201,262, Sawyer's dynamo machine of Feb'y 8, 1881, No. 237,632; Sawyer-Man soapstone switch patent, 229,476; Sawyer-Man switch patent, 210,152; same, regulator patent reissue 10134, orig. regulator patent 205,305, Sawyer-Man electric meter patent 210,151, Sawyer-Man British patent 4705 of '78, Sawyer-Man's patents Nos. 205,144, 205,303, 205,305, 210,152, 210,809, 211,262, 227,118, 229,335, 229,476; Def't's Ex. Lodyguine French Patent, Broadnax sketch, Man sketch, 1, 2, & 3; Man drawing, Man's diagram of Walker & Elm St. shop, Man's diagram of Centre St. shop, Man's drawing of tulip-shaped lamp, Sharp's diagram of Walker-street shop, Stillman Nos. 1, 2, & 3, def't's lamp, Broadnax-Sawyer-Man lamp Nos. 1 & 2, Sawyer-Man's treating apparatus, Exs. Nos. 26 & 29, "grugru palm" and "mangrove," East India cane, globes with labels, Sawyer-Man 8 switch, conductor of tulip-shaped lamp, soapstone or disk of tulip-shaped lamp, Def't's Ex. Sawyer & Man Electric Co.'s Lamp 1 & 2, Def't's Ex. Experimental Lamp Produced by Man, New York Lumber Co. lamp, U. S. zigzag lamp, U. S. M-shaped lamp, Thomson-Huston lamp, Bernstein lamp, bamboo basket Nos. 1 & 2, bamboo tray, Pittsburgh, Sawyer & Man lamp, Nos. 1, 2, 3, 4, 5, & 6; Sawyer & Man's lamp, made according to patent in suit by O. B. Shallenberger; ash lamp, hickory lamp, linwood lamp, broom-corn lamp, Piazava lamp, palmetto lamp, rattan lamp, Ixtl lamp, manilla lamp, hemp-cord lamp, linen-thread lamp, bamboo-paper lamp, linen-thread carbon, Piazava carbon, linen-twine carbon, silk carbon, Carre carbon, blotting-paper carbon, linwood, Piazava, Ixtl, or Mexican grass, bamboo paper, split bamboo, Stillman lamp, Packart-Sawyer-Man lamp Nos. 1, 2, & 3, Sawyer-Man lamps, like the ones shown in suit; Packard bulb lamps, Compl't's Ex. No. 1, being patent in suit; Compl't's Ex. No. 2, being file-wrapper & contents of application for patent in suit; Compl't's Ex No. 3, being file-wrapper & contents of Edison's application for a patent; Compl't's Ex. No. 4, being file-wrapper & contents of interference proceedings, Sawyer & Man *v.* Edison; Compl't's Ex. No. 5, being on Edison's petition to amend preliminary statement; Compl't's Ex. No. 6, Edison's motion to reopen interference; Compl't's Ex. No. 7, being aff'ts read on motion to reopen interference; Compl't's Ex. No. 8, being 9 on redecision of Commissioner of Patents granting Edison's motion to open interference; Compl't's Ex. No. 9, being supplemental proofs in reply on behalf of Edison; Compl't's Ex. No. 11, being Edison's appeal to the examiners-in-chief; Compl't's Ex. No. 12, Sawyer & Man's appeal to the Com'r in person; Compl't's Ex's Nos. 13, 14, 15, 16, 17, 18, 19, 20, 22, 23, 24, 25, 27, 28, and 30.

Depositions on part of defendant Charles Batchelor, Prof. Geo. F. Barker; *prima facie* case and in rebuttal, Prof. Cyrus F. Bracket, Amos Broadnax, P. S. Dyer, R. N. Dyer, Thos. A. Edison, Stephen D.

Field, Martin R. Force, R. M. Galloway, Hugh R. Garden, Calvan
Goddard, W. K. Griffin, Jacob Hays, Wm. Hackhausen, Wm. Holzer,
Edward H. Johnson, John M. D. Keating, John Kruesi, John
Kruesi recalled, G. P. Lowry, Albon Man, James E. O'Keeffe, James
D. Potter, James A. Russell, Geo. W. Sawyer, Wm. Sawyer, Wm.
Sharp, Thos. B. Stillman, John C. Tomlinson, Francis R. Upton,
Henry E. Vineing, Prof. Wm. P. Wilson, and J. H. Wright; also Exhibits
Herald Article of Dec. 21, 1879; Offer of Sharp's Statement for
Inspection, Compl't's Ex. Sharp's Drawings 1, 2, and 3, Edison's Exhibits
1 to 13, Compl't's Ex. Edison, Maxim & Swan Interference
Record, Edison's Ex. No. 14, Def't's Ex. Note Book No. 52, Def't's Exs.
Phil. Transactions Paper Nos. 1, 2, 3, 4, 5, & 6, Def't's Ex. Extract
from Collected Works of Sir H. Davy, Def't's Ex. Violette Paper, Sidot
paper, extracts from Watt's Dictionary of Chemistry, extract
10 from Mechanics' Magazine of 1846, published discription of
Ladiguin's electric light, Wilson's drawings, M'ch 21, '89;
Broadnax-Cheever letter, Electro Dynamic Light Record, M'ch
20, '79; Edison's Ex. No. 10, Article from Scribner; same, No.
11; record book of life of lamps; same, No. 12; memorandum
book, Def't's Ex. Fontaine's Book, Higgs' translation of same, Morton's
paper on electric light, sanitary engineer letter and interview,
Ap'l 24, '89; extract from Ferguson's Electricity, Sawyer Tribune
interview, extract from Prescott's book, extract from Du Monell
Electric Lighting, Sawyer's World letter, Morton's Tribune interview,
Preece Phil. Mag. article, Preece Electrician extract, Tyndall's
extract, Feb'y 16, '79; Bennett au V. Alon report, Redwood
extract, Engineering extract, Nos. 1, 2, 3, 4, 5, 6, 7, and 8;
Thompson's extract, Weisendaugh English Mechanic extract, Telegraphic
Journal extract, Edison's Exhibits Nos. 23, 24, and 25,
Def't's ex. and patents used on behalf of Edison on interference,
Def't's Ex. Int. Stipulation—J. H. Kitchen, ex'r; Sharp's statement,
Sawyer-Man Scientific American article, Nos. 1 and 2 and 3 and 4;
Sawyer book, Herald, Jan. 5, '80; Herald, Jan. 6, '80; Cheever-Man
letter, Arnous-Hockhausen letter, Edison's patents 264,642, 266,793,
369,280, 214,636, 214,637, 218,866, 219,628, 248,417, 224,329,
227,227, 227,228, 227,229, 223,898; English pat. to Edison, 2402 of
1880; U. S. patents, Nos. 205,144, 210,152, 210,809; W. E. Sawyer,
patent 219,771; Sawyer-Man patents, Nos. 211,262, 229,335, 227,118;
Edison's patent, 251,540; J. W. Swan patent, 233,445; Def't's Ex's
Pinkus English patent, 8644 of 1840; De Moleyn's Eng.
11 patent, No. 9053 of 1841; King's Eng. patent, No. 10919 of
1845; Greener & Staite Eng. pat., No. 11076 of 1846; Staite's
Eng. pat., 12212 of 1848; Shepard's Eng. patent, No. 13302 of 1850;
Slater & Watson Eng. pat., No. 212 of 1852; Roberts' Eng. pat.,
14198 of 1852; Binks' Eng. Patent, 119 of 1853; Way's Eng. patent,
No. 2547 of 1856; Harrison's Eng. patent, 588 of 1857; Burleigh &
Dauchell's Eng. patent, 3164 of 1857; Way's Eng. pat., No. 2841 of
1857; Konn's Eng. pat., No. 3809 of 1872; Konn's Eng. pat., No. 91
of 1873; Kosloff's Eng. pat., 441 of 1875; Jensin's (Konn's) Eng.
patent, 970 of 1875; Werdeman's Eng. pat., No. 4805 of 1876; Eng.
pat., No. 4905 of 1876; Gardner & Blossom's pat. of June 29, 1858;

Kosloff patent of Aug. 17, 1875; Woodward's patent of Aug. 29, 1876; Le Mott pat. of 1849; Gaudun's pat. of 1876; Lodyginne French pat., 1171; Edison's first incandescent lamp, Edison's commercial incandescent lamp—Ex. No. 15, portion of lamp; No. 16, carbonized blotting paper; 17, pressed and carbonized blotting paper; 18, cemented and pressed blotting paper; 19, blotting paper cemented and carbonized without pressure; No. 20, cemented and carbonized with pressure; No 21, carbonized tissue paper; 22, carbonized bristol board; Wilson's rock elm specimen, March 19, '89; Wilson maple specimen, M'ch 21, '89; specimen of lignite, Apr. 24, '89; same day sundry stipulations filed; also, certificate of Wm. T. Farnham, special examiner, filed; same day cause came on for
hearing on pleadings and proofs, and arguments proceeded
12 with; May 22, arguments proceed; May 23, arguments pro-
ceeded and are concluded. *C. A. V.*

1889, Oct. 5.—Opinion of the court with an order allowing a decree dismissing the bill filed.

1889, Nov. 12.—Notice of taxation of costs given (with proof of service thereof on respondent's solicitor) for Saturday, Nov. 16, 1889, filed.

1889, Dec'r 30.—Order granted allowing complainant to withdraw Sawyer-Man Lamp Exhibits temporarily to be used in a suit in the southern dist. of N. Y., in suit of Edison El. L't Co. *v.* U. S. Electric Light Co., to be returned upon order of this court, and same delivered to T. B. Kerr, Esq., sol. for compl't.

1890, April 5.—Defendant's bill of costs filed.

1890, June 14.—Upon notice the costs in this case taxed by the clerk. Same day, exceptions on part of def'ts to clerk's taxation filed. Same day, hearing had upon exceptions to clerk's taxation of costs. *C. A. V.*

1890, June 28.—Affidavit of E. N. Dyer on taxation of costs filed.

1890, June 10.—Additional affidavit of E. N. Dyer on taxation of costs filed.

1890, October 10.—Decree granted in the above-entitled cause that the bill of complaint be, and the same is hereby, dismissed at the cost of the said complainant filed.

1889, Oct. 10.—Petition of complainant for an appeal from the above decree to the Supreme Court of the United States presented,
and, upon motion, appeal allowed by Honorable M. W. Ache-
13 son, judge; also, citation granted, returnable in U. S. Su-
preme Court on second Monday of October, 1890, by Hon.
M. W. Acheson, J.

Also, bond on appeal in the sum of $5,000, with George Westinghouse, Jr., as surety, presented, and bond approved and filed.

1890, October 10.—Stipulation that certain exhibits offered by defendant need not be copied in the record for the U. S. Supreme Court, filed.

1890, Oct. 10.—Consent of Broadnax & Buhl that Kerr & Curtis may be substituted as solicitors for complainant, filed.

Oct. 11, 1890.—Service of citation accepted by Magnus Pflaum, Esq., of counsel for defendants.

14 In the Circuit Court of the United States in and for the Western District of Pennsylvania.

No. 5, May Term, 1888.

In Equity, on Bill.

THE CONSOLIDATED ELECTRIC LIGHT COMPANY, Complainant,
and
McKEESPORT LIGHT COMPANY, Defendant.

Suit on Patent No. 317,676, Dated May 12, 1885.

To the honorable the judges of the United States circuit court in and for the western district of Pennsylvania:

The Consolidated Electric Light Company, a corporation duly created, organized, and existing under and by virtue of the laws of the State of New York, and especially under and by virtue of a certain act of the legislature of said State, duly approved by the governor thereof, passed February 17th, 1848, and of the several acts supplemental to and amendatory thereof, and having its principal place of business in the city of New York, brings this its bill of complaint against the McKeesport Light Company of McKees- 15 port, Allegheny county, Pennsylvania, a corporation duly created, organized, and existing under and by virtue of the laws of the State of Pennsylvania.

And thereupon your orator, upon information and belief, complains and says: That before the 9th day of January, 1880, William E. Sawyer, then of the city, county and State of New York, but now deceased, and Albon Man, of Brooklyn, in the county of Kings and State of New York, were the joint, first and original inventors of a new and useful improvement in electric lights not known or used before, and not patented or described in any printed publication in this or any foreign country before their invention thereof, and not in public use, or on sale in this country, more than two years prior to their application for letters patent of the United States therefor, and did, on the said 9th day of January, 1880, apply to the Commissioner of Patents of the United States for letters patent for said invention, and did fully and in all respects comply with all the requirements of the law in that behalf, and especially did make oath that they verily believed themselves to be the first, original and joint inventors of the said improvements, and did also pay into the Treasury of the United States the fees required by law, and present to the Commissioner of Patents a petition setting forth their desire to obtain jointly an exclusive property in said improvement, and praying that letters patent might be granted to them jointly; and did also deliver and file in said office of the Commissioner of Patents a written description of their said improvement in such full, clear and exact terms as to enable any one skilled in the art with which the said improvement is most nearly connected to make and use the same, which description was duly signed by the said William E. Sawyer and Albor Man, and attested by two witnesses, as required by law.

That by certain instruments of writing, duly and jointly executed and delivered by said William E. Sawyer and Albon Man,
one bearing date October 14th, 1878, and one dated January
16 8th, 1880, and both duly recorded in the Patent Office,
the whole of said improvements were assigned to the Electro Dynamic Light Company, a corporation duly organized, and then existing under and by virtue of the laws of the State of New York, and by said last-mentioned instrument of writing the Commissioner of Patents was authorized and requested by said Sawyer and Man to issue any patent that might be granted for said improvements to the said Electro Dynamic Light Company as the assignee of the said Sawyer and Man, as by said instruments of writing, both of which are hereby proffered, or duly authenticated copies thereof, ready in court to be produced, will fully appear.

And thereupon due proceedings being had according to law, letters patent of the United States were granted to the said Electro Dynamic Light Company, its successors and assigns for said improvements, as the assignees of said William E. Sawyer and Albon Man, which letters patent were and are executed, recorded, issued and delivered in due form of law, and are dated May 12th, 1885, and numbered 316,367, as by said letters patent, or a duly authenticated copy thereof, ready in court to be produced, as your honors may direct, will fully appear.

That by said letters patent there *were* granted to the said Electro Dyn*o*mic Light Company, its successors and assigns, for the term of 17 years from the date thereof, the sole and exclusive right to make, use and vend the improvements in electric lights described, illustrated and claimed in said letters patent throughout the United States and the Territories thereof, as by said letters patent hereby proffered will fully appear.

That a d*i*scription and claims of said improvements in electric
lights *is* given in the words of said William E. Sawyer and
17 Albon Man, in a specification annexed to said letters patent,
and making part thereof, as required by law, and as fully appears by said letters patent.

And your orator further shows unto your honors that by two certain instruments of writing, both dated April 6th, 1881, and recorded in the Patent Office October 5th, 1882, made, or caused to be made, executed and delivered in due form of law by the said Electro Dynamic Light Company, the whole of the title to said letters patent and invention were conveyed to the Eastern Electric Manufacturing Company, of Middletown, Connecticut, a corporation created, organized and existing under and by virtue of the laws of the State of Connecticut, and then having an office and factory in the city of New York, as by said instruments of writing, hereby duly proffered, or duly authenticated copies thereof, ready in court to be produced, will fully appear.

That by a certain instrument of writing, dated September 30th, 1882, recorded in the Patent Office October 5th, 1882, the said Eastern Electric Manufacturing Company conveyed the whole of the title to said letters patent and invention, and all its rights of action thereunder accruing to your orator, as by said instrument of writing, hereby duly proffered, or a duly authenticated copy thereof, ready in court to be produced, will fully appear.

That your orator is now the sole and exclusive owner of said letters patent and invention, and of all rights of action thereunder accruing, and brings the same here in court ready to be produced as your honors may direct.

That said invention is of great public utility, and your orators has expended large sums of money in the purchase of said letters patent, and in perfecting said improvements and in introducing the same in public use. That your orator is now engaged in the manufacture and sale of said improvement in electric lights, and has been and is now ready and able to fully supply the public demand for
the same, and but for the infringements hereinafter com-
18 plained of, would now — able to fully supply the public de-
mand for the same, and but for the infringements hereinafter complained of, would now be in the peaceful possession and enjoyment of said letters patent and invention, and of the income derivable therefrom.

But your orator shows to this court that the defendant hereinbefore named, as your orator is informed and believes, having notice of said letters patent, and well knowing all the facts and circumstances hereinbefore set forth, with the intent and effect of injuring your orator, and in open and palpable disregard of its rights, has been, and is now infringing said letters patent, and using said invention and availing itself of the gains and profits derivable therefrom to the great loss and damage *to* your orator.

That said defendant, without the license of your orator, against its will, in violation of its rights and of said letters patent, numbered and dated as aforesaid, for said improvement in electric lights, has in the western district of Pennsylvania, caused to be used, and is now using and causing to be used, and threatens and intends still to continue to use, and caused to be used in the western district of Pennsylvania, as aforesaid, said patented invention of an improvement in electric lights, described and claimed in and by said letters patent in whole or in some material parts thereof, and the title to which is thus by law vested in your orator, and that said defendant by such using, and causing to be used has, and is now, and intends to continue to infringe said letters patent in said western district of Pennsylvania, in some material part or parts thereof by using, and causing to be used, electric lights and lamps substantially the same in principal, purpose, construction and mode of operation as the improvement in electric lights described, illustrated and claimed in said letters patent numbered and stated as aforesaid.

That said actions and doings of defendant are contrary —
19 this sort are properly cognizable and relievable, and to the
end that said defendant may, if it can, show why your orator should not have the relief hereby sought, your orator prays that the said McKeesport Light Company, over its corporate name and seal, and upon the oath of such of its officers as have the management of its affairs, and to the best of its or their knowledge, remembrance,

information and belief, full, true, direct and perfect answer make to all the averments, statements of facts and matters and things hereinbefore set forth and charged, and that as fully and particularly as if the same were here again repeated, and the defendant especially interrogated thereto.

And your orator further prays that said defendant may be strictly enjoined and restrained preliminarily and finally by a writ or writs of injunction, issuing out of and under the seal of this honorable court, from directly or indirectly, using or causing to be used, said improvements in electric lights, any or either of them, or any substantial or material part thereof, described and claimed in said letters patent, and such it is now and has been using, as hereinbefore set forth, or such as are substantially the same, or as embody the said patented invention of your orator, and from in any way directly or indirectly infringing said letters patent or any part thereof.

And your orator further prays that said defendant, its agents, associates and confederates, may be decreed to account for and pay over to your orator the gains and profits by them or either of them made or realized by making, using and vending said improvements in electric lights, or any part thereof, and also all damages sustained by your orator, in thrice the amount actually suffered by your orator, by reason of said infringement of said patent, and that your orator may have such further and other relief as may be consistent with equity and good conscience.

And may it please your honors to grant unto your or*or*ator,
20 in thrice the amount actually suffered by your orator, by
reason of said infringement of said patent, and that your
orator may have such further and other relief as may be consistent with equity and good conscience.

And may it please your honors to grant unto your orator not only a writ of injunction, issuing out of and under the seal of this honorable court, directed to said defendant, its agents, servants, attorneys, workmen, employees, associates and confederates, each and every one of them, commanding, enjoining and restraining them, and each and every one of them, both preliminarily and permanently, as your orator has above prayed and in that behalf prays, but also a writ or writs of subpœna, issuing out of and under the seal of this honorable court, directed to the said McKeesport Light Company, the defendant herein, commanding it to appear at a certain time and place in this court to answer the premises and to stand to and abide by such orders and decrees herein as may be consistent with equity and justice, and as may be made against it.

THE CONSOLIDATED ELECTRIC LIGHT CO.,
By GEO. WESTINGHOUSE, JR., *President.*

BROADNAX & BULL,
Complainant's Solicitors.
AMOS BROADNAX,
THOMAS R. KERR,
Of Counsel.

UNITED STATES OF AMERICA,
Southern District of New York, } *ss:*

George Westinghouse, Jr., being duly affirmed, deposes and says that he is president of The Consolidated Electric Light Company, the complainant herein, and has the general management of 21 its business; that he has read the foregoing — verily believes that the said William Edward Sawyer and Albon Man were the first, original and joint inventors of the invention described and claimed in the aforesaid letters patent.

GEO. WESTINGHOUSE, JR.

Subscribed and affirmed to before me this 5th day of December, 1887.

JOSEPH GUTMAN, JR.,
[L. S.] *United States Commissioner, Southern Dist. of N. Y.*

Bill filed December 8, 1887.

22 *Chancery Subpœna.*

UNITED STATES OF AMERICA,
Western District of Pennsylvania. }

The United States of America to McKeesport Light Company, a corporation organized under the laws of the State of Pennsylvania, Greeting:

We command you and every of you that you appear before our judges of our circuit court of the United States of America for the western district of Pennsylvania, at the city of Pittsburgh, in said district, on the first Monday of January, 1888, to answer the bill of complaint of The Consolidated Electric Light Company, a corporation organized under the laws of the State of New York, for infringement of letters patent filed in the clerk's office of said court, in the city of Pittsburgh, then and there to receive and abide by such judgment and decree as shall then or thereafter be made, upon pain of judgment being pronounced against you by default; and this you are in nowise to omit under such penalties as are inflicted by the laws of the United States.

Witness the Hon. Morrison R. Waite, Chief Justice of the Supreme Court of the United States of America, at the city [SEAL.] of Pittsburgh aforesaid, this 8th day of December, in the year of our Lord one thousand eight hundred and eighty-seven, and of our Independence the 112th.

H. D. GAMBLE, *Clerk.*

MEMORANDUM.—The above-named defendant is required to enter an appearance in the above-entitled cause on or before the first Monday of the month ensuing twenty days after the service of this writ; otherwise the complaint may be taken against it as confessed and a decree entered accordingly.

H. D. GAMBLE, *Clerk.*

23 *Service.*

And now, Dec. 9th, 1887, served the within writ on the McKeesport Light Company, defendant company herein named, by giving a true and attested copy of this writ to G. L. Reiber, secretary and treasurer of the company, at McKeesport, and making known to him the contents hereof; also on J. R. Gordon, superintendent, by leaving a true copy at their office in McKeesport, Pa.

So ans.—

GEO. W. MILLER,
U. S. Marshal,
Per W. B. CHAMBERS, *Deputy.*

Services	5 00
Mileage	90
	5 90

24 *Demurrer.*

United States Circuit Court, Western District of Pennsylvania.

THE CONSOLIDATED ELECTRIC LIGHT CO., Complainant, *against* McKEESPORT LIGHT COMPANY, Defendant.	In Equity. No. 5. May T., 1888. Suit on Patent No. 317,676.

The demurrer of The McKeesport Light Company, defendant, to the bill of complaint of The Consolidated Electric Light Company, complainant.

This defendant, by protestation, not confessing or acknowledging all or any of the matters and things in the said bill of complaint to be true in such manner and form as the same are therein and thereby set forth and alleged, does demur thereto, and for cause of demurrer showeth that it appears by the complainant's own showing, by its said bill of complaint, that letters patent of the United States numbered 317,676, dated May 12th, 1885, and granted to the Electro-Dynamic Light Company, upon which this suit is brought, are void and of no effect and were issued to it without warrant of authority of law for the reasons, as appears by said bill of complaint, that the said Electro-Dynamic Light Company had assigned all its right, title, and interest in and to the invention and improvement in the said letters patent described and claimed by two instruments of assignment duly made, executed, and delivered, and entered of record in the Patent Office prior to the issuance of said letters patent to it. 25

The said Electro-Dynamic Light Company, as appears by said bill of complaint, being neither the inventor and having no interest of record in the improvement in said letters patent described, and having no right to receive the same, and there being no authority or warrant of law to issue the same to it, said letters patent are null and void as aforesaid.

Wherefore, and for divers other good causes of demurrer appearing in said bill, this defendant doth demur to the said bill and to all the matters and things therein contained and humbly demands the judgment of this court whether it shall be compelled to make any other or further answer to the said bill, and prays to be hence dismissed with its costs and charges in this behalf most wrongfully sustained.

MAGNUS PFLAUM,
Solicitor for Defendant.

MAGNUS PFLAUM, *Of Counsel.*

26 I, Magnus Pflaum, do hereby certify that in my opinion the foregoing demurrer of The McKeesport Light Company, defendant, to the bill of complaint of The Consolidated E. Light Company, complainant, is well founded in law and proper to be filed in the above cause.

MAGNUS PFLAUM,
Solicitor for D'f't.

West Dist. of Penna., *ss:*

John Muse, being duly sworn, deposes and says that he is president of the McKeesport Light Company; that he has read the foregoing demurrer to the bill of complaint in this suit, and that the same is not interposed for the purpose of delaying said suit or any proceeding therein.

JOHN MUSE.

Sworn to before me this 7th day of February, 1888.
H. D. GAMBLE, *Clerk.*

Filed Feb'y 4, 1888.
H. D. GAMBLE, *Clerk.*

27 *Opinion on Demurrer & Order.*

In the Circuit Court of the United States for the Western District of Pennsylvania.

The Consolidated Electric Light Co.
v.
The McKeesport Light Co.
No. 5. May Term, 1888.
In Equity.

Sur Demurrer to Bill of Complaint.

Acheson, *J.:*

The precise question here presented was raised in the case of The Consolidated Electric Light Co. *v.* Edison Electric Light Co., 25 Fed. Rep., 719, and was decided favorably to the plaintiff. I have carefully read the opinion of Judge Wallace and perceive no reason for doubting the correctness of his conclusion. How can it be said that the patent was issued without authority of law, and therefore

is void, when in fact it was issued to the very person designated by section 4895, R. S., viz., "the assignee of the inventor?" There was, indeed, a literal compliance with the provisions of the statute. But as, by operation of law, the legal title to the patent was the issuance thereof, *eo instanti*, vested in the plaintiff as the ultimate assignee, the substantial result was the same as if it had formally issued to the plaintiff. Gayler *v.* Wilder, 10 How., 477. While
28 this view saves the patent and subserves the justice of this case, it neither runs counter to sound public policy nor tends to any evil consequences so far as I can see.

And now, March 17, 1888, the demurrer is overruled with leave to the defendant to answer the bill within thirty days.

BY THE COURT.

Filed March 17, 1888.

H. D. GAMBLE, *Clerk.*

29 United States Circuit Court, Western District of Pennsylvania.

THE CONSOLIDATED ELECTRIC LIGHT COMPANY, Complainant,
vs.
MCKEESPORT LIGHT COMPANY, Defendant.
In Equity. On Letters Patent No. 317,676.

The answer of the defendant, McKeesport Light Company, to the bill of complaint exhibited against it by The Consolidated Electric Light Company, the complainant herein.

The defendant, now and at all times hereafter reserving to itself all and all manner of benefit of exception to the manifold errors, uncertainties, imperfections and insufficiencies in the said bill of complaint contained for answer thereunto, or unto so much and such parts thereof as it is advised it is material and necessary for it to make answer unto, answering, says:

I. That it admits that it, the said defendant, is a corporation, created, organized, and existing under and by virtue of the laws of the State of Pennsylvania, and having its principal place of business in the city of McKeesport, in said State; but whether the complainant, The Consolidated Electric Light Company, is a corporation duly created, organized and existing as alleged in the bill of
30 complaint, this defendant does not know, and is not informed, and therefore denies the same; and it leaves the complainant to make such proof thereof as it may be advised.

II. That, as defendant is informed and believes, letters patent of the United States for an alleged invention for an "improvement in electric lights," being numbered 317,676, were on the 12th of May, 1885, issued to a certain alleged corporation, to wit, the Electro-Dynamic Light Company, as assignee of one William Edward Sawyer and one Albon Man; but whether said letters patent were duly issued upon due application made and upon due formalities, and in due and proper form, and in compliance with the various provisions and the requirements of law, and whether due examination was made and due proceedings were had in the United States Patent Office, and whether any, or if any, what adjudication was made in said office as alleged in the bill of complaint, this defendant has no knowledge or information, and leaves the complainant to make, and demands that it make, such full and strict proof in regard to the same as it may be advised is material or necessary.

III. That this defendant, further answering, denies on information and belief that the said invention upon which letters patent No. 317,676 were granted was not patented or described in any printed publication in this or any foreign country before the date of the said alleged invention, or that the application for said letters patent for said invention was made before the same was put in public use or on sale for more than two years, as alleged in the bill of complaint, but avers that said alleged improvements were fully shown and described before the date of the alleged invention thereof by the said Sawyer & Man in printed publications and patents hereinafter mentioned and were publicly made, used and sold for more than two years prior to the filing by the said William Edward Sawyer and Albon Man of the application upon which said letters patent, numbered 317,676, were subsequently granted.

31 IV. That this defendant denies upon information and belief, that William E. Sawyer and Albon Man were the first and original inventors of the improvements described in said letters patent; and further denies upon information and belief, that they were the joint inventors of the same, and alleges that the same are therefore void, and, on information and belief, defendant alleges that at the date at which complainant pretends to have acquired its title to the said letters patent, it was well known to the complainant and to its various officers that the said alleged invention was not the joint invention of the said Sawyer and the said Man, but, in so far as the said improvement was the invention of either, it was the separate invention of the said Sawyer, and that the said Sawyer had so declared repeatedly and in the most public and solemn manner; and that defendant verily believes that complainant bought and acquired whatever interest it now owns, or has ever owned in the said patent, with the full knowledge that the said patent was invalid.

V. That this defendant has no knowledge or information whether the Electro-Dynamic Light Company and the Eastern Electric Manufacturing Company are or were corporations duly created, organized and existing and having their offices of business, all as alleged in the bill of complaint, or were legally capable of receiving or of making the assignments alleged in said bill of complaint, and therefore denies the same, and leaves the complainant to make such full and strict proof in regard to all such averments as it may be advised is material or necessary.

VI. That this defendant does not know and is not informed whether the said invention or said letters patent were assigned by said William Edward Sawyer and Albon Man to the said Electro-Dynamic Light Company, or by said company, assigned to the said Eastern Electric Manufacturing Company, or by said last-named

company assigned, with all its rights of action thereunder to
32 the complainant herein, as alleged in the bill of complaint,
or whether said alleged assignments, or any of them, were duly recorded in the Patent Office; and this defendant therefore denies the same and leaves the complainant to make such proofs of said assignments and of each of them, and of the power of each of said alleged assignors and assignees and of the complainant to hold or assign said invention or letters patent, as it is advised.

VII. That this defendant has no knowledge or information that the complainant is the sole and exclusive owner of said letters patent and invention and of all rights of action thereunder, as alleged in the bill of complaint, and therefore denies the same and leaves the complainant to make strict proof thereof.

VIII. That this defendant denies upon information and belief that the said invention, as described by said letters patent, is of great or any public utility, or that the complainant has expended large or any sums of money in the purchase of said letters patent, or in perfecting said improvements, or in introducing the same in public use, or that the complainant is engaged in the manufacture and sale of said improvement, or is now ready and able to fully supply the public demand for the same; but this defendant, on information and belief, avers the fact to be that said invention is of no public utility whatever, and has never been introduced in public use, and that the complainant is not engaged in the manufacture and sale of said improvement, and that there is no public demand for the same. And this defendant avers, on information and belief, that the said complainant is engaged in the manufacture and sale of electric lamps embodying other and different inventions from that described in said letters patent, which other and different inventions are described and claimed in certain letters patent granted upon the inventions of Thomas A. Edison, under which this defendant is operating; that the complainant has been sued for infringement of the
said letters patent granted upon the said inventions of Thomas
33 A. Edison in the United States circuit court for the southern
district of New York, and that such suits are now pending.

IX. That this defendant denies, upon information and belief, that it has ever infringed at all or in any way, either in the western district of Pennsylvania or elsewhere, upon the said letters patent or any rights of the complainant thereunder, or that it is now infringing upon the same, or intends so to do, either by using or vending the said alleged inventions, or otherwise; and further denies that it has infringed or is now infringing the said letters patent, in any material parts thereof, in the western district of Pennsylvania, or elsewhere, by selling or using, or causing to be used or sold in the western district of Pennsylvania, or elsewhere, the said alleged invention of an improvement in electric lights, in any material parts thereof, substantially the same in principle, purpose, construction and mode of operation as that described and claimed in said letters patent, or that it has made any profit therefrom, or in any way damaged or injured the complainant thereby.

X. That this defendant, upon information and belief, alleges that said letters patent are null and void, because that at and prior to the time said letters patent were issued to the said Electro-Dynamic Light Company it had ceased to exist as a corporation, and was incapable in law of taking, receiving or holding the same.

XI. That this defendant further alleges that said letters patent were issued without authority or warrant of law, and are null and void, because at and prior to the time the said letters patent were issued to the said Electro-Dynamic Light Company, it had parted with all interest in the said invention and in the patent to be procured therefor by certain instruments of assignment duly recorded in the Patent Office, the said Electro-Dynamic Light Company at the time of the issuance of letters patent aforesaid, to wit, 34 being neither the inventor of said improvement nor the assignee of the inventor within the meaning of the statute in such case made and provided.

XII. That this defendant alleges that the said letters patent are for a different, distinct, and separate invention from that which was described in the original application of Sawyer and Man; and that said application was fraudulently and unduly enlarged and changed by making substantial or material changes, omissions or additions in the specifications and claims thereof, and that this was done years after said application was filed, and after the death of one of the alleged joint inventors named in said application, to wit, William E. Sawyer, and after intervening rights had accrued in individuals and the public, and that the said letters patent, as issued, were not based upon a proper application as required by the statute, and are, therefore, null and void.

XIII. That this defendant avers, upon information and belief, that not only was the said original application of Sawyer and Man fraudulently and unduly enlarged and changed and the said letters patent No. 317,676 issued for the different, distinct and separate invention from that which was described in the said original application of Sawyer and Man, but that prior to the issuance of said letters patent No. 317,676 an application for a patent had been filed in the office of the Commissioner of Patents by one Thomas A. Edison, describing and claiming said different and separate invention and upon which the said Edison was seeking a patent; that the said Thomas A. Edison requested the Commissioner of Patents to declare an interference between his said application and the said application of Sawyer and Man upon the said different and separate invention and protested against the issuing of the said letters patent No. 317,676 without such an interference; but, notwithstanding this fact, and notwithstanding the solemn protest of the said Thomas A. Edison against the issue of a patent upon said application of 35 Sawyer and Man for the said different and separate invention without interference first being had with said Edison as to said invention, the said letters patent were obtained surreptitiously and by fraud and without an interference with the application of said Edison as provided by law, although said Edison was at all times ready to contest the question of priority of invention before the Commissioner of Patents, and was seeking a patent for the same invention by an application for said different and separate invention then pending, and which interfered with the said application of Sawyer and Man.

XIV. That this defendant alleges, upon information and belief, that the said letters patent are void and of no effect, because the said Sawyer and Man did not by said letters patent, reveal to persons skilled in the art, or to others, knowledge of any new and useful invention or improvement, or knowledge of any value or importance whatever; and that the devices shown and described in said letters patent, or material and substantial parts thereof, are inoperative and impracticable.

XV. And this defendant, further answering, says that it is advised and avers that the specification of said letters patent does not sufficiently describe the things attempted to be covered by the claims thereof, to enable persons skilled in the art or science to which it appertains, or with which it is most nearly connected, to make, construct and use the same.

XVI. That, as this defendant is informed and believes, the said letters patent, and each and every part thereof, are void and of no effect in law, because that the said alleged invention had been prior to the said alleged invention or discovery thereof by Sawyer and Man, shown and described in the following-named letters patent, to wit:

In letters patent of the United States:
No. 20706, June 29th, 1858, Gardiner & Blossom.
No. 166,877, August 17th, 1875, Kosloff.
36 No. 181,613, August 29th, 1876, Woodward.

In letters patent of the Kingdom of Great Britain:
No. 8644, 1840.
No. 9053, 1841, De Moleyns.
No. 10919, 1845.
No. 11076, 1846, Greener & Straite.
No. 11783, 1847.
No. 12212, 1848, Straite.
No. 13302, 1850, Shepard.
No. 212, 1852, Slater & Watson.
No. 14198, 1852, Roberts.
No. 119, 1853, Binks.
No. 2547, 1856, Way.
No. 588, 1857, Harrison.
No. 3164, 1857, Burleigh & Danchell.
No. 2841, 1857, Way.
No. 282, 1858.
No. 188, 1862.
No. 847, 1865, Gordon.
No. 3809, 1872, Konn.
No. 91, 1873, Konn.
No. 441, 1875.
No. 970, 1875.
No. 4805, 1876, Werdemann.
No. 4905, 1876, Varley.

No. 1996, 1877.
No. 2585, 1877, Prosser & Moore.
No. 4432, 1877, Rapieff.
No. 861, 1878, Scott.
No. 3470, 1878, Harrison.
No. 3988, 1878.
No. 3991, 1878, Clark.
No. 4043, 1878.
No. 4595, 1878, Heinrichs.
No. 4774, 1878, Pulvermacher.
No. 5281, 1878.

In letters patent of France:
No. 4606, 1849, Le Molt.
No. 7469, 1851, Nollett.
37 No. 113,706, July 12, 1876, Gaudin.

Certificates of addition thereto, dated April 7, 1877, and June 12, 1877.

In letters patent of Belgium:
No. 542, 1851, Nollett.

And various other letters patents not now known to this defendant, but which, when ascertained, the defendant prays leave to make a part of this answer by proper amendment and averment.

XVII. That, as this defendant is informed and believes, the said letters patent and each and every part thereof are void and of no effect in law, because the said alleged invention had been described in some printed publications prior to the supposed or alleged invention or discovery thereof by Sawyer and Man, among which are the following, to wit:

Philosophical Transactions of the Royal Society, London, 1809, p. 32 *et seq.*

Philosophical Transactions of the Royal Society, London, 1815, p. 363 *et seq.*

Philosophical Transactions of the Royal Society, London, 1820, p. 26.

Philosophical Transactions of the Royal Society, London, 1821, pp 426, 427 and 435.

Philosophical Transactions of the Royal Society, London, 1832, pp. 292 and 293.

Philosophical Transactions of the Royal Society, London, 1839, p. 92.

Philosophical Transactions of the Royal Society, London, 1866, pp. 14 and 16.

Work of Sir Humphrey Davy, London:
1839, vol. II, pp. 212, 216, 218 and 219.
1840, vol. IV, pp. 109, 110, 111, 221 and 231.
1840, vol. V, pp. 172, 221, 276 and 285.

The Electrician, London, 1862–'3, vol. 3, p. 243.
" " " 1863, vol. 4, p. 29.
" " " January 25, 1879, p. 109.
The Electrician, Sept. 17, 1881.

38 Journal of the Society of Arts, London, August 22, 1873.

Annual Record of Science and Industry, New York, 1875, p. 160.

Science Record, New York, 1874, p. 211.

Golos, 129, St. Petersburg, May 11th to 23d, 1873.

Sidot Comptes Rendus, vol. 70, p. 605.

La Lumiere Electrique, October 25, 1884.

Les Mondes, 1875, vol. 1, p. 183.

Nature, 1873, vol. 8, p. 372.

The Engineer, London, 1870, vol. XXX, p. 177.

Mechanics' Magazine, London, 1845, vol. 43, p. 271.

Mechanics' Magazine, London, 1846, vol. 44, pp. 312, 315 and 348.

De La Rive, Treatise of Electricity, London, 1856, vol. 11, p. 106 and p. 280 *et seq.*

The Telegraphic Journal, London, September 1, 1873, pp. 183, 184, 260.

The Telegraphic Journal, London, June 15, 1879, p. 199.

Watts' Dictionary of Chemistry, London, 1872, vol. 1, pp. 759 and 760.

Watts' Dictionary of Chemistry, London, 1875, 2d supplement, p. 255.

Journal of Science, 1867, vol. 4, p. 430.
" 1871, vol. 1, p. 115.
" 1879, vol. 16, pp. 155 and 170.

American Journal of Science, 1822, vol, 5, pp. 108, 361.

American Journal of Science, 1824, vol. 8, p. 288.

American Journal of Science and Arts, New Haven and New York, 1853, vol. 16, p. 271.

English Mechanic and World of Science, London, 1875, vol. XXI, p. 611.

New York Herald, a newspaper published at New York city, December 20th, 1879.

And in various other printed publications not now known to this defendant, but which, when ascertained, the defendant prays leave to make a part of this answer by proper amendment and averment.

39 XVIII. That, as this defendant is informed and believes, the said letters patent, and each and every part thereof, are void and of no effect in law, because the said alleged joint inventors, Sawyer and Man, were not the original and first inventors or discoverers of said alleged invention or discovery, or of any material or substantial part thereof, but that the same, and every material and substantial part thereof, had been, prior to the said alleged invention thereof by Sawyer and Man, either known to, or used by, or both known to and used by the following persons at the places set opposite their names respectively, which persons reside now, to the best of the defendant's knowledge and belief, at the places respectively specified, to wit:

Name.	Where known or used.	Present residence.
Edward Weston	Newark, N. J.	Newark, N. J.
Moses C. Farmer	Salem and Boston, Mass., and elsewhere	New York city.
Thomas A. Edison	Menlo Park and Newark, N. J.	Llewellyn Park, N. J.
Hiram S. Maxim	New York city and elsewhere	London, England.
Nathaniel S. Keith	New York city and elsewhere	New York city.
Charles Batchelor	Menlo Park, N. J., and elsewhere	New York city.
Francis R. Upton	Menlo Park, N. J., and elsewhere	Orange, N. J.
John Kruesi	Menlo Park and elsewhere	Brooklyn, N. Y.
John F. Ott	Menlo Park and elsewhere	Newark, N. J.
Martin N. Force	Menlo Park and elsewhere	Menlo Park, N. J.

and various other persons whose names and residences are not now known to this defendant, but which, when ascertained, it prays leave to make a part of this answer by proper averment and amendment.

XIX. That, as this defendant is informed and believes, in view of the state of the art to which said alleged invention or discovery pertains, or with which it is most nearly connected, there was no invention in anything done by said Sawyer and Man, as shown and described in said letters patent.

XX. That this defendant is informed and believes that the said William Edward Sawyer and Albon Man surreptitiously and unjustly obtained the patent No. 317,676 for that which had been invented by another, viz., by one Thomas A. Edison, who was using reasonable diligence in adapting and perfecting the same, and said letters patent are therefore null and void.

XXI. And now, this defendant having answered to the various matters and things set up in the bill of complaint, denies that the complainant is entitled to the relief prayed for, or any part thereof, and this defendant prays the same advantage of the matters contained in this answer as if the same had been set up by plea or demurrer, when a plea or demurrer would have been proper, especially as to the ninth paragraph hereof.

And this defendant denies all and all manner of unlawful and other combinations and false pretending by the bill charged without this, that there is any other matter, cause or thing in the said bill of complaint contained (material or necessary to make answer unto, and not herein and hereby well and sufficiently answered, confessed, traversed and avoided or denied) true to the knowledge or belief of this defendant, all which matters and things the defendant is ready and willing to aver, maintain and prove, as this honorable court shall direct, and hereby prays to be hence dismissed, with its reasonable costs and charges, in this behalf most wrongfully sustained.

MAGNUS PFLAUM,
Solicitor for Defendant.

JOHN A. TOMLINSON,
RICH. N. DYER, *Of Counsel.*

41 STATE OF ——, } *ss:*
County of——, }

—— ——, being duly sworn, deposes and says that he is the — of The McKeesport Light Company, the defendant in this suit; that he has read the foregoing answer and knows the contents thereof, and that the same is true of his own knowledge, except as to the matters therein stated to be alleged on information and belief, and as to those matters he believes it to be true.

—— ——.

Sworn to before me this — day of——, 1888.

—— ——.

It is agreed by counsel for complainant that the foregoing answer may be filed without signature and affidavit of the defendant, which are hereby waived.

(Signed) W. BAKEWELL & SONS,
For Complainant.

42 *Replication.*

Circuit Court of the United States, Western District of Penna.

THE CONSOLIDATED ELECTRIC LIGHT COMPANY, Compl't,
vs.
MCKEESPORT LIGHT COMPANY, Def't.
No. 5. May Term, 1888.
In Equity.

Replication.

The replication of The Consolidated Electric Light Company, complainant, to the answer of McKeesport Light Company, defendant.

This repliant, saving and reserving to itself all, and all manner of advantage of exception to the manifold insufficiencies of the said answer, for replication thereunto says that it will aver and prove its said bill to be true, certain and sufficient in the law to be answered unto; and that the said answer of the said defendant is uncertain, untrue and insufficient to be replied unto by th- repliant; without this, that any other matter or thing whatsoever in the said answer contained, material or effectual in the law to be replied unto, confessed and avoided, traversed or denied, is true; all which matters and things this repliant will be ready to aver and prove, as this honorable court shall direct; and humbly pray-, as in and by its said bill it has already prayed.

THOMAS B. KERR,
Solicitor for Complainant.

Filed April 21, 1888.

H. D. GAMBLE, *Clerk.*

43 *Order Assigning Time for Taking Testimony and Appointing H. D. Gamble Examiner.*

In the Circuit Court of the United States for the Western District of Pennsylvania.

THE CONSOLIDATED ELECTRIC LIGHT CO. }
v. } No. 5. May Term, 1888.
THE McKEESPORT LIGHT CO. } In Equity.

And now, to wit, April 24, 1888, on motion of the complainant's solicitor, the following times are assigned for taking evidence, to wit: The complainants shall have until and including May 24, 1888, to take evidence in support of its bill and the defendant shall have thereafter until and including August 24, 1888, to take its evidence in defence, with leave to the defendant to move for further time if necessary and with leave to the complainant to move for time to take evidence in reply to defendant's evidence if it so desires.

H. D. Gamble is hereby appointed an examiner to take the above evidence.

BY THE COURT.

Filed April 24, 1888.

H. D. GAMBLE, *Clerk.*

44 *Order Fixing Time for Taking Compl't's Evidence in Reply.*

In the Circuit Court of the United States, West. Dist. of Pa.

CONSOLIDATED E. L. CO. }
v. } No. 5. May Term, 1888.
McKEESPORT LIGHT CO. } In Equity.

And now, to wit, Sept. 10, 1888, the time for taking complainant's evidence in reply is fixed at three months, to begin and date from October 15, 1888.

BY THE COURT.

Filed Sept. 10, 1888.

H. D. GAMBLE, *Clerk.*

45 *Stipulation Extending Time for Closing Compl't's Proofs in Reply to and Including Feb'y 15, 1889.*

United States Circuit Court, Western District of Pennsylvania.

THE CONSOLIDATED ELECTRIC LIGHT COMPANY }
v. } No. 5. May Term, 1888.
THE McKEESPORT LIGHT COMPANY. } In Equity.

And now, to wit, January 15, 1889, it is hereby stipulated that in view of the absence of the solicitor for the defendant until November 19, 1888, the time for closing the complainant's proofs in reply is extended to and including February 15, 1889.

THOMAS B. KERR,
Solicitor for Complainants.
RICH'D N. DYER,
Of Counsel for Defendants.

Filed February 5, 1889.

H. D. GAMBLE, *Clerk.*

46 *Proof of Service of Notice of Motion for Two Months in which to Take Def't's Testimony.*

United States Circuit Court, Western District of Pennsylvania.

CONSOLIDATED ELECTRIC LIGHT COMPANY
v.
MCKEESPORT LIGHT CO.
No. 5. May Term, 1888.
In Equity.

To Thos. B. Kerr, Esq., solicitor for complainant:

Take notice that on Saturday, February 16, 1889, at 10 o'clock a. m., I will move the court for two months' time, commencing Monday, Feb'y 18, 1889, within which the defendant may take testimony in reply to the case made by the complainant and in support of the several defences set up in the defendant's answer herein, and for such other and further relief in the premises as to the court shall seem meet.

MAGNUS PFLAUM,
Solicitor for Def't.

Service of above notice is acknowledged and exception is taken to that part after the word "herein" as not in accordance with the leave of court.

47 THOS. B. KERR,
Sol. for Compl't.

Feb'y 9, 1889.

Filed Feb'y 11, 1889.

H. D. GAMBLE, *Clerk.*

Opinion and Order sur Above Application.

Per Curiam:

It is very clear to us that as a matter of strict legal right the defendant is not entitled to an order allowing the introduction at this stage of the case of evidence-in-chief. It was the duty of the defendant to put in the proofs in support of such of the defenses as were relied on within the period of three months heretofore assigned for that purpose, and we recognize the cogency of the objections urged against the allowance of the present application. Nevertheless, that there may be no possible failure of justice, we have concluded to grant the defendant leave to take further evidence to sustain the defenses generally, but we will limit the time for so doing to one month from this date. At the end of that period the plaintiff shall have one month to put in evidence in reply, and the cause shall be set down for final hearing at the next term of the court; and it is so ordered.

Filed Feb'y 18, 1889.

H. D. GAMBLE, *Clerk.*

48 *Motion for an Extension of Time for Taking Defendant's Testimony and Order Thereon.*

In the United States Circuit Court, Western District of Pennsylvania.

CONSOLIDATED ELECTRIC LIGHT COMPANY *v.* THE MCKEESPORT LIGHT COMPANY.	No. 5. May Term, 1888. In Equity.

And now, March 14, 1889, Magnus Pflaum, solicitor for defendants, moves the court for an order extending defendants' time to take testimony, under the general defenses set forth in the answer, ten days from the expiration of the time assigned to defendants by the order of the court herein of February 18, 1889, and for such further or other relief as may be just.

And now, March 14, 1889, the above motion — argued by counsel, and thereupon, upon consideration, it is ordered that the time for taking the defendants' testimony be extended until Saturday, the 23d day of March, 1889, inclusive, the period of one month heretofore assigned to the plaintiffs to take proofs in reply to run from the date above last mentioned.

BY THE COURT.

Filed March 14, 1889.

H. D. GAMBLE, *Clerk.*

49 *Order Permitting Defendants to Take Testimony in Impeachment of Testimony of W. H. Church.*

United States Circuit Court, Western District of Pennsylvania.

THE CONSOLIDATED ELECTRIC LIGHT CO.
v.
MCKEESPORT LIGHT COMPANY.

On motion of defendant, by Walter K. Griffin, its counsel, and on reading and filing the affidavit of said W. K. Griffin, annexed to the notice of motion, and after hearing counsel for the respective parties, it is ordered that defendant have to and including Tuesday, May 7, 1889, to call and examine John C. Tomlinson and Richard N. Dyer as witnesses in its behalf; the examination of said witnesses to be restricted to the contradiction of the answers of the witness William H. Church on cross-examination by Mr. Griffin and as to the alleged interviews of said Church with said Tomlinson and Dyer and the statements by him then made, as detailed in said cross-examination.

By the Court.

May 4, 1889.

Filed May 4, 1889.

H. D. GAMBLE, *Clerk.*

50 *Stipulation Respecting Appointment of John H. Kitchen Examiner on Part of Defendant.*

United States Circuit Court, Western District of Pennsylvania.

The Consolidated Electric Light Company *against* The McKeesport Light Company.	In Equity. Letters Patent No. 317,676.

It is hereby stipulated and agreed by and between the respective parties to the above-entitled suit that John H. Kitchen, Esq., one of the standing examiners of the circuit court of the United States for the southern district of New York, be appointed special examiner in the above suit to take the proofs on behalf of the defendant therein, and that such proofs may be taken in the city of New York and that the proofs so taken before the said John H. Kitchen, Esq., and in the city of New York, shall have the same force and effect as though taken before one of the standing examiners of the circuit court of the United States for the western district of Pennsylvania, and

It is further agreed and stipulated that an order in conformity with this stipulation may be entered by the defendant in the above-entitled suit at any time without notice.

Dated July 20th, 1888.

MAGNUS PFLAUM,
Solicitor for Defendant.
THOMAS B. KERR,
By W. BAKEWELL & SONS,
Solicitors for Plaintiff.

51 *Order Appointing J. H. Kitchen Examiner on Part of Defendant.*

United States Circuit Court, Western District of Pennsylvania.

The Consolidated Electric Light Company *against* The McKeesport Light Company.	No. 5. May T., 1888. In Equity. Letters Patent No. 317,676.

On reading and filing the annexed stipulation entered into between the solicitors for the respective parties to the above-entitled suit;

It is ordered that John H. Kitchen, Esq., one of the standing examiners of the circuit court of the United States, for the southern district of New York, be and he hereby is appointed special examiner in the above suit to take the proofs on behalf of the defendant therein, and

It is further ordered that such proofs may be taken in the city of New York, and with the same force and effect as though taken before one of the standing examiners of the circuit court of the United States for the western district of Pennsylvania.

Dated July 28th, 1888.

[SEAL.] By THE COURT.

Filed July 28, 1888.

H. D. GAMBLE, *Cl'k.*

52 *Appointment of Wm. T. Farnham Examiner.*

United States Circuit Court, Western District of Pennsylvania.

Consolidated Electric Light Co.
v.
McKeesport Light Co.
No. 5. May T., 1888.
Equity.

On motion of W. Bakewell & Sons, William T. Farnham, notary public of the city of New York, is hereby appointed examiner to take testimony of witnesses and other evidence on part of complainant.

H. D. GAMBLE, *Clerk.*

Filed November 28, 1888.

H. D. GAMBLE, *Clerk.*

53 *Order Appointing Wm. T. Farnham Examiner on Part of Defendant.*

In the Circuit Court of the United States for the Western District of Pennsylvania.

Consolidated Electric Light Company
vs.
McKeesport Light Company.
No. 5. May Term, 1888. In Equity.

Upon presentation to the court of the stipulation hereto attached, entered into by the respective solicitors for complainant and defendant.

It is ordered, that Wm. T. Farnham, a notary public in the city of New York, State of New York, be and he hereby is appointed special examiner in the above suit to take proofs on behalf of the defendant therein under the order of this court dated the 18th day of February, 1889, and during any extensions of time given the defendant by such order, and that the proofs so taken before the said Wm. T. Farnham shall have the same force and effect as though taken before one of the standing examiners of the circuit court of the United States for the western district of Pennsylvania. This order of appointment is made *nunc pro tunc.*

Dated Feb'y 23, 1889.

By THE COURT.

54 United States Circuit Court, Western District of Pennsylvania.

THE CONSOLIDATED ELECTRIC LIGHT COMPANY
v.
THE McKEESPORT LIGHT CO.

No. 5. May Term, 1888.
In Equity.

It is hereby stipulated and agreed by and between the parties to the above-entitled suit that William T. Farnham, Esq., of New York city, be appointed special examiner in the above suit to take proofs on behalf of the defendant herein under the order of the court dated the 18th of February, 1889, and during any extensions of the time given the defendant by such order, and that the proofs so taken before the said William T. Farnham shall have the same force and effect as though taken by one of the standing examiners of the circuit court of the United States for the western district of Pennsylvania; and

It is further agreed and stipulated that an order in conformity with this stipulation may be entered by the defendant in the above-entitled suit at any time without notice *nunc pro tunc* as of the date of this stipulation.

55 Dated New York, February 21st, 1889.

THOMAS B. KERR,
For Complainant.
MAGNUS PFLAUM,
For Defendant.

Filed February 23, 1889.

H. D. GAMBLE, *Clerk.*

56 *Order Appointing John A. Shields Ex'r Com.*

In the Circuit Court of the United States for the Western District of Pennsylvania.

CONSOLIDATED ELECTRIC LIGHT COMPANY.
vs.
McKEESPORT LIGHT COMPANY.

No. 5. May Term, 1888.
In Equity.

And now, to wit, April 4, 1889, upon motion of Thos. B. Kerr, Esq., solicitor for the complainant, John A. Shields, an U. S. com'r for the southern district of New York, residing in the city of New York, is specially appointed an examiner to take testimony on behalf of the complainant in the above-entitled suit, as provided by the 67th rule, in equity, and the amendments thereto.

BY THE COURT.

Filed April 4, 1889.

H. D. GAMBLE, *Clerk.*

57 *Complainant's Evidence-in-chief.*

Testimony taken on behalf of complainant *of* final hearing, pursuant to the 67th rule, in equity, as amended, before H. D. Gamble, Esq., special examiner.

Pittsburgh, Pa., *May 8th*, 1888.

Met pursuant to notice.

Present: Thomas B. Kerr, Esq., on behalf of complainant; John C. Tomlinson, Esq., on behalf of defendant.

Proof of the incorporation of the complainant and defendant corporations is hereby waived.

Counsel for complainant offers in evidence a certified copy of the patent in suit, No. 317,676, granted on May 12th, 1885, to the Electro Dynamic Light Company of New York, assignee of William E. Sawyer and Albon Man, and the same is marked "Complainant's Exhibit Complainant's Patent, H. D. G., examiner."

(Objected to by counsel for defendant as irrelevant, and upon the further ground that the patent is invalid, having been issued to an assignee, who had, prior to the grant of the patent, parted of record with all interest in the invention or application.)

Counsel for complainant also offers in evidence a copy of an assignment from Sawyer and Man aforesaid, to the Electro Dynamic Light Company aforesaid, of the invention covered by the patent in suit, and the same is marked "Complainant's Exhibit Sawyer and Man Assignment of October 14th, 1878, H. D. G., examiner."

Counsel for complainant also offers in evidence a copy of the assignment of Sawyer and Man to the Electro Dynamic Light Company of the patent in suit, and the same is marked "Complainant's Exhibit Sawyer and Man Assignment of January 9th, 1880, H. D. G., examiner."

58 Counsel for complainant also offers in evidence a copy of the assignment of the Electro Dynamic Light Company to William H. Church, trustee, of the patent in suit, and the same is marked "Complainant's Exhibit Electro Dynamic Light Company Assignment of April 6th, 1881, H. D. G., examiner."

Counsel for complainant also offers in evidence a copy of the assignment of William H. Church, trustee, to the Eastern Electric Manufacturing Company of the patent in suit, and the same is marked "Complainant's Exhibit Church Assignment of April 6th, 1881, H. D. G., ex'r."

Counsel for complainant also offers in evidence a copy of the assignment of the Eastern Electric Manufacturing Company to the complainant of the patent in suit, and the same is marked "Complainant's Exhibit Eastern Electric Manufacturing Company Assignment of September 30th, 1882, H. D. G, examiner."

Counsel for complainant also offers a copy of the assignment from William E. Sawyer and Albon Man to the Electro Dynamic Light Company, and the same is marked "Complainant's Exhibit Sawyer and Man Assignment of April 5th, 1881, H. D. G., examiner."

Testimony of Franklin L. Pope.

FRANKLIN L. POPE, being duly sworn on the part of the complainant, testifies in answer to interrogatories by the counsel for complainant, as follows:

Int. 1. State your name, age, residence and occupation.

Ans. Franklin L. Pope; age, 47; Elmora, Union county, New Jersey. I am an electrical engineer and solicitor of patents, and an editor of a technical periodical published in the city of New York under the name of The Electrical Engineer.

Int. 2. What practical experience have you had in connection with electricity?

59 A. I have been employed for thirty years in more or less intimate connection with work having to do with the industrial applications of electricity, and have devoted much time to study and experimentation relating to this work. I have also tried to keep myself well informed as to the progress of electrical science and art, and have read much that has been written on the subject, and published in scientific and technical publications. I have written many articles on these subjects for my own and other technical periodicals, and have many times been called upon to give testimony in the United States courts in suits involving questions of infringement of patents of methods and apparatus for applying electricity in the arts. I have had much experience in designing, constructing and operating electrical and magnetic apparatus of almost every description, and have made a considerable number of inventions in telegraph and fire-alarm apparatus, electric railways and railway signals, electric lighting and the like, some of which have gone into very extended practical use. I was assistant engineer of the American and of the Western Union Telegraph Company; was assistant engineer in charge of the American division of the telegraph line which was projected, and in great part constructed between the United States and Siberia by way of Behring's straits in 1865, and I also constructed and put in operation the first system of distributing stock exchange and market quotations in private offices, which was in New York in 1867. I was for many years employed by the Western Union Telegraph — as an expert to examine for them new inventions and patents, and for the last eight years have been in business in New York city on my own account, as a solicitor of patents and general expert in electrical work.

3 Q. Are you familiar with the complainant's patent?

A. I am.

4 Q. Look at the incandescent electric lamp now shown you, marked "Exhibit Defendant's Lamp," and with the under-

60 standing that it is made in the following manner, namely:

The incandescing conductor is made from bamboo. The bamboo is received by the defendant's vendor in strips about one-sixteenth of an inch thick, one-quarter of an inch wide, and ten or twelve inches long, the strips being cut from the surface of the cane. The hard surface of these strips being removed, they are planed to the desired thickness, and the piece to be used in the lamp is cut from the strip. The ends of the piece to which the leading-in wires are to be attached are made larger than the light-giving part. This piece is bent into a hair-pin shape upon a hot cylinder, and then placed in an air-tight "form" or mold to hold it in its proper shape, and carbonized at a high temperature in a furnace. When taken from the furnace, it is attached to the leading-in wires, and is put in the lamp bulb from which the air is then exhausted. The completed lamp chamber is one made entirely of glass and hermetically sealed by the fusion of the glass around the leading-in wires: Please compare the said lamp with the complainant's patent, and state whether, in your opinion, it embodies the invention set forth and claimed therein.

Ans. I have carefully read the specification and inspected the drawings of the complainant's patent, and believe that I understand the invention described and claimed therein.

I have examined the incandescent lamp shown me, and with the understanding that it was made in the manner described in the question, I believe that I understand its mode of operation and the method and process of its manufacture.

The defendant's lamp is a structure or article of manufacture composed of three essential parts.

First, an enclosing chamber composed wholly of glass, which has been hermetically sealed after the removal of the atmospheric air originally contained therein.

Second, of a light-giving portion which may be termed the illuminant, consisting of a resisting conductor of arch or horseshoe 61 form, made of a fibrous organic substance, brought to the required shape and then carbonized in a retort, or closed vessel.

Third, of connecting or leading wires or conductors electrically connected to the ends of the carbon illuminant, and made to pass air-tight through the walls of the enclosing chamber of glass.

I find that the structure of defendant's lamp, which I have described, contains the same elements, combined in substantially the same way, and organized to operate in the same manner, to produce the same result, as the structure described and claimed in complainant's patent. The specification of the patent in suit sets forth that the invention is an improvement upon an apparatus shown in prior letters patent granted to the same inventors June 18th, 1878 (No. 205,144.) The specification goes on to say:

"Our invention relates more especially to the incandescing conductor, its substance, its form, and its combination with the other elements composing the lamp. Its object is to secure a cheap and effective apparatus, and our improvement consists, first, of the combination in a lamp composed wholly of glass (as described in patent No. 205,144), of an incandescing conductor of carbon made from a vegetable fibrous material, in contradistinction to a similar conductor made from mineral or gas carbon, and also in the form of such conductor so made from such vegetable carbon, and combined in a lighting circuit within the exhausted chamber of the lamp."

Referring back to patent No. 205,144, I find described therein a lamp for giving light by incandescence, in which a straight, thin rod of mineral carbon included in an electric circuit is supported by means of suitable standards in a vertical position within an air-tight chamber, composed wholly of glass, and having leading-in wires passing air-tight through the glass walls of the chamber. This air-tight chamber is charged with an artificial atmosphere, preferably of nitrogen, for the purpose of absolutely exclud-
62 ing oxygen, a gas which would chemically unite with and destroy the illuminant when at a high temperature.

The essential difference which I find to exist between the invention set forth in the present patent and that of the former patent upon which it is stated to be an improvement, relates, as the specification points out, to the substance and to the form of the incandescing conductor or illuminant, and it consists, according to the statement of the patentees, in the combination with an all-glass lamp chamber "of an incandescing conductor of carbon made from a vegetable fibrous material, in contradistinction to a similar conductor made from mineral or gas carbon, and also in the form of such conductor so made from such vegetable carbon, and combined in the lighting circuit within the exhausted chamber of the lamp."

Hence the improvement in the illuminant is twofold, as it relates to its form, and also to its substance.

Referring first to the form, the carbon illuminant of the patent in suit, is of what is termed by the patentees an "arch" form, as generically distinguished from the straight form of the corresponding part in the former patent. One objection to the straight illuminant arises from the fact that the wires leading from the source of electrical supply are conveniently, and almost necessarily brought to the lamp in a direction parallel to each other; hence it becomes necessary with a straight vertical illuminant, such as that of the former patent, to carry one of the opaque and non-luminous leading-in conductors to the upper end of the carbon and past its luminous portion, which cannot be done without casting a dense shadow in at least one direction, which, for obvious reasons, is objectionable. This objection is avoided by the use of the arch-shaped carbon, as pointed out at lines 9–13, of page 2, of the specification of complainant's patent. A second advantage of this form is that the expansion and contraction of the carbon necessarily arising from the extreme variations of temperature to which it is subjected, are com-
63 pensated for in the arch itself, and this without the necessity of altering the position of the terminal supports, or of providing any special devices or means for adjustment, such as were necessary in the earlier form of lamp described in patent No. 205,144. This feature is referred to in the specification, beginning at line 100 of page 1. A third advantage, which is quite important in practice, although not mentioned by the patentees, is that by thus doubling the incandescent conductor back upon itself in the form of an arch or loop, a much greater length can be placed within a glass globe or bulb of the form and dimensions usually preferred for lamps, than would be possible in case a straight carbon were

used; and a fourth advantage, also not referred to by the patentees, is that the diffusion or distribution of the light through the space to be illuminated is more uniform with an arch-shaped than with a straight illuminant, especially when the arch is placed in an inverted position.

Referring, second, to the substance of the illuminant, the specification explains that this is formed of organic as distinguished from inorganic carbon. Inorganic carbon, of which the so-called mineral or gas carbon is an example, consists of an aggregation of minute particles of carbon, which adhere together in dense and extremely hard masses. This substance can only be worked into shape with extreme difficulty and labor, and is harder and more inflexible and brittle even than glass. Organic carbon, on the contrary, is of a cellular or fibrous character, is comparatively soft, and by proper manufacture may be made extremely flexible, elastic and tough. By the employment of the last-named species of carbon several important advantages are secured. Some of these advantages are mentioned on page 2, line 21, of the specification as follows:

"The advantage resulting from the manufacture of the carbon from vegetable fibrous or textile material, instead of mineral or gas
carbon, are many. Among them may be mentioned the con-
64 venience afforded for cutting and making the conductor in
the desired form and size, the purity and equality of the carbon obtained, its susceptibility to tempering, both as to hardness and resistance, and its toughness and durability."

Moreover, the illuminant may be partially or wholly shaped before carbonizing. This method of procedure, which is referred to on page 1, lines 91–94, permits, first, of a selection of the proper material for producing carbon of uniformly good quality; second, of shaping the same so as to admit of more uniform and complete carbonization than would otherwise be possible; third, of shaping the same with economy and convenience; fourth, of giving to the illuminant, while in the process of manufacture, a predetermined resistance to the electric current, by varying its length, cross-section and density, whereby it can be adapted to any required system of electrical distribution; and fifth, it preserves the organic form and structure of the original blank, thereby conferring upon the illuminant great toughness and durability.

The patent, as I understand it, sets forth both a discovery and an invention. The discovery is that structural or organic carbon possesses an inherent adaptation to the peculiar requirements of incandescent lighting, and the invention consists in endowing such carbon with certain valuable properties and a better form, and in combining the same with other elements already known, but which were necessary to constitute a practical incandescent lamp for lighting by electricity.

I will now compare the structure of the defendant's lamp with the several claims of the patent. The first claim is as follows:

"An incandescing conductor for an electric lamp, of carbonized fibrous or textile material, and of an arch or horseshoe shape, substantially as hereinbefore set forth."

65 I understand this claim to be for what may be termed an article of manufacture, to wit, an incandescing conductor of fibrous or textile material for an electric lamp, and of an arch shape—that is to say, the conductor claimed must be of a certain material, and also of a certain form.

The defendant's lamp contains an incandescing conductor of a fibrous material, to wit, bamboo cane, which is first shaped and then carbonized, and afterwards mounted in the lamp in the form of an arch or horseshoe. The incandescing conductor or illuminant of defendant's lamp is, therefore, composed of the material, and has the same shape as that claimed in the first claim, and it possesses all the advantages I have mentioned as arising therefrom.

The second claim is as follows:

"The combination, substantially as hereinbefore set forth, of an electric circuit and an incandescing conductor of carbonized fibrous material, included in and forming part of said circuit, and a transpatent hermetically sealed chamber in which the conductor is enclosed."

I understand this claim to be for a combination of an incandescing conductor of the material specified, being the same as the material of the first claim, but irrespective of its form, in combination with an electric circuit in which it is included, and a transparent hermetically sealed chamber within which it is enclosed, which chamber I find by reference to the specification is one from which carbon-consuming gases are excluded.

I find all the elements of this combination present in the defendant's lamp when the same is in operation; the structure, combination and mode of operation being substantially the same. In this lamp the air which contains oxygen, a carbon-consuming gas is excluded, having been withdrawn by the exhaustion of the globe.

The third claim is as follows:

"The incandescing conductor for an electric lamp, formed of carbonized paper, substantially as described."

66 I understand this claim to be for an incandescing conductor, not of carbonized fibrous or textile material generally, but of a specific variety of such material, namely, paper. Assuming the patentees to use the term "paper" in a generic sense, it might be held to mean vegetable fiber in thin flat sheets, however produced; whether by the ordinary and well-known process of paper-making, or by shaving with an edge tool from a mass of wood as for example, in the case of the material commercially known as wood-paper hangings. In my judgement the bamboo or endogenous wood from which the defendant's carbon is made, can hardly be considered to properly fall within the class of material apparently intended by the patentees to be covered by this claim.

It might be contended that, inasmuch as the actual material is the same, that is to say, interlaced vegetable fiber, and that this is reduced to thin flat sheets or plates, in one or more directions before carbonizing, it would, in view of the state of the art, and assuming the patentees to be the first to use organic material in any form reduced to such thin sheets or plates, constitute a substantial equivalent, especially as such thin sheets had already been used in the industrial arts as an equivalent for paper for some purposes; but on the whole I am inclined to the opinion that the patentees designed to limit the scope of this claim to the specific article of paper in the common acceptation of the term, that is to say, thin sheets made from macerated vegetable pulp, pressed and dried.

The fourth claim is as follows:

"An incandescing electric lamp consisting of the following elements in combination: First, an illuminating chamber made wholly of glass hermetically sealed, and out of which all carbon-consuming gas has been exhausted or driven; second, an electric circuit conductor passing through the glass wall of said chamber and hermetically sealed therein, as described; third, an illuminating conductor in said circuit, and forming part thereof within said
67 chamber, consisting of carbon made from a fibrous or textile material, having the form of an arch or loop, substantially as described, for the purpose specified."

I find all the elements of this claim present in the structure of the defendants, namely: First, an illuminating chamber made wholly of glass and hermetically sealed, out of which all carbon-consuming gas, that is to say, oxygen, has been exhausted; second, a circuit conductor passing through and hermetically sealed into the glass wall of the chamber; and third, the incandescent or illuminating conductor consisting of carbon made from a fibrous or textile material, and in the form of an arch or loop.

My opinion, therefore, is that the defendant's lamp contains the invention set forth in the specification and claimed in the first, second, and fourth claims of the patent in suit.

Counsel for complainant offers in evidence the lamp shown to the witness in connection with the fourth interrogatory, and referred to throughout the testimony as "Complainant's Exhibit Defendant's Lamp, H. D. G., examiner," and it is so labeled by the examiner.

Counsel for defendant admits that the lamp offered in evidence by complainant, and marked "Complainant's Exhibit Defendant's Lamp," is a type of the lamps in use by the defendant, and is made substantially as described in the assumption of complainant's counsel in Int. No. 4.

Cross-examination of FRANKLIN L. POPE by J. C. TOMLINSON, Esq., counsel for defendant:

5 X Q. In your answer to question 4, you say the defendant's lamp consists of three essential parts, first, an enclosing chamber composed wholly of glass, which has been hermetically sealed after the removal of the atmospheric air originally contained therein. Please look at defendant's lamp, and tell me whether the following is a correct description of its structure: The lamp consists of
68 what may be called two parts, one part consisting of an enclosing globe or bulb made entirely of glass; the other part

consisting of an incandescing conductor and wires to which it is attached in the interior glass portion. The inside part contains a filament of carbon first united mechanically and then electro-plated to two small platinum wires. These platinum wires pass through the glass, the glass being sealed around the wires by the fusion of the glass. The inside part is then inserted in the glass bulb and a seal is made by hermetically sealing the glass bulb and the glass of the inside part by fusion of the glass; the lamp as an entirety being now complete, the air is exhausted from the top of the bulb where the "tit" is, and which previously was an open tube, and after being exhausted a hermetical seal is made at this point by the fusion of the glass.

Ans. I think your question correctly describes the structure of the lamp and the manner in which its parts are assembled together. I am unable to determine from any inspection of the exhibit whether the ends of the incandescing conductor are united to the leading-in wires by the process specifically mentioned, namely, electro-plating. They are, however, united in some manner which ensures a good conducting electrical connection between the incandescing conductor and the leading-in wires.

X Int. 6. Is it not true that the completed lamp chamber of defendant's lamp is composed entirely of glass, except only where the platinum wires pass through the glass, around which the glass is fused?

Ans. Yes.

X Int. 7. At what point or points in defendant's lamp is there any danger of leakage, if at all?

Ans. There is practically no danger of leakage except at the points where the leading-in wires pass through the walls of the chamber.

X Int. 8. Do you know why at this point platinum wires are used?

69 A. Doubtless for the reason that the co-efficient of expansion by variations of temperature is very nearly the same in platinum and in glass. If I am rightly informed, platinum more closely approaches glass in this respect than any other metal.

9 X Q. Have I a correct understanding that these platinum wires are very small, and that the glass is fused around them?

A. Yes. I should say the thickness of the wire in the "Exhibit Defendant's Lamp" would not exceed four or five thousandths of an inch, and the glass is sealed around it by fusion for a length of something like one-quarter of an inch.

10 X Q. What is the electrical resistance of defendant's lamp?

A. This cannot be determined except approximately from its appearance; somewhat more than two hundred ohms when cold, a little more than half the cold resistance when heated would perhaps be a fair approximation.

11 X Q. Is not defendant's lamp intended to maintain a high vacuum?

A. Yes.

12 X Q. What is the length of the conductor that becomes incandescent in the defendant's lamp?

A. I should judge about six inches.

13 X Q. In your fourth answer, when speaking of the patent in suit, you refer to letters patent No. 205,144, granted to Sawyer and Man, and say the points of difference between the patent in suit and the patent No. 205,144, consist in the substance and form of the conductor which in the patent in suit is of a fibrous origin and in the arch form, whereas, in the former patent, the conductor was straight and of non-fibrous carbon. When the patent in suit speaks
of the lamp being made "wholly of glass," do you under-
70 stand that it refers to such a lamp as shown in the patent in
suit, and in the patent No. 205,144 as wholly of glass, in the
sense of these patents?

Ans. I do not understand the meaning of the expression to be restricted to a chamber made wholly of glass and made in the precise form and in the particular manner that is described in patents No. 205,144 and in the patent in suit, but to refer in general to a lamp chamber made wholly of glass of which the construction shown in these two patents is one example.

X Int. 14. Do you understand the construction shown in patent No. 205,144?

Ans. I think so.

X Int. 15. The patent in suit between lines 20–25, page 1, says, "Our improvements consist, first, of the combination in a lamp chamber composed wholly of glass, as described in patent No. 205,144, of an incandescing conductor, &c." Do you understand from this statement that the inventors regarded the lamp chamber of patent No. 205,144, as composed wholly of glass?

Ans. Apparently they did so regard it.

X Int. 16. Do you so regard it?

Ans. Yes.

X Int. 17. Do you think it is composed wholly of glass in the sense in which defendant's lamp is composed wholly of glass?

Ans. I think so, inasmuch as in both structures the chamber is composed wholly of glass, except as to the openings through the walls, which are filled with the substance of the leading-in wires. In the ordinary use of language both chambers may, in my opinion, be regarded as being wholly of glass.

X Int. 18. Do you know where the terms or words "wholly of glass," as applied to incandescent lamps had their first expression in the art?

Ans. I do not.

71 19 X Q. Or as to what style of construction they were first
applied?

A. I do not.

20 X Q. You give them then their popular meaning, and any lamp chamber which in a general sense was wholly of glass would be within the meaning of those terms?

A. I should hardly give it quite so broad a signification as that. The meaning the expression conveys to my mind is a chamber which is wholly of glass except in so far as is necessary to convey an electric current into the chamber and out again by means of the metallic conductors.

21 X Q. Must the chamber be of one continuous piece of glass to be wholly of glass within your understanding of the words, or would a glass dome resting on a glass base, there being an artificial cement between the dome and the base, constitute a chamber composed wholly of glass within your understanding of those words?

A. I think such a chamber as you have described may properly be regarded as a chamber wholly of glass.

22 X Q. Would the thickness of the cement have anything to do with it?

A. I do not see that it would.

23 X Q. You say you understand the construction of patent No. 205,144?

A. I think so.

24 X Q. Is there anything in patent No. 205,144 which describes the chamber as being made wholly of glass?

A. I do not think the patent contains any specific statement to that effect in so many words. It does, however, describe a glass globe fitted and ground air-tight to a glass base, the joint being, as the patentees state, slightly coated with fir-balsam, or some cement, when being put together. It is also stated that two holes are drilled through the base, into which metallic tubes are fitted, through which the conductors pass, and these tubes electrically
form a part of the conductor. Such a structure is, in *of the*
72 *conductor. Such a structure is, in* my opinion, properly de-
scribed as a chamber composed wholly of glass.

X Int. 25. The glass dome of the lamp of patent No. 205,144 is, as I understand, placed upon a glass base, and the two united together by a cement and further held by pressure; am I correct?

Ans. I do not understand that the parts are, strictly speaking, united by a cement. They are held together by a mechanical clamping device, and the function of the cement is solely to prevent leakage. That is to say, if the parts fitted each other with absolute accuracy the action of the clamps would be sufficient to maintain the union between the parts, and the employment of any intervening substance would be wholly unnecessary. The patentees state that the fir-balsam or cement is used "in order the better to insure that hermetical sealing which is indispensable to the preservation of the incandescent conductor." I do not find any other function suggested.

X Int. 26. Would such a structure as is here shown preserve such a vacuum as is required to be preserved in defendant's lamp?

Ans. I think it doubtful if so high a vacuum could be preserved with that particular structure.

X Int. 27. In patent No. 205,144 the conductors "J" "K" are made hollow, are they not?

Ans. Yes.

X Int. 28. They pass through bolts, which bolts in turn pass through the glass plate forming the base of the lamp, do they not?

Ans. Yes.

X Int. 29. Would the structure at these points preserve such a vacuum as is necessary to be preserved in defendant's lamp?

Ans. Probably not; that is, not a high vacuum.

X Int. 30. There are, then, four points of danger of leakage in this lamp; first, where the glass dome rests on the glass
73 base; second, where the bolts pass through the glass base; third, where the tubes pass through the metallic bolts; and fourth, the point outside where the tubes can be connected with the apparatus to charge the lamp with the artificial atmosphere?

A. Yes, such would be the case if constructed in accordance with the drawings.

31 X Q. Is there anything to indicate in this patent that the tubes are made of a material having the same or approximately the same co-efficient of expansion and contraction as the glass?

A. I think not. It is apparently left entirely to the discretion of the constructor as to what metal he would use.

32 X Q. Would this structure, as a whole, preserve such a vacuum as is required to be preserved in defendant's lamp?

A. It undoubtedly would be insufficient to preserve such a high vacuum as that which is actually used in defendant's lamp.

33 X Q. What do you understand to be the object of the lumps of sodium or potassium marked respectively "R" and "S," and shown in this drawing?

A. The patentees state that these are placed in the chamber by preference as a safeguard against an infinitesimal leakage. These substances have a great affinity for oxygen, and the evident intention of the patentees was to have these substances in the lamp, so that in case any small amount of oxygen should penetrate the lamp chamber it would be absorbed, and not brought in contact with the carbon.

34 X Q. This would rather look as though they expected what they call an infinitesimal leakage, would it not?

A. It shows that they contemplated the possibility of it.

35 X Q. Do you not think their contemplation was justified?

74 Ans. Yes; I think it might be fairly assumed that it was.

X Int. 36. What do you understand to be the object of the soapstone disc "C" in this lamp?

Ans. It appears to have been to obstruct the radiation of heat from the illuminant towards the base of the lamp, and thus to prevent the metallic parts at the base from being too much heated.

X Int. 37. Why were the conductors "J" and "K" made so long?

(Before any further examination in regard to patent No. 205,144, it is objected to by counsel for complainant as incompetent and immaterial.)

Ans. Apparently for the purpose of increasing the distance between the illuminant and the base of the lamp.

X Int. 38. I do not know that I understand you: how increase the distance?

Ans. The longer the conductors are the higher the illuminant which is supported upon them is raised above the base.

X Int. 39. That I understand, but these conductors are made fluted, so as to have a greater length than would be required to place the illuminant at the point above the base of the lamp which it occupies. What I intended to ask was, why this length of conductor is employed?

Ans. Apparently for the purpose of increasing the radiating surface, so that a less amount of heat is conducted to the base, or a less amount of heat reaches the base by transmission through the conductors.

X Int. 40. Now, if this structure would have maintained the atmospheric conditions the inventors desired, the soapstone disc and the fluted conductors would have been unnecessary, would they not?

Ans. Perhaps so. The type of lamp shown is calculated to generate a great amount of heat while in operation, and this
75 might be sufficient to cause fractures from unequal expansion
of the glass of the chamber itself when of the configuration shown in the drawing, but it is explained in the specification that the object of the soapstone diaphragm was to prevent leakage which might arise from expansion of the parts surrounding in joints, and the spiral arrangement of the conductors was also designed to aid in bringing about this result.

41 X Q. The presence of these structures, then, would indicate that the inventors did not consider that their lamp without them would maintain the atmospheric conditions desired.

A. They were evidently added as safeguards against a difficulty which they spprehended might arise. It is not perhaps necessary to infer that they considered them absolutely indispensable.

42 X Q. They of course added to the expense of the construction?

A. Undoubtedly.

43 X Q. Do you understand from this patent that the lamp was to contain an artificial atmosphere at atmospheric pressure.

A. The patentees state that the atmospheric air is to be expelled from the globe or chamber and its place supplied by an artificial atmosphere. I think it is not distinctly stated whether this artificial atmosphere is to be maintained at the same pressure as that of the external air, but I infer that such is the design.

44 X Q. It is stated in the patent that "a perfect vacuum is unattainable." If at the time this application was filed this was the best construction the patentees had been able to get, should you not think then that they were quite justified in their statement?

A. I think the statement is justified in any event, for so far as we yet know it is literally true.

76 45 X Q. For all practical purposes at the present time *time*
a perfect vacuum is obtained and preserved in such a lamp as defendant's, is it not?

Ans. For practical purposes, yes.

X Int. 46. Now, if at the time of the application for this patent No. 205,144, the structure shown was the best the patentee had been able to get, should you not think that for all practical purposes of incandescent lighting they were justified in their statement that a perfect vacuum is unattainable?

Ans. I should regard it as quite doubtful whether a perfect vacuum could be maintained in a chamber having the construction described and shown in this patent, but I am not willing to go so far as to say that it is impossible.

X Int. 47. What should you say was the resistance of the incandescent conductor of the lamp of patent No. 205,144?

Ans. I could not say; possibly one ohm or something like that.

X Int. 48. Turning now to the patent in suit, what do you regard the invention of the first claim of the patent to be?

Ans. In my opinion it is what is technically known as an article of manufacture, namely, an incandescing conductor, for an electric lamp, of a specific material and of a particular form, the material being fibrous or textile material which has been carbonized in such a manner as to confer upon it certain properties and to which has been given an arch or horseshoe shape.

X Int. 49. I do not know as I understand what you mean by saying that the material has been so carbonized as to confer upon it certain properties. Suppose you had an arch-shaped conductor made of fibrous carbon which had not been so carbonized as to confer upon it what you mean by certain properties, would it be within the invention of the claim?

Ans. As I understand it, the carbonization must have
77 been effected in such manner as to confer upon the material
the properties set forth in the specification as tending to increase its usefulness as an incandescing conductor. These qualities are particularly mentioned in the specification, lines 24–30, as follows: "Among them may be mentioned the convenience afforded for cutting and making the conductor in the desired form and size, the purity and quality of the carbon obtained, its susceptibility to tempering both as to hardness and resistance, and its toughness and durability." It is possible to carbonize fibrous or textile material or at least to convert it into a form of carbon which does not possess these properties or any of them to a useful extent, and such material would not, in my judgment, be within the meaning of the terms of the claim.

50 X Q. In order, then, to predicate infringement of the claim you would have to know something more than whether the conductor alleged to infringe was of carbonized fibrous or textile material, and of an arch or horseshoe shape?

A. It would only be necessary to know, in addition to this, that it possessed the properties or some of the properties which are mentioned in the specification, and which reference I have quoted in my last answer. The presence of some of these properties can be determined without difficulty by a mere inspection of the lamp.

51 X Q. That may all be, but as I understand you, the possession of these properties, or some of them must be present to constitute infringement?

A. Yes, I so understand it.

52 X Q. Now, as this may become very important, what are the

properties specifically, in your judgment, that must be possessed to predicate infringement?

A. The carbon must, in the first place, have been made from fibrous or textile material. This must have been carbonized in such a manner as to preserve the organic structure of the material, 78 and thereby to possess qualities of tenacity or toughness and durability. The quality of durability implies that it should have a certain degree of flexibility and elasticity, or rather resilience. This quality also implies a certain purity and uniformity of the structure of the carbon throughout. There may be other qualities desirable, but those I have mentioned appear to be essential.

X Int. 53. The possession or absence of these properties depends entirely upon whether the material has been properly carbonized, does it not?

Ans. Yes; they can only be obtained, so far as my present knowledge extends, by carbonizing the material in a retort, or similar vessel, from which air is excluded.

X Int. 54. It comes down to this, then, if I understand you correctly: To infringe this claim the conductor must have been made from fibrous material, be of an arch shape, and have been properly carbonized?

Ans. Yes; I think that expresses it.

X Int. 55. To have the conductor of the fibrous or textile material, and of an arch form which has been properly carbonized so as to come within what you understand to be the invention of this claim, what is necessary to be done to insure such carbonization, in your judgment?

Ans. It is necessary to shape the material either wholly or in part; that is to say, to shape it in at least one of its dimensions, namely, breadth or thickness, before carbonizing, and to carbonize it by heat in a closed retort or similar vessel to which the air cannot have access during the process of carbonization.

X Int. 56. Do we then get down to this: That to predicate infringement of this claim you must not only have a conductor of carbonized fibrous or textile material, and of an arch form, but in carbonizing the material it must have been cut to size in at least one of its dimensions before carbonization, and carbonized in a closed retort, or similar vessel, from which air is excluded?

79 Ans. I am not willing to assent exactly to that statement. The invention, as I have said, is, in my opinion, an article of manufacture made from certain raw material and possessing certain properties or qualities. So far as I am aware, these properties or qualities can only be conferred upon the material by first shaping it in at least one of its dimensions, and afterwards carbonizing it in a closed vessel; but should any process be hereafter discovered by which the same raw material can be treated so as to endow it with the same qualities, the manufactured article would, in my judgment, still be that of the claim.

57 X Q. You regard the claim then as practically covering a conclusion. In other words, you may get the article of manufacture of the claim, to wit, an in*ca*ndescent conductor of carbonized fibrous

or textile material, and of an arch or horseshoe shape, but such article may or may not infringe, according as it does or does not possess certain qualities.

A. It is a conclusion in the sense that any completed manufactured article may be the conclusion of a process consisting of successive steps, and it would not be infringed by an article which did not possess any of the essential qualities such as those mentioned in the specification, in which its peculiar value for the purposes for which it is to be used resides.

58 X Q. Don't you regard your position as taking an extremely novel view of a claim or invention?

A. I do not know that it is. I am not aware that the novelty of qualities found in an article of manufacture is necessarily dependent upon the process employed in producing it. Of course such may be the case, but it is not necessarily the case.

59 X Q. The trouble is that the claim is not for a process, but, as you say, for an article, and it seems to me extremely novel to say that while you may get the article of the claim, you cannot say whether you have got the invention of the claim until you know whether the article has or has not certain properties. This would make an infringement depend upon the skill of the infringer. If he did his work well he would infringe; if he did his work poorly he would not, and yet in each case you have the same article. Isn't that a novel position?

Ans. I do not consider it the same article unless it has substantially the same properties with reference to the purpose for which it is to be used, and so long as it has those properties I am unable to see how it is material by what process the properties are conferred upon the article, so long as there is some process, either well known or pointed out in the specification which will answer the purpose.

X Int. 60. Here we have defendant's lamp, which you say infringes. Suppose I should bring you another lamp exactly like this, excepting that the carbon filament had been improperly carbonized. Would this second lamp infringe the claim of the patent?

Ans. If the second lamp possessed the qualities pointed out in the specification which I enumerated in my answer to Int. 48 I think it certainly would infringe. If the filament had been carbonized in such a way that its organic structure was destroyed, and it was rendered inelastic and brittle, as, for example, like mineral or gas carbon, then it would not be an infringement.

X Int. 61. Your definition of the claim seems to open the door to a question of degree. An infringement must depend, as you say, not upon the article itself, but upon the possession by that article of certain properties. At one end of the line there would be a clear case of infringement; at the other there would be none. Can you point out what you would call the dividing line, and say just when infringement would be present and when it would not?

Ans. It does not appear to me that there is any real difficulty in practice in drawing a distinction between organic material which

has been carbonized in such a manner as to preserve its
81 organic structure, its elasticity, flexibility and toughness, and material which has been carbonized in such a way that these properties have been destroyed, and this, it seems to me, is the real distinction. The claim evidently contemplates an incandescing conductor possessing qualities which render it useful as an element of an electric lamp. If a conductor was formed of fibrous material and carbonized in the open air, or in such a manner that the air had partial access to it, it would be soft and friable, entirely inelastic and utterly useless for the purpose contemplated by the patentees. Such an article, obviously, would not be the one to which the claim is designed to refer.

62 X Q. Do you attach any special meaning to the words "substantially as hereinbefore set forth" in the claim?

A. They are intended to refer, of course, to the description in the specification, but I consider that such reference would be implied even if these words were not present. They have no other meaning to my mind.

63 X Q. Which of the elements of the second claim do you regard as new at the time the application was filed?

A. I am not certain that any of the elements are new.

64 X Q. Is the combination new?

A. So far as I know it was new at the date when this invention is alleged to have been made.

65 X Q. I did not ask that. What I would like to know is if you consider the combination new at the time the application was filed.

A. If I recollect right, the combination had been described in a printed publication prior to the date on which the application purports to have been filed. That is to say, January 9th, 1880.

66 X Q. Had the invention of the first claim also been described in a printed publication prior to that time?

A. I think it had.

82 X Int. 67. Had the invention of the third claim been described in a printed publication prior to that time?

Ans. I think so.

X Int. 68. And of the fourth?

Ans. I think so.

X Int. 69. To what publication are you referring?

(Objected to as incompetent and as not being cross-examination.)

Ans. The publication which I have in mind is the "New York Herald."

X Int. 70. Carbonized fibrous material had been used as an incandescent conductor for an electric lamp long anterior to the application for the patent in suit, had it not? There were many patents and publications showing and describing lamps in which the conductor was stated to have been of carbonized fibrous material?

(Objected to as incompetent.)

Ans. I do not know about the use. There were publications, and possibly patents, in which charcoal was described as the incandescing conductor, and charcoal, broadly speaking, is cabonized fibrous material.

X Int. 71. There were numerous patents and publications in which incandescent lamps were shown having arch or horseshoe shaped conductors, were there not, long prior to the application for the patent in suit?

(Objection repeated.)

Ans. I think there were one or more instances of the use of a conductor which might be regarded as of an arch or horseshoe shape anterior to the date of the application for the complainant's patent.

X Int. 72. Do you know whether any patents or publications long anterior to the application for the patent in suit described cutting fibrous material to the size desired, and carbonizing it after being so cut for use in electric lamps?

(Objection repeated.)

83 A. I do not recall any such instance.

73 X Q. Was it not well known long prior to the application for the patent in suit how to carbonize fibrous or teztile material, and had not such material been carbonized repeatedly, and descriptions published of the way it had been carbonized, so that the material after carbonization would possess the properties pointed out in the patent in suit?

A. Certainly; all this was well known in the arts.

74 X Q. Had you any connection with the application for the patent in suit, or were you consulted in any way in regard to it?

A. I had no connection with it, but I think I was once consulted about it. I recognize the drawing which forms the first sheet of the illustrations accompanying the patent in suit as having been shown me several years ago. I did not, however, read the specification, nor was I made acquainted with its contents.

75 X Q. Have you read recently, and are you famillliar with the original application for the patent in suit?

Objected to as incompetent and as not being cross-examination.

A. I have read a copy of it once since the patent was issued, but cannot say that I am at all familiar with it as distinguished from the specification as issued.

76 X Q. I show you what purports to be a copy of the specification and claims as originally filed. Do you find anything in this specification to indicate a preference on the part of the inventors for fibrous or non-fibrous carbon?

Counsel for complainant objects to the question as not cross-examination, and therefore incompetent, and this objection is now entered to any further questions which may be asked relating to the application, or to the file-wrapper and contents of the patent in suit.

A. The first and second claims refer to incandescing arcs 84 (meaning, I suppose, incandescing curved illuminating conductors) of carbon, broadly, while the third claim includes, as one of its elements, an incandescing arc of carbonized paper. This would seem to indicate a preference for the fibrous material for practical purposes, inasmuch as it is the specific form which is preferred to be claimed in connection with the gerneric form.

X Int. 77. Any preference that they might have then for fibrous or non-fibrous material is left to be inferred and is not expressed?

Ans. No express statement of preference occurs in the specification, so far as I observe.

X Int 78. Does this original specification point out or suggest any advantages that would be possessed by fibrous over non-fibrous carbon?

Ans. I think not.

X Int. 79. In the specification it is stated "we have tried carbonized paper covered with powdered plumbago." What do you understand such statement to mean?

Ans. It means to my mind exactly what it says, that carbonized papĕr had been used by the patentees in the combination which they describe.

X Int. 80. What meaning do you attach to the words "covered with powdered plumbago" as connected with the statement of the use of carbonized paper?

Ans. Its most obvious meaning is that powdered plumbago had been applied to the surface of the paper after carbonization. It may possibly mean that paper covered with powdered plumbago had been carbonized. I think the first is the most probable meaning of it.

X Int. 81. Or, in other words, that what they tried was not pure carbonized paper, but a composit conductor of paper covered with plumbago?

Ans. The passage appears to mean a combination of carbonized paper and powdered plumbago. Whether the plumbago is applied before or after carbonization, or both, does not appear to be clear.

85 82 X Q. What advantages does this original specification point out as being possessed by the arch form?

A. I do not find that anything is mentioned beyond the fact that the shadow cast by the arched burner is less than that produced by other forms of burners, referring, I presume, to such an arrangement of the burner as that shown in patent No. 205,144, upon which this invention professes to be an improvement.

83 X Q. Bearing in mind that patent No. 205,144 contemplated the use, as you think, of an inert atmosphere at atmospheric pressure, do you find anything in this original application for the patent in suit to suggest that the lamp contemplated in this original application was to have anything but an inert atmosphere at atmospheric pressure?

A. The specification says "we have used such burners in close transparent chambers, in a vacuum, in nitrogen gas, and in hydrogen gas, but have attained the best results in the vacuum, or attenuated atmosphere of nitrogen, the great desideratum being to exclude oxygen from the combustion chamber, as is well understood." This appears to distinctly imply that the desideratum being to exclude oxygen from the chamber this might be effected in different ways mentioned, preference being expressed for either a vacuum or an attenuated atmosphere of nitrogen. The plain meaning of the statement is that either the nitrogen atmosphere or a vacuum may be used, according to the convenient or preference of the constructor.

84 X Q. Bearing in mind patent No. 205,144, and reading this original application, and considering the drawing of the lamp which I now show you, what should you say the resistance of this lamp was? (Drawing of the patent in suit shown witness.)

A. It is difficult to say exactly, because so much depends upon the density and consequent conducting power of the carbon. Assuming figures 3 and 4 to be drawn to the actual size of the
86 carbon, I should imagine the actual resistance of the incandescing conductor would be about one ohm, possibly somewhat less than that. I assume, of course, that the carbon is of the ordinary quality of fibrous carbon.

X Int. 85. Suppose this conductor were of hard carbon, what would its resistance be?

Ans. It would be considerably less; perhaps not more than half as much.

X Int. 86. It would be about half an ohm, you would think?

Ans. Say half an ohm or less.

X Int. 87. In this lamp, as I understand, we have the soapstone disc, the fluted conductors, and the same general construction of the lamp base as is shown in patent No. 205,144?

Ans. Nothing is said about the soapstone disc, although the reference to the former patent 205,144 might raise a presumption that it was intended to be used.

X Int. 88. There are the same fluted conductors, are there not?

Ans. Yes.

X Int. 89. And the same general construction of the lamp base?

Ans. Yes.

X Int. 90. Is it your opinion that the lamp, as shown in the drawings of this patent as explained by the original specification, and the reference to patent No. 205,144 would be practically operative as an incandescent lamp?

Ans. I think so.

X Int. 91. Capable of use commercially?

Ans. I see no reason why it should not.

X Int. 92. Do you think it would maintain a vacuum under conditions of actual use?

Ans. As I have before said I think it doubtful if it would maintain a high vacuum for any great length of time. I see no reason, however, why, if carefully made and filled with nitrogen at or
87 somewhat less than atmospheric pressure, it might not operate successfully for a considerable length of time.

93 X Q. You would prefer then the atmosphere of nitrogen to an attempt at a vacuum in such a lamp?

A. Speaking from my general knowledge and in the absence of experimental knowledge, I should say that with the precise mechanical construction shown the best results would be obtained with a nitrogen atmosphere.

94 X Q. Suppose you had a thousand of these lamps, bearing in mind that they would have a resistance of about one ohm each, arranged in multiple-arc circuit and a quarter of a mile from the point where the current that supplied them was generated, what, approximately, would be the size of the conductors running from the scource of electrical supply to the lamps?

A. Under the conditions of distribution assumed, it would be very absurd to make the incandescent conductor of the size and shape shown in the drawings, but assuming that this were done, the conductors leading from the scource of supply to the lamps would necessarily have to be very large.

95 X Q. In order that we may get at some idea of their size, suppose these conductors to be of copper, what should you say their diameter would have to be? I, of course, understand that any answer you may make to this would be only approximate.

A. They would need to be very large; possibly 4 or 5 inches in diameter.

96 X Q. As a practical question, considering the cost of installation, such an installation would be absurd, would it not?

A. Of course it would be utterly absurd. If there were any reason why the constructor should be confined to the precise length and section of an incandescent conductor shown in the drawings of the
patent, he would get a much better result by placing his
88 thousand lamps in series, in which case a conductor large
enough for one lamp would be large enough for all.

X Int. 97. Well, now, we will suppose you arrange your thousand lamps in series, the resistance of each lamp being an ohm. Do you think that would be a practical installation?

Ans. Certainly it would.

X Int. 98. You would have to have in this case a current of much greater pressure, or electro-motive force, than in the other, would you not?

Ans Certainly.

X Int. 99. What would have to be the electro-motive force or pressure of your current for such an installation?

Ans. Perhaps it might be something like 1,000 volts.

X Int. 100. If you are to arrange such lamps as these in series, is it not an advantage to have the resistance as low as possible?

Ans. Yes.

X Int. 101. As you increase the electro-motive force coming to such lamps as these, do you increase the chances of destruction of the lamp, or lessen its light?

Ans. No, because the difference of potential between the terminals of any individual lamp is no greater when 1,000 lamps are in series than with any less number. Increasing the pressure in proportion to the number of lamps in series increases the electric strain on the generator, but not on the individual lamps.

X Int. 102. Your first lamp in such an installation would have a resistance of one ohm in the conductor and a current of an electromotive force of 1,000 volts passing through it, would it not?

Ans. Yes.

X Int. 103. Don't you think that would destroy the lamps, such lamps as shown in this patent?

Ans. No, because the same current passes through the other
89 999 lamps also, and the combined resistance of these diminishes the current, so that the actual strength of the current passing through any one lamp and the actual difference of potential between the terminals of any one lamp is the same, irrespective of the number of lamps in the circuit.

104 X Q. Do you think incandescent lighting would have come into practical use if the art had never gone further than such a lamp as shown in this patent?

A. Not into anything like the universal use that it is at present, but nevertheless, such a system as I have referred to, namely, a large number of lamps of low resistance placed in series in a single circuit has many elements of utility, and would have found extended practical application. Substantially the same principle is now coming into use in many places for street lighting by incandescence.

105 X Q. What form of arrangement, multiple arc of series, would you consider best adapted for a lamp of the kind shown in this patent?

A. For a lamp of the particular dimensions shown in this patent, the series system, but I consider that it would be the same kind of a lamp if the length of its illuminant were increased, and its cross-section diminished so as to increase its resistance. An incandescent lamp is like a telegraph instrument or any other translating device. Its resistance is made greater or less according to the system of distribution or strength of current in which it is designed to be operated.

106 X Q. Was it not old at the time the application for the patent in suit was filed, to enclose an incandescent conductor in a transparent, hermetically sealed chamber?

A. Yes; such an organization had been described in printed publications prior to that date.

107 X Q. Was not this construction also old at the date of the application for the patent in suit: an electric lamp consisting of an illuminating chamber made wholly of glass hermetically
90 sealed, and out of which all carbon-consuming gas had been exhausted or driven, an electric circuit conductor passing through the glass wall of such chamber and hermetically sealed therein, and an illuminating conductor in such circuit?

Ans. It had been described in prior publications before that date.

X Int. 108. In your direct examination you have enumerated what you consider the advantages of the arch-shaped form. Please briefly restate these advantages, numbering them consecutively?

Ans. First, by making use of this shape the objectionable shadows are avoided; second, the expansion and contraction of the carbon, arising from changes in temperature, are compensated for in the arch itself without the necessity of adjusting its point or points of attachment; third, a longer carbon having a greater resistance can be placed in a globe or chamber of given dimensions; and, fourth, the distribution of light throughout the space to be illuminated may be made somewhat more uniform than with a straight carbon.

X Int. 109. So far as the original application is concerned, none of these advantages but the first is mentioned or hinted at; is this not true?

Ans. The first is the only one referred to as far as I observe.

X Int. 110. You have stated in your direct examination on the advantages which you consider to be possessed by a conductor of carbonized fibrous material; please restate what you consider the advantages of such a conductor to be, numbering them consecutively.

Ans. First, greater facility of selecting raw material of good and uniform quality for carbonization; second, ability to bring the material into proper form and size for thorough and uniform carbonization; third, ability to predetermine approximately the resistance to be given to the carbon before carbonization; fourth, convenience of thus shaping and forming while the material is 91
in a condition to be easily worked; fifth, the uniform specific resistance and mechanical condition of the carbon thus obtained; sixth, its susceptibility of being hardened and its resistance brought to a standard after carbonization; seventh, its superior mechanical qualities in respect to toughness, resilience, and durability. There are, perhaps, other minor advantages, but I think this list comprises the most essential ones.

111 X Q. Now, not one of these advantages are pointed out or even hinted at in the original application, are they?

Former objection repeated.

A. I think not.

112 X Q. If the inventors knew of these advantages, either of form or substance, don't you think it rather remarkable that in their original application no reference was made to them, or any of them?

Objected to as incompetent, and also for the reason stated in the former objection.

A. I do not know that it is. Such a statement of the advantages of an invention is very often omitted in the specification, and, in fact, in my practice as a solicitor before the Patent Office, I have occasionally been required by the examiner to erase every reference of the kind from the specification.

113 X Q. If your opinion as to the invention be correct, that the invention is not merely a conductor of fibrous carbon and in a horseshoe form, but such a conductor and in such a form, possessing certain qualities, do you not think it strange that the existance of these very things, namely, the qualities of the conductor on which you

would predicate infringement are in no way mentioned in the original application?

Objection continued.

A. I think it quite possible that the applicants were not
92 fully aware at the time the application was made of the *of the*
relative importance of this feature of their invention. The specification indicates that at the time of preparing the application they regarded the form of the incandescent conductor as the most important part of their invention. There is nothing unusual about this, as it is the most common thing in the world for inventors at first to fix upon some comparatively unimportant portion of their invention or discovery as its great feature, whereas this may be something that is old and well known, and no invention at all, while a better-informed person would see in some part of the invention, which its originators had regarded as of minor importance, a principle or combination of great value.

X Int. 114. Who, in such case, would be the inventor, the man that discovered the value or the man who had no idea of it?

(Objected to as incompetent.)

Ans. The latter, unquestionably. If a man should pick up a shining stone and show it to a lapidary, and he should tell the man that it was a diamond, it would none the less be the property of the original finder.

X Int. 115. Do you gather from the original specification that the point to which the inventors attributed value was the arch or horseshoe form?

(Objected to as incompetent.)

Ans. They certainly attributed value to the form, because they specially state its advantages, and they also claim the form, but they did not overlook the advantages of the carbon made from fibrous material, otherwise they would not have taken the trouble to specially claim an incandescing arc of carbonized paper as distinguished from carbon generally.

X Int. 116. But do you think, reading the original specification, that they considered the great point of their invention the arch form rather than the material?

Ans. I think that, taken as a whole, the specification and
93 claims perhaps indicate that the applicants attached rather
more importance to the form than to the specific material, but it is clear that they did not overlook the importance of the latter.

117 X Q. So far as there is any advantage in the arch form; that advantage is independent of the material of which the conductor is composed, is it not?

A. It may be said to be in one sense, but it is nevertheless true that the form and dimensions which it is possible to give to the arch may depend very greatly on the material of which it is made.

118 X Q. Take such form and dimensions as are shown in the

drawing of the patent. The advantages of such a form and dimensions are independent of the material, are they not?

A. The particular form and dimensions shown in the drawing could probably be constructed from almost any material which is capable of being used at all for an incandescent conductor.

119 X Q. Now are the advantages of the material independent of the form in which the material may be in?

A. Substantially, I think they are.

120 X Q. The original application speaks of the use of arches, both of fibrous carbon and of hard carbon; would there be any difference as to the durability in a lamp such as is shown in the drawing of a patent of a hard carbon conductor, and of a fibrous carbon conductor of the size of the conductor shown in such drawing?

(Objected to as incompetent.)

A. It would be hard to say, in the absence of experimental knowledge, but I should expect that it would be difficult to form such an arch from hard carbon which would be as uniform in its density and cross-section throughout as one made from structural carbon, and in case there were any want of uniformity giving rise to a greater resistance at one point than another, I should expect the carbon to become overheated at that point, and hence to be
94 liable to become fractured; but, as I have already intimated, I have no experimental knowledge which would enable me to answer the question positively.

X Int. 121. Are there not advantages of economy in the use of a vacuum over an artificial atmosphere of inert gas?

Ans. Undoubtedly.

X Int. 122. The inert gas would conduct the heat and thereby reduce the candle power and increase the heat of the lamp?

Ans. To some extent, unquestionably.

X Int. 123. This very increase of heat would endanger the life of the lamp?

Ans. I am not sure as to that; it might have some effect on it.

X Int. 124. You have referred to a publication in the "New York Herald," as I understand you, in your judgment, anticipates and describes the inventions of the claims of the patent in suit. I hand you what purports to be a copy of the fifth sheet of the "New York Herald" of Sunday, December 21st, 1879. Is this the article to which you referred?

(Objected to as not cross-examination and therefore not competent, and the alleged sheet of the "New York Herald" is objected to as incompetent.)

Ans. To be exact, I did not state the publication anticipted the invention, but that to the best of my recollection, it was published prior to the date on which the application for the patent in suit purports to have been made; that is to say, January 9th, 1880. The paper now handed me is, to the best of my recollection, similar to the publication which I had in mind, and I presume is a correct copy of the same.

X Int. 125. If the invention were made on the date of the application, this publication would anticipate it, as I understand you, in your judgment?

Ans. I have no doubt it would.

95 MAY 10TH, 1888.

Counsel for defendant produces what purports to be a copy of the Herald article referred to by the witness yesterday, and requests the examiner to mark the same "Herald article of December 21, for identification, H. D. G., examiner (L. C. W.) May 10th, 1888."

126 X Q. In your answer to the 55th question yesterday, if I understood you correctly, you said that in order for the fibrous conductor to possess the qualities necessary to be possessed in order to constitute infringement it would have to be cut either in the dimension of its thickness or width prior to carbonization. Would a conductor cut from a block of carbonized fibrous or textile material infringe the first claim of the patent?

A. In my opinion it would if it possessed the qualities which I have specified as being, in my judgment, essential to constitute it the article referred to by the first claim. I think, however, it is doubtful if carbon cut from a car-ized mass or block would, as a matter of fact, possess the qualities which would bring it within the scope of the first claim.

127 X Q. Do you base this opinion on the belief that the block of material could not be properly carbonized?

A. I think that in carbonizing a block of material the character, or at least the degree of carbonization would vary in different parts, being more complete and thorough near the external surface than in the interior. If it were possible to carbonize a block with uniformity in every part, and to cut from it an incandescing conductor which would possess all the qualities which I have said that I regarded as essential to constitute it the incandescing conductor of the first claim, then I should regard it as the conductor meant by the claim whether it was cut from a block or mass of fibrous carbon or not.

96

128 X Q. I understand it to be your opinion, however, that a block of carbon could not be so carbonized as — confer upon a conductor cut from it the properties you consider necessary. If this be so, assume that the patent as issued had contained the specification and claims as originally filed; would it in that case have stated to persons skilled in the art the invention so fully and completely as that those persons could have availed themselves of what you consider the valuable features of the invention? In answering this question, please bear in mind that there is no statement or suggestion in the original specification that the material is to be cut to size in the dimension of its width or thickness and carbonized as so cut.

Ans. While it is true that there is no explicit statement to this effect in the specification as originally filed, yet it is true that the use of paper is mentioned as one of the materials from which the incandescing conductor may be constructed, and paper is also specifically claimed as a material in one of the claims. Paper is unquestionably a fibrous material which has been brought to a shape adapting it for the purpose required in one of its dimensions before carbonization. I think therefore, that while there is no specific mention of the advantages to be derived from the use of paper, yet the fact that it is specifically claimed shows that the applicants considered it to possess such advantages.

X Int. 129. That may all be, but the point I should like your opinion on is, as to whether if the patent had issued with the specification and claims as originally filed, you would think that such a patent pointed out the invention in such a way as to enable persons skilled in the art to make, use and construct the same? You will of course bear in mind your testimony that the great point of the invention is in so carbonizing the material that it will possess the properties you have referred to?

Ans. The essential point of the invention seems to me to be the article of manufacture to which I have referred in my testimony heretofore, made of a certain material and possessing certain 97 qualities. Now this material, in one of its forms, is described in the original specification and pointed out in one of the claims, and it seems to me that it is quite sufficient not only to show what the invention is, but to enable it to be practised.

130 X Q. For the moment let us assume that all mention of paper were left out in the original specification and claim; would there then be anything to indicate to persons skilled in the art the way of making the conductor of the application so that it would possess the properties which give it value?

(Former objection repeated as to the file-wrapper and contents.)

A. I scarcely think so. The only reference which can at all be considered as bearing upon the matter is the mention of wood carbon among the substances which the applicants have tried, and wood carbon is apparently used as an alternative term for charcoal. Charcoal, however, is a substance which does not necessarily possess the qualities which I have said that I consider the essential characteristics of the material of the first claim; hence I think the original specification aside from the mention of paper does not definitely refer to the subject.

131 X Q. Now if you should take this original application and the drawing of the patent and wished to follow closely the apparatus shown and described, and were to make your conductor of paper covered with plumbago, please tell me just how you would prepare such a conductor. I ask you in making the conductor to follow the dimensions shown in the drawing.

(Objection continued.)

A. I think a person designing to follow the directions of the specification would first form his carbon of one or more thicknesses

of paper cut to the arch or horseshoe form, that he would then carbonize it and afterwards apply powdered plumbago to its surface,
and finally mount it in the lamp by attaching it to the lead-
98 ing-in conductors. As I have once before said, the language
of the specification does not make it quite clear whether the plumbago is intended to be applied before or after carbonization, but I think the most probable inference is that it meant after carbonization.

X Int. 132. Well, how would you apply it, and how much would you apply?

Ans. I should probably apply it by rubbing it on with a brush. As to the quantity, I should probably put on all that would adhere to the surface.

X Int. 133. How much would adhere to the surface?

Ans. I cannot say.

X Int. 134. What effect would the plumbago, as you would apply it, have on the conductor?

(Objected to generally as incompetent.)

Ans. I should not expect it to have any other effect than to diminish the electrical resistance of the incandescing conductor as a whole.

X Int. 135. Would the carbon, after the plumbago had been so applied, have the uniformity and purity of structure which the patent contemplates, according to your judgment?

Ans. I think so. I do not think that the purity or uniformity of structure is diminished by the external application of plumbago.

X Int. 136. Now let us see; if the plumbago had any effect, would it not lessen the resistance of the portion of the conductor to which it was applied?

Ans. It would be more nearly right to say that it would constitute an additional conductor parallel to and on the surface of the carbon conductor.

X Int. 137. The internal part of the conductor which the plumbago had not reached would have a different resistance than the outside on which the plumbago was, or the plumbago shell, if you choose to look at it in that way?

Ans. Yes.

X Int. 138. The practical effect would then be, would —
99 ance, and it would be deflected from the inner part to the
outer part of the conductor?

A. That would be the tendency, unquestionably.

139 X Q. Would the organic structure of the conductor at the point where the plumbago had been applied be interfered with by the filling up of the pores or cells?

A. No, I do not think it would. While the pores might be filled up, the organic structure or frame-work would remain unchanged, and the advantages which follow from its presence would be undiminished, the advantages being the toughness, flexibility and resilience which characterize the fibrous or cellular carbon.

140 X Q. Now, if you put enough plumbago on, all the current would leave the fibrous or paper interior, and you would practically

have as the light-giving part of the conductor a hard carbon conductor, would you not?

A. I think it would be quite impossible to mechanically attach a sufficient quantity of powdered plumbago to the surface of a conductor to deflect the whole or even the greater portion of the current from the organic part of the conductor.

141 X Q. From your knowledge of the art would you consider it an advantage or a disadvantage to cover the carbon with powdered plumbago?

A. I do not conceive that any disadvantages would arise from it except under certain conditions, as for example, when it was desired to make the resistance of the incandescing conductor as high as possible, in which case the plumbago would diminish it, and therefore be disadvantageous. On the other hand, if it were desired to make the resistance of the conductor very small, then the plumbago might possibly be of some advantage.

142 X Q. You express a doubt as to whether the true meaning of
this original application is that powdered plumbago is to be
100 placed upon the paper after carbonization or *or* before. If you
should conclude that it was to be placed upon the paper before, how would you make the paper conductor in accordance with the application?

(The former objection as to all examination relating to the application is repeated.)

Ans. I should brush the plumbago onto the surface of the paper after it was shaped, and before it was carbonized?

X Int. 143. Would this have any different or other effect than placing plumbago on the paper after it was carbonized?

Ans. I should expect it to have the same kind of effect, put perhaps in less degree.

X Int. 144. You say you would take several pieces of paper and put them together so as to get the thickness shown in the drawing; how would you cause the separate sheets of paper to adhere?

Ans. I should probably use some such material as molasses, which is capable of being converted into carbon by heat, and apply it to the surface and force them together by strong pressure.

X Int. 145. Would your pressure affect the organic structure of your carbon?

Ans. Only by diminishing the size of the cells or interstices. It would not injuriously affect it.

X Int. 146. Would the resistance of such a conductor be uniform in its different layers after carbonization?

Ans. Yes, if the different layers were cut from the same quality of paper.

X Int. 147. How about the molasses paste?

Ans. That might, of course, form a stratum of different conducting capacity from the paper, but as these strata are longitudinal and extend throughout the whole length of the incandescing conductor, and not transversely, they could produce no injurious results.

101 X Int. 148. How many sheets of paper would you have to

put together do you think to make up a conductor of the thickness shown in the drawing?

A. It would depend on the thickness of the paper used; possibly half a dozen thicknesses.

149 X Q. Would the molasses paste be about as thick as the sheets of paper between which it was placed?

A. No; it would need only to be very thin.

150 X Q. In the resultant mass what would be the relation in material between the paper and the molasses paste?

A. Possibly 50 to 1, or something like that.

151 X Q. To produce such a result you would have to lay the molasses on very thin, would you not?

A. Certainly.

152 X Q. Do you think it would be possible to lay it on so thinly as to have it bear that relation to the paper?

A. I should not expect to find any difficulty in doing so.

153 X Q. What would be the resistance of the carbonized molasses compared with the paper?

A. I have no means of judging. It probably would not be precisely the same; it might be more or less, I cannot say.

154 X Q. Would not the molasses penetrate the paper so that the resultant mass would be really a compound of paper and molasses?

A. That would depend on the condition of the paper. It would penetrate unsized paper, but in the case of sized or calendered paper I should expect it to remain on the external surface.

155 X Q. If you, as a result of this process, got a conductor in which the molasses had penetrated the paper to such an extent as to form a composite solid mass with the paper, would such a conductor have the same properties as a conductor of carbonized paper?

102 Ans. I should expect its properties to be the same except that its resistance would be lessened.

X Int. 156. In view of the fact that the only mention of paper in the original application is paper covered with plumbago, would you understand from the claim of the original application that the paper of the claim was the paper covered with plumbago, which the inventors had said they had tried?

(Former objection repeated.)

Ans. I do not think the claim would necessarily be limited to paper prepared with plumbago, even though no mention were made in the specification of paper not so prepared, provided that the use of paper, either with or without plumbago, was new, and either with or without plumbago would serve a more or less useful purpose in the application for which it was designed by the inventors.

X Int. 157. What do you understand to be meant by paper as used in the original application?

Ans. I suppose it to mean vegetable fiber, macerated and pressed into sheets and dried; the ordinary paper of commerce.

X Int. 158. You say the mention of paper suggests to your mind that the conductor was to be of the size of the paper in the dimension of its width or thickness. Upon what do you base that opinion?

Ans. Upon the fact that if paper in that form was carbonized, and cut to shape in its other dimensions before or after carbonization it would form a suitable incandescent conductor for the purposes contemplated by the applicants.

X Int. 159. Is there not on the market material which would come under the term "paper," which, as purchased, would not have the width or thickness desired for an incandescent conductor?

Ans. Material is sold in the market which is manufactured by substantially the same process as paper, which perhaps would
103 be too thick to be capable of thorough and suitable carbonization for the purpose intended. Such material does not, I think, go under the ordinary designation of paper. The thicker papers or paper-like fabrics, being usually termed cards or boards. I suppose there must be in trade some certain thickness that technically distinguishes paper from board, although I do not know what it is, except in a very general way.

160 X Q. Do you think that all material that is of the same general composition and character and origin as paper, but which does not come in sheets like sheets of writing paper, is excluded from the term paper, as used in the application?

A. It would be to some extent a matter of experiment to determine whether material of this character were included or not. In speaking of paper, the applicants evidently intended to convey information that paper of the ordinary and usual thickness would serve the purpose. It might be found by experiment that fibrous board of considerable thickness, not commercially known as paper, would also serve the purpose, and it might also be found by further experiment that beyond a certain thickness the material would be incapable of receiving proper and uniform carbonization; therefore it would be left to the discretion, knowledge and observation of the constructor as to how far he might safely go in this direction.

161 X Q. How thick would a sheet of paper have to be outside of what you consider the inventors to have meant by the term paper in the application?

A. It is difficult to say exactly; perhaps something like one sixty-fourth of an inch might be considered as a very thick paper. I am not sufficiently conversant with the technicalities of the paper trade to say exactly, if, indeed, there be any exact limit.

162 X Q. How do you know that the inventors in their
104 original specification did not contemplate carbonization of a large block or mass of paper and the cutting of the conductor from this mass after its carbonization?

(Former objection repeated.)

Ans. If they had meant to include such blocks or masses I should have expected them to use some more appropriate term, as for example, papier-mache, which is one of the names given to masses of paper-like material of that character. In their use of the word paper it is reasonable to suppose that they use the word in its ordinary signification.

X Int. 163. If they had contemplated cutting fibrous material to size in the width or thickness of the conductor, would it not be equally reasonable to suppose that they would have pointed out that fact.

(Objection repeated.)

Ans. Possibly.

X Int. 164. If in point of fact the inventors contemplated carbonizing a mass of fibrous material and cutting the conductor from such mass, all that you regard as of value in the invention was not contemplated by them?

Ans. If they had contemplated that method of procedure alone to the exclusion of the process of bringing the mass to form in one of its dimensions, then I think as a matter of fact that what I regard as the most important part of the invention would not have been present, because I do not consider that the results aimed at could have been reached in that way.

X Int. 165. If we assume that fibrous material carbonized was original with the inventors of the patent in suit, and if we further assume that the patent had been issued on the application as filed, do we not practically come to this point: That the patent would not disclose in and of itself the value you attribute to the invention, but its value could only be ascertained by independent and outside experimentation. To be more specific: If a man should carbonize
a mass of fibrous material, and cut his conductor from it he
105 would not attain the value of the invention; if, however, he
should cut his material to size and then carbonize it, he
would, but it would be left to his judgment and to experiment and test on his part to ascertain which was the valuable thing to do. To conclude, the work of getting the valuable conductor would not depend on his following the patent, but upon his ascertaining for himself, outside of the patent and independent of the patent, what was the proper thing to be done?

A. I cannot quite agree with you in your statement. The application describes the use of carbonized paper, and expressly claims it as the specific form of carbon, which it may be presumed from this fact the inventors considered either the most novel or the most useful form of it. If the constructor followed the specification in this particular he would obtain a product having certain valuable qualities. I do not see why any further experimentation should be required. He has simply to put this carbon into the lamp as directed, and it is ready for use.

166 X Q. But how about the fibrous material other than paper?

A. The descriptions and directions as to other fibrous material are very meagre, and possibly insufficient to identify any particular material, but it seems quite clear to me that the applicants have described one form of material namely, paper, which is useful, and which is sufficient to support the claim which is made for it, and also a broad claim for fibrous or textile material.

167 X Q. If they regarded their invention in the same light as you regard it, this original application is a mighty bad one, isn't it?

A. It must be admitted that it is susceptible of much improvement.

168 X Q. In pointing out the properties which the carbon made
from fibrous material must possess in order to infringe the in-
106 vention as you regard it, you say in your 52d answer, "it
must have been carbonized in such a manner as to preserve
the organic structure of the material." Suppose the organic structure of the fibrous material to have been destroyed, would a conductor made from this material, in your judgment, infringe the invention of the first claim?

Ans. If the organic structure of the material be destroyed, the carbon would be friable and inflexible, destitute of toughness, elasticity and strength, and would, therefore, be useless for the purposes contemplated by the patentees; hence, in my opinion, it would not be within the scope of the claims.

X Int. 169. Are you familiar with what is known as tamadine?

(Objected to as incompetent.)

Ans. I know something of its character and properties.

X Int. 170. Would a conductor of such material be within the invention of the patent, as you understand it?

Ans. I think so.

X Int. 171. Is the organic structure of the fibrous material there destroyed?

Ans. I do not think it is. The coarser organic structure is broken up, but the extreme toughness and tensile strength of the material shows that the essence of the organic structure is still present.

X Int. 172. Suppose I got a hard carbon conductor which had the requisite flexibility, elasticity and toughness and durability, and had the same general properties which you consider necessary to the invention of the patent in suit, would such a conductor infringe, in your opinion?

Ans. It would not, because, in the language of the first claim, the carbon must be of carbonized fibrous or textile material, and, in the language of the second claim, of carbonized fibrous material, and, in the language of the fourth claim, made from a fibrous or textile material, and neither of these things would be true, in any sense, of
the material technically known as hard carbon.

107 173 X Q. In a series arrangement of lamps, assuming the
same conditions to which I referred yesterday, namely, a
thousand lamps in the series, the destruction of the first lamp would cause the other 999 to go out unless some means were provided for switching the current from the lamp that was broken?

A. Yes.

174 X Q. Under the conditions we have assumed of a thousand lamps in series, each lamp of one ohm resistance, you have said that a current of approximately a thousand volts would be required to bring them to incandescence. If this current of 1,000 volts were put through but one lamp, would it not destroy the lamp?

A. Undoubtedly.

175 X Q. In referring to the drawing of the patent in suit you have mentioned that the length, thickness and width of the carbon conductor there shown could be reduced. As you increase the length of the conductor or decrease the width or thickness, would you not have to introduce corresponding changes in the structure itself, and would not the difficulty of maintaining the life of the carbon be increased as you decreased its width or thickness, or increased its length?

A. It would undoubtedly be advisable, though perhaps not strictly necessary, to modify the construction of some of the other parts of the lamp, if the length of the incandescing conductor were greatly increased and its cross-section diminished, and it is unquestionably true that, other things being equal, the longer and thinner the incandescent conductor the less is the life of the lamp.

176 X Q. Suppose you took the exact structure shown in the drawing and put in place of the fibrous conductor shown in the drawing the fibrous conductor of defendant's lamp; how long do you think it would last?

A. I have no means of forming even an approximate es-
108 timate, but I may say that its life would be very much —
than that of the thick and short conductor shown, and would be much shorter than it would be in a chamber so constructed as to maintain continuously a high artificial vacuum.

X Int. 177. Please tell me in units of time what your best judgment would be as to how long it would last. I, of course, understand that any answer you may make to this question is largely of the nature of a guess.

Ans. I prefer not to express any opinion in the absence of any experimental knowledge on the subject.

X Int. 178. I am sorry to press the question, and we will take your answer with due allowance for the absence of experimental knowledge. Will you be good enough, therefore, to answer my previous question, in units of time?

Ans. It would be quite impossible for me to express an opinion on this matter which would be of any value whatever. I am quite willing to repeat the statement I have already made; that its life would be very much shorter than that of the short and thick incandescent conductor, and very much shorter than it would be in a high vacuum.

X Int. 179. The difficulty is that in general expressions like "very much shorter" we do not present the sharp contrast which I would like to get upon the record. The life of such a lamp as defendant's is, in the present state of the art, I assume, thoroughly well known. The average life of such a lamp would be in the neighborhood of a thousand burning hours, would it not?

Ans. In the case of a well-constructed lamp, such as is easily attainable in the present state of the art, I think your assumption quite within limits.

X Int. 180. Well, now what, in burning hours, minutes or seconds, do you think would be the life of a carbon filament such as is shown in defendant's lamp, if put in the exact structure shown in the drawing of the patent?

Ans. I must repeat that I cannot form an opinion, for while I have considerable experimental knowledge of the performance of lamps substantially of the construction and dimensions of the defendant's lamp, I have no practical experience whatever with incandescent carbons enclosed in a chamber constructed precisely like that described in complainant's patent, and in the absence of such knowledge I must decline to express a definite opinion. 109

181 X Q. Are you aware that a suit on this same patent is pending in the United — circuit court for the southern district of New York between The Edison Electric Light Company as defendant and The Consolidated Electric Light Company as complainant?

A. I am.

182 X Q. Have you read the deposition of Professor Edwin J. Houston, who was called as an expert by the complainant in such suit?

A. I have read portions of it.

183 X Q. In that case the following question was asked and the following answer made by Professor Houston:

"264 X Q. What do you understand to be meant by carbonized paper covered with plumbago?"

"A. By the use of the phrase 'carbonized paper covered with plumbago,' as contained in the language of the original specification, I understand the phrase as a somewhat awkward manner of expressing the method employed in obtaining the carbonized paper. The paper was *to* covered with powdered plumbago while subjected to the carbonizing heat. This method of carbonizing material was well known in the art, and is the method most commonly used at this time in the manufacture of incandescent electric lamps, and I suppose that the inventors did not consider it necessary to enter more fully into detail."

I understand that you do not agree with his opinion of Professor Houston that the expression "carbonized paper covered with plumbago" means that the paper was covered with plumbago while undergoing the process of carbonization?

110 (Objected to as incompetent.)

Ans. While I do not wish to traverse the statement of Professor Houston, yet his interpretation of the phrase in the specification is one which had not occurred to me, and I still think that my own interpretation is a more natural and probable one.

X Int. 184. Are you aware that in the suit referred to Professor Houston regarded the use of bamboo as an infringement of the third claim of the patent in suit?

Ans. That is my understanding of his testimony.

X Int. 185. I understand that you do not concur in that view.

Ans. No; I have not felt myself justified in taking that position.

X Int. 186. In the patent, as issued, the specification states that the inventors have used the burners of the patent in a vacuum, in nitrogen gas and in hydrogen gas. The statement is then made "but we have obtained the best results in a vacuum, or an attenuated atmosphere of nitrogen gas." I understand it to be your opinion, as an expert, that such a lamp as shown in the drawing of the patent would yield the best results if an inert atmosphere were used instead of a vacuum; or, in other words, your opinion theoretically would be contrary to their statement. Am I correct in so understanding you?

Ans. I do not understand that there is any real conflict between the statement in the specification and the opinion which I have expressed. The patentees say that the two best results are those which have been attained in a vacuum and in nitrogen gas, but they do not undertake to say which of these two is the best. I have said that, in my opinion, the nitrogen would be likely to give the best results of those two.

Redirect examination by Mr. Kerr:

Int. 187. Refer to your answer to question 22, and explain what thickness of cement you had in mind.

111 A. Such a layer of cement as would ordinarily be used for the purpose of packing the joint in the manner indicated by the patentees. A thin layer would be all that would be necessary or proper to be used.

New York, *May 24th*, 1888.

The examination of Franklin L. Pope is continued by consent at the office of John C. Tomlinson, counsel for defendant, No. 40 Wall street.

188 Q. State whether the incandescing conductor formed of carbonized paper, mentioned in the third claim, would, in your opinion, possess the properties or advantages which in your answer 110 you consider to be possessed by a conductor of carbonized fibrous material.

A. It would unquestionably. The quality of paper may be very readily determined upon by inspection; it is already in proper size in one dimension for thorough and uniform carbonization; its resistance can be approximately predetermined, being in proportion to the area of its cross-section, or very nearly so; it is readily shaped before carbonization; its resistance after carbonization is quite uniform; it may be hardened and its resistance standardized after carbonization, and its mechanical qualities are excellent.

189 Q. Assuming that the expression "fibrous or textile material," as used in the first, second and fourth claims should be merely held to be synonomous with the word "paper" as used in the third claim, would you still have the same opinion as you have expressed about that claim, and its embodiment in the defendant's lamp?

A. In my direct testimony I have stated the understanding of this patent, which appeared to me to be the most natural and proper one; that is to say, that it contains certain generic claims for an

illuminant made of carbonized fibrous or textile material
112 broadly, and also a specific claim to such an illuminant when
made of one particular kind of such material, namely "paper," a material formed by artificial means as distinguished from other organic material in which the structural arrangement is natural, or the result of organic growth. If the word "paper," as used in the third claim, is to be regarded as synonymous with the expression "fibrous or textile material," as used in the first, second and fourth claims, then I should regard any sort of fibrous or textile material having the same properties as respects this particular use, which I have named in my fourth answer, and by which the same advantages are reached, as constituting an equivalent thereof, and covered by the said claim; that is to say, supposing the specification to remain as it now is, and the third claim to be the only claim of the patent, there is no doubt in my mind that other organic substances capable of the same use, and having the same properties, so far as the object and purpose of the invention is concerned, would be equivalents of paper. The specification mentions wood as a suitable material, and bamboo being a particular variety of wood, would fall within the general definition, and would therefore, under these circumstances, be an equivalent of paper.

Recross-examination by Mr. TOMLINSON:

X Int. 190. Do you still adhere to the opinion expressed by you in your direct examination and cross-examination, that the defendant's lamp is not covered by the third claim?

Ans. With my present understanding of the specification and claims, I still think that the third claim, in view of the language of the first, second and fourth claims, is limited to a carbon made of paper in the ordinary signification of that term, and, therefore, that the defendant's lamp does not infringe it.

X Int. 191. If then fibrous or textile material, as used in
113 the first, second and fourth claims, should be held to be merely
synonymous with the word paper as used in the third claim, as assumed by you in answer to question 189, would you consider such holding to be correct?

A. I should hardly think so. All paper is, of course, fibrous or textile material, but all fibrous or textile material is not paper in any usual or proper signification of the term. I regard paper as a material in which the structural organization is partially or entirely artificial, and therefore it does not seem to me proper to consider the term synonymous with the broader expression "fibrous or textile material."

FRANKLIN L. POPE.

Proof of the incorporation of the Electro-Dynamic Light Company, and of the Eastern Electric Manufacturing Company, is hereby waived by counsel by defendant.

Certification of the copies of the afore-mentioned six assignments is hereby waived by counsel for defendant.

Complainant's case closed.

Complainant's Exhibit Sawyer and Man Assignment of October 14, 1878. H. D. G., Ex'r.

Whereas, we, William Edward Sawyer, of the city, county and State of New York, and Albon Man of Brooklyn, county of Kings and State aforesaid, have made the following-entitled inventions, viz:

Firstly. Certain improvements in "electrical lighting apparatus and circuits."

Secondly. Certain improvements in "carbons for electric lights," and in the treatment thereof—for which we are about to apply for letters patent of the United States—and whereas the "Electro-Dynamic Light Company," a corporation created and existing under and by virtue of the laws of the State of New York, has purchased of us all our right, title and interest in and to said 114 inventions, and any and all letters patent of the United States, which may be hereafter granted for the same; and has paid us for the said inventions the sum of one dollar, and given us other good and sufficient considerations for the same, the receipt of which we hereby acknowledge, and with which we hereby declare ourselves satisfied, contented and paid—now, therefore, upon consideration aforesaid, we, the said William Edward Sawyer and Albon Man, have — and do hereby sell, assign and convey to the said company the whole of our right, title and interest in and to the said inventions, and any and all United States letters patent, which may hereafter be granted for the same, for the said company to have, hold and enjoy for its own use and behoof, and for the use and behoof of its legal representatives as fully and entirely as we would have held and enjoyed the same had this assignment and sale not been made, for the whole term for which said letters patent may be granted including any extensions thereof, and through the whole of the United States and the Territories thereof; and we do hereby covenant for ourselves and our legal representatives, that we are now the sole owners of said inventions, and have good right and lawful authority to make and execute this conveyance, in manner aforesaid, and that we will at any and all proper and reasonable times make and execute any and all proper papers that may be necessary to apply for and obtain letters patent of the United States, for said inventions and any and all proper papers that may be necessary to vest the title thereof in said corporation.

In witness whereof, we have hereunto set our hands and seals this the 14th day of October, 1878.

W. E. SAWYER. [SEAL.]
ALBON MANN. [SEAL.]

Witness:
WILLIAM H. BROADNAX.
AMOS BROADNAX.

115 Received for record, October 22, 1878, and recorded in *in* Liber H 23, page 448, of Transfers of Patents.

In testimony whereof, I have caused the seal of the Patent Office to be hereunto affixed.

[SEAL.] W. H. DOOLITTLE,
Acting Commissioner.

Ex'd : F. C. T.

COMPLAINANT'S EXHIBIT SAWYER AND MAN ASSIGNMENT OF JANUARY 9TH, 1880. H. D. G., Ex'r.

Liber W 24, page 380.

In consideration of the sum of five dollars to us in hand paid, we hereby assign, sell and set over to the Electro-*E*ynamic Light Company of New York an entire right, title and interest in and to an improvement in electric lights, as set forth in an application this day prepared and executed by us preparatory to applying for letters patent therefor, and we hereby request the Commissioner of Patents to issue the said patent to the aforesaid company as our assignee.

WILLIAM EDWARD SAWYER.
ALBON MAN.

Witnesses:
WM. D. BALDWIN.
WM. H. CAURCH.

Recorded January 9th, 1880.
Ex'd : C, F. E. L. L.

COMPLAINANT'S EXHIBIT ELECTRO-DYNAMIC LIGHT COMPANY ASSIGNMENT OF APRIL 6TH, 1881. H. D. G., Ex'r.

This deed of assignment, made this, the 6th day of April, 1881, between the Electro-Dynamic Light Company, a corporation created and existing under and by virtue of the laws of the State of New York, of the first part, and William H. Church, of Brooklyn, county of Kings and State of New York, of the second part.

116 Witnesseth: That for the consideration hereinafter mentioned the said Electro-Dynamic Light Company has and does hereby assign, transfer and convey to the said William H. Church, all and singular the letters patent of the United States dated and numbered as follows, viz: One dated June 25, 1878, and numbered 205,303 for "improvement in electric lighting systems;" one dated June 18th, 1878, and numbered 205,144 for "improvement in electric lamps;" one dated June 25th, 1878, and numbered 205,305 for "improvement in regulators for electric lights;" one dated November 19th, 1878, and numbered 210,152 for "improvement in switches for electric lights;" one dated December 10th, 1878, and numbered 210,809 for "improvements in electric lamps;" one dated January 7th, 1879, and numbered 211,262 for "improvements in carbons for electric lights;" one dated June 29th, 1880, and numbered 229,335 for "carbons for electric lights;" one dated June 29th, 1880, and numbered 229,476 for "improvement in electric switches;" one dated November 19th, 1878, and numbered

210,151 for "improvement in electric meters;" one dated September 16th, 1879, and numbered 219,771 for "improvements in electric lamps;" one dated February 8th, 1881, and numbered 237,632 for "dynamo-electric machines," and also two undivided fifths of the whole of letters patent of the United States numbered and dated as follows, viz: One dated August 14th, 1877, and numbered 194,111 for "electric engineering and lighting apparatus and system;" one dated August 21st, 1877, and numbered 194,500 for "electric candles;" one dated August 28th, 1877, and numbered 194,563 for "electric lighting apparatus;" one dated November 6th, 1877, and numbered 196,834 for "electric engineering and lighting systems;" which interests in said last-mentioned letters patent were assigned by William E. Sawyer to Albon Man by a certain deed of assignment dated May 14th, 1878, and recorded in Liber S 22,
117 page 464, Transfers of Patents, and which interests in said
patents were duly assigned by said Albon Man to said Electro-Dynamic Light Company by deed of assignment duly recorded in the Patent Office in Liber C 24, in pages 294, 295, 296, and 297, and dated, all of them, July 15th, 1878, together with all and singular the invention owned by said company, and described, illustrated, claimed or suggested in said letters patent; and also all inventions owned by said company, for which applications for patents are now pending in the United States.

And also all covenants, assignments and agreements made by William E. Sawyer with Albon Man, and assigned to said Electro Dynamic Light Company, and which are now owned by said company, having reference to said patents and inventions, any or either of them, in which said company is interested, in so far as the said covenants or agreements appertain to letters patent for said inventions, any or either of them, in the United States of America, but not elsewhere, for the said William H. Church to have, hold and enjoy for his own use, benefit and behoof, and for the use, benefit and behoof of his assigns and legal representatives to the full end of the term for which said letters patents have been, or may hereafter be granted, issued, reissued, or extended, any or either of them, in and for the whole of the United States and the Territories thereof, and also all covenants and agreements at any time made by the said William E. Sawyer and Albon Man, or either of them, jointly or severally, with the said Electro-Dynamic Light Company for the reissue or extension of said letters patent, any or either of them, or that in anywise appertains to said patents and inventions, or applications for patents for the same in the United States of America, but not elsewhere, and that as fully and entirely as the same would, might and could have been held and enjoyed by the said Electro-Dynamic Light Company had this assignment and transfer not been made.

In trust, nevertheless, for the said William H. Church
118 to hold to the use and benefit of the said Electro-Dynamic
Light Company, and especially to assign, transfer and convey to the Eastern Electric Manufacturing Company, of Middletown, Connecticut.

All and singular the said letters patents and inventions, and applications for letters patents, and the covenants and agreements aforesaid, the same to all intents and purposes as the said Electro-Dynamic Light Company, does hereby assign, transfer and convey the said letters patents, inventions, applications for patents, covenants and agreements to the said William H. Church and his assigns.

The consideration for this deed is that the said William H. Church subscribe for nine-twentieths of the whole of the capital stock of the Eastern Electric Manufacturing Company, and pay for the same by transferring, conveying and assigning to said company the whole of said letters patents, inventions, applications for letters patents, covenants and agreements aforesaid. The said William H. Church being hereby authorized to receive from said company the certificate or certificates of transfer of said stock of said Eastern Electric Manufacturing Company, and hold the same for the use and benefit of the share and scrip holders of the Electro-Dynamic Light Company, according to their respective interest in said company, after having first assigned and transferred to such persons as shall be designated by the trustees of the Electro-Dynamic Light Company such shares of stock of the Eastern Electric Manufacturing Company as the said board of trustees deem expedient and proper, and which division of shares having been made and accepted as aforesaid, the trust hereby created shall cease and determine, and the said trustee shall be discharged of his said trust.

It being the intention of this instrument that the said William H. Church, as such trustee, shall convey to the said Eastern Electric Manufacturing Company the title absolutely to the letters pat-
119 ents, inventions, applications for letters patent, covenants and agreements aforesaid, and not to continue the trust hereby created.

In witness whereof, the said Electric Dynamic Light Company has hereto subscribed its name and affixed its seal by its president and treasurer, the day and year above written.

ELECTRO-DYNAMIC LIGHT COMPANY,
[SEAL.] By THOS. WALLACE, *President*,
JACOB HAYS, *Treasurer*.

Witness:
AMOS BROADNAX.

Received for record October 5th, 1882, and recorded in Liber J 28, page 429, of Transfers of Patents.

In testimony whereof, I have caused the seal of the Patent Office to be hereunto affixed.

[SEAL.] E. M. MARBLE,
Commissioner.

Ex'd: M. T.

CITY, COUNTY, AND STATE OF NEW YORK, *ss:*

On this, the 15th day of December, A. D. 1885, personally came before me Jacob Hays, to me personally known to be the person whose name is hereto subscribed, and made solemn oath that on the 6th day of April, 1881, on the day of the date of the execution of the within assignment he was treasurer of the Electro-Dynamic Light Company, and that Thomas Wallace was president of said company at the date last aforesaid, and that the said instrument was signed by the said Thomas Wallace as president of said company, and by deponent as treasurer thereof, and that the signatures written at the foot of said assignment are the signatures of *op*ponent and said Thomas Wallace, and that they are duly authorized by said company to execute said instrument in manner and form as aforesaid.

JACOB HAYS.

120 Subscribed and sworn to before me, this 15th day of December, 1885.

J. CHARLES BULL,
Notary Public, N. Y. Co., N. Y.

Complainant's Exhibit Church Assignment of April 6th, 1881.
H. D. G., Ex'r.

This deed of assignment made this, the 6th day of April, 1881, between William H Church, of Brooklyn, in the county of Kings and State of New York, trustee of the Electro-Dynamic Light Company, and of its share and scrip holders, of the first part; and the Eastern Electric Manufacturing Company, of Middletown, Connecticut, a corporation created and existing under and by virtue of the laws of the State of Connecticut, and having an office and workshop in the city of New York, of the second part.

Witnesseth: That whereas by a certain instrument of writing bearing even date herewith, the Electro-Dynamic Light Company, a corporation created and existing under and by virtue of the laws of the State of New York, assigned, transferred and conveyed to the said William H. Church all and singular the letters patent of the United States dated and numbered as follows, viz: One dated June 25th, 1878, and numbered 205,303 for "improvement in electric lighting systems;" one dated June 18th, 1878, and numbered 205,144 for "improvement in electric lamps;" one dated June 25th, 1878, and numbered 205,305 for "improvement in regulators for electric lights;" one dated November 19th, 1878, and numbered 210,152 for "improvement in switches for electric lights;" one dated December 10th, 1878, and numbered 210,809 for "improvements in electric lamps;" one dated January 7th, 1879, and numbered 211,262 121 for electric lights;" one dated June 29th, 1880, and numbered 229,476 for "improvement in electric switches;" one dated November 19th, 1878, and numbered 210,151 for "improvement in electric meters;" one dated September 16th, 1879, and numbered 219,771 for "improvement in electric lamps;" one dated February 8th, 1881, and numbered 237,632 for "dynamo-electric machines," and also two undivided fifths of the whole of letters patent of the United States numbered and dated as follows, viz: One dated August 14th, 1877, and numbered 194,111 for "electric engineering and lighting apparatus and system;" one dated August 21st, 1877, and numbered 194,500 for "electric candles;" one dated August 28th, 1877, and numbered 194,563 for "electric lighting apparatus;" one dated November 6th, 1877, and numbered 196,834 for "electric engineering and lighting systems," which interests in said last-mentioned letters patents were assigned by William E. Sawyer to Albon Man by a certain deed of assignment dated May 14th, 1878, and recorded in Liber S 22, page 464, Transfers of Patents, and which interests in said patents were duly assigned by said Albon Man to said Electro-Dynamic Light Company by deed of assignment duly recorded in the Patent Office in Liber C 24, in pages 294, 295, 296 and 297, and dated, all of them, July 15th, 1878, together with all and singular the inventions owned by said company and described, illustrated, claimed or suggested in said letters patent, any or either of them, and all interests in said letters patent owned by said company, any or either of them, whether owned by said company in whole or in part, and also all inventions owned by said company for which applications for patents are now pending in the United States, and also all assignments, covenants and agreements made by William E. Sawyer with Albon Man, and assigned to said Electro-Dynamic Light Company, or which are now owned by said company, having reference to said patents and inventions, any 122 or either of them, in which the said *by said company, having reference to said patents and inventions, any or either of them, in which the said,* company is now interested in so far as the said covenants or agreements appertain to letters patent for said inventions, any or either of them, in the United States of America, but not elsewhere, for the said William H. Church to have, hold and enjoy for his own use, benefit and behoof, and for the use, benefit and behoof of his assigns and legal representatives, to the full end of the term for which the said letters patents have been or may hereafter be granted, issued, reissued or extended, any or either of them, in and for the whole of the United States and the Territories thereof, and also:

All covenants and agreements at any time made by the said William E. Sawyer and Albon Mann or either of them jointly and severally, with the said Electro-Dynamic Light Company for the reissue or extension of said letters patent, any or either of them, or that in any way appertains to said patents and inventions or applications for patents for the same in the United States of America, but not elsewhere, and that as fully and entirely as the same would, might or could have been held and enjoyed by the said Electro-Dynamic Light Company had said assignment and transfer not been made.

In trust, nevertheless, for the said William H. Church, to hold to the use and benefit of the said Electro-Dynamic Light Company, and especially to assign, transfer and convey to the said Eastern Electric Manufacturing Company of Middletown, Connecticut.

All and singular the said letters patent and inventions and applications for letters patent and the covenants and agreements aforesaid, the same to all intents and purposes as the said Electro-Dynamic Light Company conveyed the same to said William H. Church and his assigns.

123 The consideration for said deed from said Electro-Dynamic Light Company to said Church being that said Church shall subscribe for nine-twentieths of the whole of — company, and pay for the same by transferring, conveying and assigning to said company the whole of the said letters patents, inventions, applications for letters patent, covenants and agreements aforesaid.

The said William H. Church is authorized by said deed to receive from said company the certificate or certificates of transfer of said stock of said Eastern Electric Manufacturing Company.

Now, therefore, the said William H. Church having accepted the trust created by said deed hereby covenants that he has subscribed for said nine-twentieths of the whole of the capital stock of the said Eastern Electric Manufacturing Company, and that the certificate of transfer of said stock has been delivered to him by said company.

Wherefore, in consideration of said nine-twentieths of the whole of said capital stock of said Eastern Electric Manufacturing Company, the said William H. Church, as trustee for said Electro-Dynamic Light Company, and its share and scrip holders, has, and he does hereby assign, transfer and convey to the said Eastern Electric Manufacturing Company, all, and singular the aforesaid letters patents and inventions and applications for letters patents, and all and singular the covenants and agreements so conveyed to him by the Electro-Dynamic Light Company, as aforesaid, and that as fully and entirely as the same were conveyed to said Church by said deed, for the said Eastern Electric Manufacturing Company, its successors and assigns, to have, hold and *and* enjoy for its and their own use, benefit and behoof absolutely through the whole of the unexpired term of said letters patent, any or either of them, and through all the renewals, reissues and extensions thereof.

In witness whereof, the said William H. Church, trustee, has hereunto set his hand and seal, the day and year above written.

WM. H. CHURCH, *Trustee.* [SEAL.]

Witness:

AMOS BROADNAX.

124 Received for record October 5th, 1882, and recorded in Liber J 28, page 433, of Transfers of Patents.

In testimony whereof, I have caused the seal of the Patent Office to be hereunto affixed.

[SEAL.]

E. M. MARBLE,
Commissioner.

Ex'd: M. T.

Complainant's Exhibit Eastern Electric Manufacturing Company's Assignment of September 30th, 1882. H. D. G. Ex'r.

This deed of assignment made this 30th day of September, 1882, by and between the Eastern Electric Manufacturing Company, of Middletown, Connecticut, a corporation created and existing under and by virtue of the laws of the State of Connecticut, and having an office in the city of New York, of the first part; and the Consolidated Electric Light Company, a corporation created and existing under and by virtue of the laws of the State of New York, and having its principal place of business in the city of New York.

Witnesseth: That whereas the said Eastern Electric Manufacturing Company is the owner of certain inventions and letters patent of the United States, hereinafter mentioned and designated.

And whereas, by a certain instrument in writing dated June 10th, 1882, and a certain supplemental agreement dated July 8th, 1882, the said Eastern Electric Manufacturing Company, for the consideration of four thousand and five hundred shares of the capital stock of said Consolidated Electric Light Company of the par value of one hundred dollars each, full paid and non-assessable, and for other considerations mentioned in said contract of June 10th, 1882, and said supplement of July 8th, 1882, agreed to convey to said Consolidated Electric Light Company all and singular the
125 inventions, letters patent, rights and franchises now belonging to it, and belonging to it at the time of making said agreement of June 10th, 1882.

Now, therefore, in performance of said agreement, and in consideration of said four thousand and five hundred shares of the capital stock of said Consolidated Electric Light Company of the par value of one hundred dollars each full paid and non-assessable, and for other considerations mentioned in said contract ,the rec-ipt of which is hereby acknowledged,

The said Eastern Electric Manufacturing Company hereby assigns, transfers and conveys to the said Consolidated Electric Light Company all and singular the inventions, letters patent, rights and franchises now owned by it, and owned by it at the time of making said contract of June 10th, 1882, and especially the joint letters patent of the United States granted to William Edward Sawyer and Albon Man, dated and numbered as follows, viz:

One dated June 25th, 1878, and No. 205,303.
One dated June 18th, 1878, and No. 205,144.
One dated June 25th, 1878, and No. 205,305.
One dated November 19th, 1878, and No. 210,152.
One dated December 10th, 1878, and No. 210,809.
One dated January 7th, 1879, and No. 211,262.
One dated June 29th, 1880, and No. 229,335.
One dated June 29th, 1880, and No. 229,476.

And also the letters patent granted to William Edward Sawye*d* dated and numbered as follows, viz: One dated November 19th, 1878, and No. 210,151; one dated September 16th, 1879, and No. 219,771; one dated February 8th, 1881, and No. 237,632.

And also two undivided fifths of the whole of each of the following letters patent granted to William Edward Sawyer, viz:

One dated August 14th, 1877, and No. 194,111.

One dated August 21st, 1877, and No. 194,500.

One dated August 28th, 1877, and No. 194,563.

126 One dated November 6th, 1877, and No. 196,834.

And also the joint letters patent of the United States granted to William E. Sawyer and Edward R. Knowles dated May 10th, 1881, and No. 241,242.

And also the joint letters patent of the United States granted to William Edward Sawyer and Robert Street, dated and numbered as follows, viz:

One dated May 10th, 1881, and No. 241,430.

One dated August 23d, 1881, and No. 245,976.

Also the joint letters patent of the United States granted to William Edward Sawyer and William Sawyer, dated and numbered as follows, viz:

One dated December 14th, 1880, and No. 235,460.

One dated January 11th, 1881, and No. 236,460.

And also the letters patent of the United States granted to Thomas B. Stillman, numbered and dated as follows, viz:

One dated March 23d, 1880, and No. 225,730.

One dated April 20th, 1880, and No. 226,632.

One dated May 11th, 1880, and No. 227,454.

And also the letters patent of the United States granted to Edward R. Knowles, dated May 11th, 1880, and No. 227,365.

And also the letters patent of the United States granted to William Sawyer, dated and numbered as follows, viz:

One dated February 17th, 1880, and No. 224,612.

Six dated May 11th, 1880, and numbered respectively 227,386, 227,387, 227,388, 227,389, 227,390 and 227,845.

Two dated May 25th, 1880, and numbered respectively 228,122 and 228,123.

Two dated July 20th, 1880, and numbered respectively 230,345 and 230,346.

One dated October 12th, 1880, and No. 233,284

Two dated December 14th, 1880, and No. 235,385 and 235,459 respectively.

One dated February 8th, 1881, and No. 237,608.

Together with all and singular the inventions owned by 127 the said Eastern Electric Manufacturing Company, and described, illustrated, claimed or suggested in said letters patent, any or either of them, and all interest in said letters patent, any or either of them whether owned by said company in whole or in part, and also all inventions owned by said company for which applications are now pending in the United States, and especially the application No. 547, filed January 9th, 1880, and all the divisions thereof, and also any and all applications which may be made, arise or grow out of, or in anywise appertain to any or either of said letters patents, or applications for patents now pending.

And also, all assignments, grants, licenses, covenants and agreements owned by said Eastern Electric Manufacturing Company, in anywise appertaining to said patents, any or either of them, or to any patents or inventions appertaining to electric lighting now owned by said company, are hereby conveyed to said Consolidated Electric Light Company for the said company to have, hold and enjoy for its own use, benefit and behoof; and for the use, benefit and behoof of its successors, assigns and legal representatives to the full end of the term for which said letters patent are, or may hereafter be granted, issued, reissued or extended, any or either of them, in and for the whole of the United States and Territories thereof.

And also all the property and assets of every nature and kind whatsoever belonging to the said Eastern Electric Manufacturing Company, and all which belonged to it at the time of making said contract of June 10th, 1880, is hereby transferred and conveyed to the said Consolidated Electric Light Company, and that as fully and entirely as the same would or might have been held and enjoyed by the said Eastern Electric Manufacturing Company *and* this assignment and transfer not have been made.

And the said Eastern Electric Manufacturing Company hereby covenants with the said Consolidated Electric Light Company that it is now the sole owner of the whole of said inventions and letters patent; that it has now the sole and exclusive right to use said inventions, and to work said letters patent, subject only to the licenses and agreements hereinafter mentioned, the whole of which are hereby conveyed to said Consolidated Electric Light Company as aforesaid; and that said inventions and letters patent are free, clear and not encumbered by, or for any claim, lien, mortgage or demand whatsoever; and that it has good right and lawful authority to make and execute this deed of assignment, and transfer in manner and form as aforesaid. 128

And said Eastern Electric Manufacturing Company hereby covenants with the said Consolidated Electric Light Company that the following and no other licenses and contracts under and appertaining to said patents have been made by it, and are now outstanding, viz: A certain license dated March 1st, 1881, to the Commonwealth Electric Light and Manufacturing Company of Pennsylvania, and a certain supplement thereto dated June 8th, 1882, granting the right to use said patents and inventions in the State of Pennsylvania. A certain license dated October 14, 1881, to the Illinois Electric Manufacturing Company for the State of Illinois. A certain agreement by said company with A. J. Works, dated August 27th, 1880, appertaining to certain rights under the patents then owned by it in the District of Columbia, and the State of West Virginia.

The said Eastern Electric Manufacturing Company hereby conveys to said Consolidated Electric Light Company all its right, title and interest in and to said licenses and agreements, and all its rights of action thereunto appertaining both in law and equity, and all benefits and advantages growing out of the same:

The said Consolidated Electric Light Company taking this assignment subject to the conditions and advantages of said licenses and agreements.

And it is hereby covenanted and agreed between the said Eastern Electric Manufacturing Company and said Consolidated
129 dated Electric Light Company, and this assignment is made
upon this express condition:

That said Consolidated Electric Light Company shall not sell, lease or otherwise dispose of all its patents, patent rights, and other rights and property to any individual or corporation, nor by lease, license, or otherwise grant to any individual or corporation having an interest, directly or indirectly, in any other patents or system of electric lighting, any rights under said patents, nor permit the use or exercise of such rights by such individual or corporation without the consent in writing of holders of not less than five-sixths of the capital stock of said Consolidated Electric Light Company, and that all conveyances, grants and licences made by said Consolidated Electric Light Company under said patents, any or either of them, in violation thereof, shall be absolutely null and void as being without authority and of no force or effect in law.

In witness whereof, the said Eastern Electric Manufacturing Company has hereto signed its name and affixed its seal the day and year first above written.

The words "and agreements" in the fourth line of seventh page having been first interlined. Also on page 3 the words, "and also the letters patent granted to William Edward Sawyer, dated and numbered as follows, viz: One dated November 19th, 1878, and No. 210,151; one dated September 16th, 1879, and No. 219,771; one dated February 8th, 1881, and No. 237,632," having been first written in the margin. And the words, "and all which belonged to it at the time of making said contract of June 10th, 1880," having been first interlined between the sixteenth and seventeenth lines on the sixth page.

[SEAL.]

THE EASTERN ELECTRIC
MANF'G CO.,
By HORACE LITTLE, *President.*
W. N. PEARNE, *Secretary.*

Signed, sealed and delivered in presence of—
WILLIAM H. CLARKSON.
JAMES M. SULLIVAN.

130 STATE OF NEW YORK, } ss:
County of New York, }

NEW YORK CITY, *Sept. 30th, A. D.* 1882.

Personally appeared Horace Little, president, and W. N. Pearne, secretary of the Eastern Electric Manufacturing Company, signers and sealers of the foregoing instrument, and acknowledged the same to be their free act and deed, before me, as the president and secretary respectively of said company, and the free act and deed of said company; and they also made solemn oath before me that they were the above-described officers of said company, and that the seal affixed to the foregoing instrument was the corporate seal of said company, and that it was affixed thereto by proper authority of said company, and that they signed their names thereto by like authority as the president and secretary of said company.

In witness whereof, I have hereunto set my hand and affixed my official seal this 30th day of September, A. D. 1882.

[SEAL.] WILLIAM H. CLARKSON,
Commissioner for Connecticut in New York, 117 Broadway, N. Y. City, and Notary Public for New York County, N. Y.

Received for record October 5th, 1882, and recorded in Liber J 28, page 441, of Transfers of Patents.

In testimony whereof I have caused the seal of the Patent Office to be hereunto affixed.

E. M. MARBLE,
Commissioner.

Ex'd: M. T.

COMPLAINANT'S EXHIBIT SAWYER AND MAN ASSIGNMENT OF APRIL 5TH, 1881. H. D. G., EX'R.

This deed of assignment, made this 5th day of April, 1881, by and between William E. Sawyer, of New York city, county and
131 State, and Albon Man, of Brooklyn, county of Kings and State aforesaid, of the first part, and the Electro-Dynamic Light Company, a corporation created and existing under and by virtue of the laws of the State of New York, of the second part.

Witnesseth: That whereas the said William E. Saw*p*er and Albon Man are the joint inventors of certain improvements in electric lighting, for which they have made and filed a joint application for letters patent of the United States, and which application was filed in the Patent Office January 9th, 1880, and which invention, by a brief instrument in writing, bearing no date, was assigned to the said Electro-Dynamic Light Company, said assignment having been recorded in the Patent Office January 9th, 1880, in Liber, W 24, page 380.

But whereas said assignment is not accompanied with sufficient covenants to enable said company to fully control said invention and to properly protect it with letters patent, the said Sawyer and Man, for the consideration mentioned in said assignment, and for other good and sufficient considerations, the receipt of which is hereby acknowledged, and with which they, jointly and severally, declare themselves satisfied, contented, and paid, hereby jointly and severally assign, transfer, and convey to the said Electro-Dynamic Light Company the whole of the said invention described, claimed, illustrated, or suggested in said application for said patent, together with all drawings, models, and papers appertaining to said inven-

tion and application for said patent; and also any and all patents that may be hereafter issued for said invention upon said application, or any subdivisions that may be made of said application, including any part or parts of said invention for the said Electro-Dynamic Light Company, its successors and assigns, to have, hold, and enjoy for its and their own use, benefit, and behoof through the whole of the term for which letters patent or patents may be granted, issued, reissued, or extended for the said invention or any
132 subdivision thereof, for, to, and in whole of the United States and the Territories thereof, as fully and entirely as the said William E. Sawyer and Albon Man, or either of them, might, could, or would have held and enjoyed the same jointly or severally had this assignment and transfer not been made.

And for the consideration aforesaid the said William E. Sawyer and Albon Man do hereby covenant individually, each for himself, with the said Electro-Dynamic Light Company that since the making and executing by them of said assignment of said invention, and said application for said letters patent for the same, they have not done or caused to be done, jointly or severally, any act or deed calculated or intended to defeat or encumber the title to said invention, or any letters patent that may be granted therefor.

And for the consideration aforesaid the said William E. Sawyer and Albon Man hereby covenants, each for himself individually, with said company that they will at any time hereafter, upon the advice of the counsel of said company, or the counsel for its successors or assigns, that the same is necessary for the better and more perfect enjoyment of said letters patent and invention by said company, execute any papers, drawing, or writing necessary to procure additional patents for said inventions, or which may be necessary to amend said applications or patents by reissue, disclaimer, or otherwise, as provided by law, and also any papers or writing that may be necessary to more fully vest the title to said inventions, or any letters patents that may be granted for the same unto said company.

And for the consideration aforesaid William E. Sawyer and Albon Man hereby declares, each for himself, that the purpose of this instrument is not to supersede any instrument of conveyance heretofore made by them to said company of said invention or application for letters patent, but is intended to confirm and supplement the same, and to supply any defect, deficiency, or omissions of said previous assignments, and to make and add such additional
133 covenants as are herein contained for the purpose of perfecting and enlarging the title of said company to said inventions, and any letters patent that may be granted therefor, and to enable it at any time hereafter to apply for any additional patents for said invention, or to reissue, disclaim, or otherwise amend those above specified as aforesaid.

And the Commissioner of Patents is hereby authorized and requested to issue any and all patents that may be granted for said inventions, or any part or subdivision thereof, to the said Electro Dynamic Light Company, its successor or assigns, as the assignee of the entire right and title of said Sawyer and Man, either jointly or severally, in and to the same.

In witness whereof the said William E. Sawyer and Albon Man have hereto set their hands and seals the day and year above written.

W. E. SAWYER. [SEAL.]
ALBON MAN. [SEAL.]

Witness:
AMOS BROADNAX.

Received for record April 18th, 1881, and recorded in Liber, N. 26, page 366, of Transfers of Patents.

In testimony whereof, I have caused the seal of the Patent Office to be hereunto affixed.

V. D. STOCKBRIDGE,
Acting Commissioner.

Ex'd: F. C. T.

134 United States Circuit Court, Western District of Pennsylvania.

THE CONSOLIDATED ELECTRIC LIGHT COMPANY *against* THE MCKEESPORT LIGHT COMPANY.	No. 5. May Term, 1888. In Equity. Suit on Letters Patent No. 317,676.

NEW YORK, *July 31st*, 1888.

Testimony taken before John H. Kitchen, Esq., one of the standing examiners of the circuit court of the United States for the southern district of New York, pursuant to a consent between the parties to the above-entitled suit, dated July 20th, 1888, and to an order made in the above-entitled suit dated July 28th, 1888.

Present: Mr. Thomas B. Kerr, for complainant; Messrs. John C. Tomlinson and Richard N. Dyer, for defendant.

Counsel for defendant produces a fac-simile copy of an article published in the "New York Herald" on December 21st, 1879, headed "Edison's light" and previously referred to in this suit and marked for identification "Herald article of December 21st for identification, H. D. G., examiner" (L. C. W., May 10th, 1888).

Complainant's counsel hereby stipulates on the record and agrees that the "New York Herald" is a newspaper published in the city of New York and largely circulated throughout the United States and that it was so published and circulated during and prior to the month of December, 1879.

135 Complainant's counsel further stipulates on the record that the paper referred to and marked "Herald article of December 21st for identification, H. D. G., examiner (L. C. W., May 10th, 1888)," is a correct and exact copy of an article published in the "New York Herald" on December 21st, 1879.

Complainant's counsel consents that the paper referred to may be offered in evidence with the same force and effect as though a copy of the "New York Herald" of December 21st, 1879, containing such article was offered in evidence and due and proper proof made of the publication of such article in the "New York Herald" and due and proper proof made that the "New York Herald" is a paper published and circulated in the city of New York and was so published and circulated during the month of December, 1879.

Defendant's counsel offer in evidence the paper marked "Herald article of December 21st for identification, H. D. G., examiner (L. C. W., May 10th, 1888)," and the same is marked Defendant's Exhibit Herald Article of December 21st, 1879.

GEORGE F. BARKER, a witness produced on behalf of the defendant, being duly sworn according to law and interrogated by Mr. TOMLINSON, testifies as follows:

1 Q. What is your name, age, residence, and occupation?

A. George F. Barker; age, 51 years; residence, Philadelphia; I am a professor of physics in the University of Pennsylvania.

2 Q. Please state what experience you have had as a scientist and the recognitions you have received as such and more especially with respect to the subject of electricity?

A. I went to Philadelphia in 1873 from Yale college, where I had held a professorship of physiological chemistry for several years. I had also been the professor of chemistry in several
136 other institutions previously. I am a member of the National Academy of Science and have been president of the American Association for the Advancement of Science. I was one of the commissioners of the United States at the Paris electrical exhibition of 1881 and a delegate to the International Congress of Electricians. I was also appointed by the Government a member of the United States electrical commission, in the fall of 1884.

3 Q. Please state how closely you have followed the advancement of the application of electricity to the useful arts, and more especially its application for purposes of illumination?

A. I have always taken a special interest in electrical matters and have made them a subject of instruction to my classes, and have been called as an expert in a great variety and number of cases involving their useful applications. I have attempted to keep myself informed of the progress of electrical science from the published literature on the subject, have always had an extensive collection of apparatus at my disposal for purposes of experiment and investigation, and have experimented variously in the applications of electricity to useful purposes, especially to electric lighting, for some years past.

4 Q. Have you read and are you familiar with and do you understand the invention described and claimed in letters patent of the United States No. 317,676, dated May 12th, 1885, the patent in suit?

A. I have read the patent referred to, and am familiar with it, and believe that I understand the invention described and claimed in such patent.

5 Q. Have you read and are you familiar with the article headed

"Edison's light," printed and published in the "New York Herald" on December 21st, 1879, which has been offered in evidence in this suit and is marked "Defendant's Exhibit Herald Article of December 21st, 1879"?

A. I have carefully read such article, and understand and am familiar with the statements and matter therein contained.

137 6 Q. Have you read and are you familiar with the following questions submitted to, and the following answers made by, Mr. F. L. Pope, who was called as an expert for the complainant herein, to wit, questions and answers 59, 60, 61, 62, 63, 64, 65, 120 and 121?

A. I have read the testimony of Mr. Pope, referred to, and am familiar with it.

7 Q. Please state whether, in your opinion, the "Herald" article referred to contains a complete and full description of the invention of the first, second, third and fourth claims of the patent in suit?

A. In my opinion the article referred to is a complete and full description of the invention described and claimed in the patent in suit and is a complete and full anticipation of the inventions of the 1st, 2d, 3d and 4th claims of that patent.

8 Q. Do you, then, agree with Mr. Pope that if the invention of the patent in suit was made on the day of the application, this publication would be a complete anticipation of it?

A. I agree entirely with Mr. Pope, and, to use his language, "I have no doubt it would."

GEORGE F. BARKER.

Direct examination closed.

138 *Complainant's Testimony in Reply.*

Testimony in reply on the part of complainant, taken herein pursuant to the 67th rule of the United States Supreme Court, in equity, as amended, before William T. Farnham, Esq., of the city of New York, special examiner herein.

NEW YORK, *November* 28, 1888.

Met pursuant to notice.

Present: Thomas B. Kerr, Esq., and Leonard E. Curtis, Esq., on behalf of complainant, and John C. Tomlinson, Esq., on behalf of defendant.

Testimony of Amos Broadnax.

AMOS BROADNAX, being called and duly sworn, testifies as follows:

Int. 1. What is your name, age, residence and occupation?

Ans. My name is Amos Broadnax. I am 61 years of age, I reside at 41 Jefferson avenue, Brooklyn. I am a lawyer by profession, engaged more especially in the practice of the patent law, and have been since 1856, having had my office since 1862 in the city of New

York, previous to that in Washington, and previous to that in St. Louis, Missouri.

Int. 2. When, and under what circumstances, did you first see an incandescent electric lamp?

Ans. To the best of my recollection, I first saw an incandescent electric lamp in June or July, 1878. The circumstances which led to my seeing the lamp are these: I met Mr. Albon Man, some
139 time in either of the months I have mentioned, on the corner of Nassau and Wall streets, in the city of New York, and he there told me about an electric lamp that he and Mr. Wm. E. Sawyer had invented and made. He invited me to come up to his office, No. 3 Mercer street, in New York, and see the lamp. A few days after that I called at Mr. Man's office, No. 3 Mercer street, and he there showed me the lamp, taking it out of his safe and showing and explaining it to me. He, thereupon, invited me to go with him to No. 2 Howard street, on the corner of Centre street, N. Y., to the workshop of himself and Mr. Sawyer, and see the lamp illuminated. I went with him, and there and for the first time I met and was introduced to Mr. Wm. E. Sawyer. After a little talk about patents, the lamps and electric lighting, Mr. Sawyer put the lamp on the lighting circuit, that had its source in the shop of Arnoux & Hockhausen, and the lamp was illuminated. Perhaps it will be proper to add in this connection, that I was at that time very well acquainted with Mr. Albon Man, having made his acquaintance in the latter part of the year 1868, and had obtained a number of patents for him or in which he was interested.

3 Q. Can you produce a lamp such as you saw at that time? And if so, please do it.

A. I have here in my possession an incandescent electric lamp, substantially such as was shown to me by Mr. Man at that time. This lamp, however, has not got the cup upon its base by which it was to be screwed on the fixture, as I think that lamp had. The lamp I am referring to is an exhibit in case 3472, between The Edison Electric Light Company and The Consolidated Electric Light Company, and also in case 3469, between the same parties, both in the southern district of New York. I have also a lamp in my possession which I now produce, which is substantially the same lamp as the one last referred to, differing from it, however, in the
140 manner of its sealing; otherwise, I don't think there is any substantial difference between the two lamps.

Said lamp is offered in evidence and marked "Complainant's Exhibit Broadnax Sawyer-Man Lamp No. 1, November 28, 1888."

Int. 4. When, if ever, did you next see a Sawyer-Man incandescent lamp, and if so, under what circumstances?

Ans. Some time in the fore part of October, 1878, Mr. Albon Man and William E. Sawyer came to my office and retained me as solicitor for the Electro Dynamic Light Company, a New York corporation, more especially to take out some patents for improvements in incandescent electric lamps, the inventions of Sawyer & Man. I then again saw, within a few days after that, a number of their incandescent electric lamps, and I prepared applications for patents for the inventions, or a part of them, that were then brought to me, and drew an assignment dated October 14, 1878, of some of those inventions to the Electro Dynamic Light Company, which assignment is in evidence in this case as Complainant's "Exhibit Sawyer-Man Assignment of October 14, 1878."

Int. 5. Please describe the lamps you then saw.

Ans. I saw then, or about that time, say between October 15 and November 15, at their works on the corner of Walker and Elm streets in New York, two practical types of lamps. The one type is illlustrated in patent 210,809, granted to Wm. E. Sawyer and Albon Man; the other is fairly illustrated, although not exactly so, in the drawing of the patent in suit; the principal difference between the two lamps, being in the form and substance of their illuminants. In the one case, the illuminant was a straight pencil or filament of carbon, and in the other case, the illuminant was in the form substantially of the letter U. In this case the absolute continuity of the circuit was maintained, both ends of the illuminant being permanently connected to the leading- in conductors of the lamp. In the
141 other case, I mean the case of the straight pencil or filament,
only one end is fixed, that is, clamped to the leading-in conductor, the other end being held in contact with the conductor by means of a spring or weight.

6 Q. Can you state what material the illuminants of these lamps was composed of?

A. The illuminants were composed of carbon in both cases; the straight carbons were composed of what is known as treated carbon, or pure-deposit carbon, that is, carbon produced by treating the illuminant electrically in the presence of a *d*ydrocarbon gas or fluid. In some cases the original pencils was made of some fibrous material cut to size, carbonized and then treated as described in the patent to Sawyer & Man, 211,262, the fibrous part of the carbon being afterwards removed, leaving a straight shell either in the form of a tube, or in the form of a trough of pure-deposit carbon. In the other case, the carbon was made of paper cut to size and shape and then carbonized, and more or less treated by the process of the patent I have mentioned, and then put in the lamp. It must be understood, however, that in neither case did I see these carbons put into the lamp, but I frequently saw the carbons treated, I saw the blanks, in the case of paper, out of which they were made, and I saw these blanks after they were carbonized; that is to say, I saw blank illuminants taken out of the box in which they had been carbonized, and I saw them treated, but I don't remember that I ever saw any put in the lamp, but I saw the lamp with the carbons in them, and which I was told by both Sawyer and Man were the carbons about which I have been testifying, and I have every reason to believe, acting as I was in a confidential relation to those gentlemen, that they were the same carbons that I had seen, as I have already stated.

7 Q. What do you mean by the expression, "put into the lamp"?

142 Ans. When I say "put into the lamp," I mean that I did not see the illuminant put in the lighting circuit, and the lighting circuit put in the lamp. In short, I did not see the lamp made, but did see the different parts of the lamp before they were assembled, and did see them after they were assembled, but did not see them being assembled. I saw these carbons, nevertheless, in the electric circuit while they were being treated and prepared for use in the lamp. I desire to add, also, that in the case of the straight pencil it was a common practice for them to make the illuminant by simply treating it slightly, preparatory to using it in the lamp, leaving the fibrous carbon intact as a part of the illuminant.

Int. 8. State how often, and how many of these Sawyer-Man lamps with arch-shaped carbons made of paper or fibrous material you saw in use during the period from November, 1878, to December, 1879?

Ans. During the month of November, 1878, I saw a number of these lamps at the works of Sawyer & Man, or the Electro Dynamic Light Co., rather, at the corner of Walker and Elm streets; just how many I cannot say. I have a very distinct recollection of seeing in November, 1878, two of these lamps suspended from a chandelier hanging in the center of the room very brilliantly illuminated, and in addition to these central lamps, there were, I think, either three or four, perhaps more, set in brackets around the room, of the same lamps. I saw these lamps there, I can't say now how many times, but quite often. Sometimes they would be illuminated and sometimes not, when I went there. It is impossible for me, after so much time has elapsed, to state how many times I saw those lamps as well as other lamps.

Int. 9. How did the lamps mentioned in your last answer operate when you saw them in use?

Ans. The practical operation of the lamps was perfect, so far as I was able to judge; I could see no defects in the operation of 143 the lamps, nor did I hear of any. The luminosity of the lamps was very high, ranging, I should say, from thirty to fifty candle power. There was no break in the operation of the lamps during the time I was there.

10 Q. How did their operation compare with the operation of the incandescent electric lamps in common commercial use at the present time?

A. As to that I can only testify as to their operation during the time that I saw them. During the time that I saw them their operation was as perfect as any lamp of to-day, that is, their light-giving quality or power. Whether they were as economical as the lamp of to-day I don't know, but in so far as their function of giving a steady bright light is concerned, they were equal to any incandescent electric lamps I ever saw from that time to this.

11 Q. It seems to me that you have not fully answered my question 8, as to the number of these lamps that you saw. Please do so now.

A. I saw a number of lamps as I have stated in November, and I think also in December, 1878, and possibly in January, 1879, but as to January, I am not clear or certain of seeing any of these lamps in operation, but I think I saw some of these lamps in operation in November or December, 1879, at Mr. Sawyer's house in 54th street, I think it was 54th street, I am not certain as to the number of the street, but I think it was 54th street or in that neighborhood. Mr. Sawyer had a number of these Sawyer-Man lamps there on exhibition, and some of them I think were these hoop carbon lamps. As to the number of these lamps that I saw, I cannot tell how many of them I did see.

Adjourned till 2½ p. m.

Resumed after adjournment.

144 12 Q. Please describe the apparatus and operation of treating the fibrous material or blanks from which the illuminants were made, as far as you obtained knowledge of the same from seeing the apparatus and operation?

Ans. The apparatus used in treating these carbons, or rather a portion of it, I now produce. The apparatus as a whole consisted of a large lamp chamber. I mean by that the globe of a lamp which was made of glass. To the bottom of that chamber a disc of glass was ground and sealed. On the inside surface of this disc was placed two electrodes, secured by tubular pieces of metal passing through and sealed into the disc. The two electrodes raised up above the disc side by side, were somewhere about eight inches in length. The top ends of these electrodes were connected to the bottom side of a soapstone disc through which two holes were bored, in which were inserted studs, the tops of which were made in the form of clamps. In these clamps the two ends of the carbon to be treated were secured so as to complete the circuit in the lamp, the clamping studs passing through the soapstone disc and uniting the conductor below the discs in the circuit, the two conductors being of course separated and insulated from each other so as to make a complete electric circuit. The globe of the apparatus was filled with hydrocarbon gas or fluid. I think gas was used when I saw it in operation. The electric circuit was then connected to the tubes, and the current sent through the carbon while it was immersed in the gas, and was continued until the carbon was treated to the degree required, the carbon being raised electrically to high incandescence. The globe of the apparatus I have not got, but I have got the glass discs with the two electrodes set thereon united to the soapstone disc and the clamping studs, and I now produce it.

Int. 13. Please describe the apparatus and operation of carbonizing the fibrous material or blanks from which the illuminants were made, as far as you obtained knowledge of the same from seeing the apparatus and operation?

145 Ans. I do not know that I can describe with much minuteness the retort in which the carbons were made. I mean, of course, the paper carbonized, but a general description of it is this: It consisted of an iron or clay retort, as I should judge,

about four inches long and two inches or perhaps two and a half inches in diameter. This retort was taken out of the furnace of the steam boiler used to drive the machinery in the Walker and Elm streets shops. It was quite hot when I first saw it or when it was brought into the exhibition room, and it was allowed to cool down there sufficiently to enable them to open it. I think Mr. Wm. Sawyer (Dr. Wm. E. Sawyer's father) who was employed there, and who was a machinist by trade opened it. After he opened it, he called my attention to it. He said: "Here Mr. Broadnax, you can see what these carbons are like." I went to him and together we looked at them, he taking them out with a piece of wire and showing them to me. I did not see the paper blanks put in the retort, but I understood from him that the retort was first charged with a layer of powdered carbon, which was pressed down to a smooth surface upon which the material to be carbonized was laid. This material was covered over with a layer of powdered carbon, and pressed down as in the first instance. Another course or layer of the material to be carbonized was then put in the retort, and another layer of carbon was put in and so on till the retort was full. It was then covered with a lid, which was fastened. Just how it was fastened I cannot tell, as I did not observe the thing in detail especially. What I was interested in most was to see the carbons as they appeared when they came out of the box.

Some of the carbons when they came out were quite hard, dense, smooth and strong. Some of them were soft and only partially carbonized, and as I should say, scarcely fit for use, but they were sufficiently carbonized, as Mr. Sawyer explained to me, to enable him to get a current through them in the treating apparatus. I think old Mr. Sawyer told me in response to my question as to how hot he had made the retort in which the carbons were contained,
146 that they had heated it up as high as they could in the furnace of the boiler, and then put it in the ash pit and covered it with ashes until it was cooled down to the condition it was when he brought it in, which was scarcely a dull red heat. Some parts of it were not red hot. I recollect asking him if he could get heat enough in the boiler furnace to make perfect carbonization. He replied that he did not, and that that would account for the imperfect condition of some of the carbons.

Int. 14. State how these paper carbons compared with those you saw in the lamp, in appearance.

Ans. They were the same in appearance, but there was a great variety of shapes.

Int. 15. Please state what these great varieties of shapes were.

Ans. Some of them were straight pieces of carbon, slips or filaments cut from drawing paper, I should say. I say that, because the pieces that I saw that were not carbonized, were pieces cut from drawing paper. Some of them were in the form of a circular washer, a complete ring having a small section broken out: some of them were in the form of a bow or loop of irregular form, like that shown in the sketch I now make and produce.

Said sketch is offered in evidence and marked "Complainant's Exhibit Broadnax Sketch, Nov. 28, 1888."

(Here follows diagram marked p. 147.)

Int. 16. Did you see any lamps at that time, viz: October, November or December, 1878, in which the fibrous carbon illuminant was made of any other material beside paper?

Ans. I cannot be certain that I did. There was a good deal of talk there between Mr. Man and Sawyer and I about carbons made of all sorts of fibrous material, but I don't recollect of seeing lamps in which carbons made from such fibrous material were used; I have a very distinct recollection of seeing the paper carbons, and of talking about the others.

148 17 Q. What other materials do you refer to?

A. Broom corn and willow twigs, the fibre of the twigs and a great variety of wood that Man told me about, the names of which I cannot now undertake to repeat, hemp, manilla and cotton thread was especially mentioned, I recollect that. I cannot say now that I saw any of these materials carbonized or used in the lamps.

18 Q. Can you produce a lamp such as you saw used in 1878, by Sawyer and Man, having a fibrous carbon illuminant, and if so, please do it.

A. Yes. The lamp I now produce, or substantially such a lamp. The two ends of the bow-shaped illuminant are slipped down in the divided ends of the carbon-holders of this lamp and were fastened in there by some sort of carbonaceous cement, I don't know what the cement was made of. The bow or arch of the illuminant projecting above the holders.

The lamp referred to is offered in evidence and marked "Complainant's Exhibit Sawyer-Man Broadnax Lamp No. 2, Nov. 28, 1888."

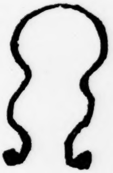
19 Q. State what you know of the history of the two lamps now in evidence. "Exhibits Broadnax Sawyer-Man Nos. 1 and 2?"

A. The two lamps referred to in the question were given to me by Albon Man, I should say from six to eight months to a year ago, to be used as exhibits in the case of The Consolidated Electric Light Co. *vs.* The Edison Electric Light Co. and Thomas A. Edison, in the southern district of New York, a suit founded on the patent in suit here, and I have had them in my possession ever since, and I recognize them as the same lamps or substantially the same lamps, that I saw in the laboratory of the Electro Dynamic Light Co., in the fall of 1878, as I have testified.

The portion of the treating apparatus referred to by the witness in answer to 12 Q. is now offered in evidence as "Complainant's Exhibit Sawyer-Man Treating Apparatus, Nov. 28, 1888."

149 Int. 20. State whether you were at any time requested by Sawyer & Man, or either of them, to apply for a patent on

No. 286
C. E. Light Co.
v
McK. Light Co
} p. 147



US Circuit Court
Western Dist of Pa
Consolidated E Co
vs
McKeesport L Co
Complainants Exhibit
Broadway Sketch
Nov 28 1888
W. J.
S. E.

the fibrous-carbon illuminant, and if so, please give all that occurred in regard to the same?

Ans. Two or three days previous to October 14, 1878, Sawyer & Man came to my office and brought the inventions mentioned in the assignment, dated Oct. 14, 1878, to me to patent for the Electric Dynamic Light Co., as inventions of theirs, and Mr. Man more especially requested in the presence of Mr. Sawyer, and to which Mr. Sawyer assented, that those inventions should at once be conveyed to the Electro Dynamic Light Co., and that I should then proceed to patent them, and I accordingly did proceed, and drew the assignment, and at once prepared an application for a patent for two of the inventions mentioned in that assignment, viz.: the "improvement in electric-lighting apparatus and circuits," and also for the improvements in the "treatment of carbons to be used for electric lighting." The preparation of the application for the carbons themselves was temporarily deferred until I could have time to consider the best form to put the application in. I mean, of course, the invention of the bow or U-shaped carbon made of paper or other fibrous material. The application for the lighting circuits and apparatus, and for the process for treating carbons was filed as soon as I could prepare them, which was within a week probably. The preparation of the application for what we now call the fibrous-carbon conductor, making the subject-matter of the patent in suit, was deferred at first because I was in doubt as to the patentability of some of the features that Sawyer & Man wanted to claim. The feature about which I was in doubt, and about which they were very tenacious, was the making the incandescent conductor of paper or other fibrous material. I had no doubt about the patentability of the loop form of the carbon conductor in combination with the lighting circuit in the lamp, believing as I did, and as they did
150 at that time, that such a form of conductor was new, irrespective of the carbon of which it was made; but whether the incandescent conductor made of fibrous or textile material irrespective of its form or combination was a patentable invention, was a question about which I had my doubts, and I took a good deal of time to think about it and to make up my mind as to the best form to put it in, and whether if such a patent could be obtained, it could be sustained. Upon this subject I had a good many interviews with Sawyer and Man, and we discussed the subject in its various aspects under all the light that we had at that time upon the matter. Mr. Man and Mr. Sawyer and myself, respectively, drew a good many different forms of claims to cover that invention. Finally, I drew a complete specification of the invention in lead pencil on buff drafting paper at my house in Baltic street, Brooklyn, Mr. Man having become very solicitous and urgent in having me prepare such an application. After the specification was prepared I took it over to Mr. Man's office, No. 3 Mercer street, going directly from my house to his office. Mr. Man took the draft of the specification in his hand and glanced over it, but was so much occupied with the business of his office that I could not get his attention. He told me to take the paper to Sawyer and go over it with him. I took

the paper, going directly from Man's office to Sawyer's office, which was then in Walker street, and tried to get Sawyer to read it over with me, but he was busy writing a paper of some sort and would not take the time to go through the specification and discuss it with me, but said he would take the paper and read it and amend it, if necessary, so as to convey his thoughts, and return it to me. I explained to him that the paper contained probably more than it ought to contain in some aspects of it, and in some it probably did not contain enough, and I specially requested him to write in and strike out what he thought would be proper, he being then, or was
thought to be, a very good electrician, and I having very lit-
151 tle knowledge of the subject. I left the paper with *ject. I*
left the paper with him, and I have never seen it since. This took place, as I think, in April, 1879. At all events, it was just before Sawyer went to Ansonia to superintend the making of the Sawyer & Man lamps at the works of Wallace & Sons. During that same summer I went to Ansonia on a visit to the works of Wallace & Sons, along with Thomas Sault, an engineer of New Haven, and while there I met Mr. Sawyer and asked him if he had revised the specification that I had given him. He said he had not, but that he had read it over, and would give it his attention as soon as he could get time. I do not recollect of ever having spoken to him about the paper afterwards, nor do I remember his mentioning the paper to me afterwards. In fact, I did not see Mr. Sawyer again until quite late in the fall, either in November or December, 1879, when he was engaged in an effort to organize the Eastern Electric Manufacturing Company, and had become bitterly hostile to the interests of the Electro Dynamic Light Co. I went to see him either in November or December at his house, I think, which was in 54th street, New York, where he was engaged in making an exhibition of the Sawyer-Man lamps, as a part of his scheme in organizing the Eastern Electric Manufacturing Co. I went there, I think, with Albon Man to get him to execute some papers, which he refused to do. What the papers were that I took to him for his execution I do not now remember, but they were some papers in the interest of the Electro Dynamic Co., which he very positively and peremptorily refused to execute. After that I don't think I saw Mr. Sawyer or had any intercourse with him till after the organization of the Eastern Electric Manufacturing Co. and the assignment of the patents of the Electro Dynamic Light Co., known as the Sawyer-Man patents, to the Eastern Electric Manufacturing Company.

Adjourned till Tuesday, the 4th day of December next, at 11 a. m.

152 TUESDAY, *December 4th*, 1888—11 a. m.

Met pursuant to adjournment and adjourned till 2½ p. m.

2½ P. M.

Met, present counsel as before, and the examination of Mr. BROADNAX proceeded as follows:

21 Q. You have referred to an assignment dated October 14, 1878,

which is in evidence as "Complainant's Exhibit Sawyer-Man Assignment of October 14, 1878," please state whether any of the inventions referred to in that assignment were patented, and if so, give the number and dates of such patents.

A. Yes, there were. Two of them were patented immediately. The first patent is entitled "Improvement in switches for electric lights," and is numbered 210,152, and is dated November 19, 1878. The application for that patent was filed October 15, 1878, and in the first paragraph of this specification the invention is described as "certain new and useful improvements in electric-lighting apparatus and circuits," the same as in the assignments referred to. The second invention is entitled in the assignment as "Carbon for electric lights." For that invention the application was not filed until January 9, 1880, and the patent is dated and numbered as follows: May 12, 1885, No. 317,676, the same being the patent in suit. The third invention which was conveyed by that assignment was for a novel process of treating carbons for electric light. The application for that patent was filed October 15, 1878. The patent is dated January 7, 1879, and is numbered 211,262. These three inventions were all conveyed by Sawyer and Man to the Electro-Dynamic Light Company by the assignment mentioned in the question.

153 Int. 22. There is an assignment in evidence called "Complainant's Exhibit Sawyer-Man Assignment of January 9, 1880;" can you state the purpose of that assignment, in view of the fact that the invention therein conveyed is in accordance with your last answer, one of those conveyed by the assignment of October 14, 1878?

Ans. I did not draw the assignment referred to in the question, but I was present when the assignment was executed by Albon Man, and I understood from him at that time, that the object of that assignment was to authorize the Commissioner of Patents to issue the said patent to the Electro Dynamic Light Company as the assignee of Sawyer & Man, which the assignment of October 14, 1878, omitted to do.

Int. 23. What was the attitude of Sawyer to Man and to the Electro Dynamic Light Company during the period from November, 1878, until December, 1879?

Ans. As I understood it, from my intercourse with them, the relation between Sawyer and Man was quite friendly in November, 1878. In December of the same year, the relations between Sawyer and Man as individuals, and between Sawyer and the Electro Dynamic Light Company became somewhat strained, on account of the intemperate habits of Mr. Sawyer. In January of 1879, about the same strained condition continued, but perhaps growing a little more pronounced, and it continued in that way until March, 1879, when the Electro Dynamic Light Company and Mr. Man, who was president of that company, determined to close their shop or laboratory of which Mr. Sawyer was the superintendent. Mr. Sawyer then, or about that time, as I understood it, demanded of the Electro Dynamic Light Company a license or right to work under all their patents, which the company, as I understood it, refused to give him;

but shortly after that, or about that time, as I now remember, an arrangement was made with Wallace & Sons to manufacture
154 the Sawyer-Man lamp, under the supervision of Mr. Sawyer at the workshop of Wallace & Sons at Ansonia, Conn. Mr. Sawyer, in performance of this arrangement, went to Ansonia and had under his supervision a lot of lamps manufactured. I saw Mr. Sawyer at the works of Wallace & Sons in the summer of 1879, I think it was June or July. I talked with him about the lamps in a general way, and about the Electro Dynamic Light Company. Sawyer during that interview, while he did not say anything that was pronounced, against Mr. Man or the Electro Dynamic Light Company, seemed to me from his conversation to be restless and dissatisfied with his position there. From that time on, until some time in November or December, 1879, I don't recollect of seeing Mr. Sawyer, but at the time last mentioned, I in company with Albon Man visited his house, which I think was in West 54th street, west of Sixth avenue. I went up there with Mr. Man and took some papers with me, in the interest of the Electro Dynamic Light Company for Mr. Sawyer to execute. What those papers were, I cannot now be certain, but my impression is, that it was an application for the reissue of the Sawyer-Man patent No. 205,303, dated January 25, 1878. I recollect that I had been instructed by the Electro Dynamic Light Company to prepare an application for the reissue of that patent and I think it was that application that Mr. Man and I went to get Mr. Sawyer to execute at the time mentioned. Mr. Man solicited in my presence Mr. Sawyer and urged him in a friendly way to execute the paper, which Sawyer refused to do. I afterwards, on the same occasion, when Mr. Man was not present, urged upon Mr. Sawyer the importance of executing the paper. Mr. Sawyer replied that he had considered all that, and said he would be "damned if he would execute any papers in the interest of the Electro Dynamic Light Company." I don't recollect of having any further intercourse with Mr. Sawyer until the time the negotiations were pending about the transfer of the patents of the Electro Dynamic Light Company to the Eastern Elec-
155 tric Manufacturing Company, which was in the early part of April, 1881.

Int. 24. Did you during the period between the time you prepared the specification which you gave to Sawyer, in December, 1879, make any effort of any kind to get the application for the patent in suit executed?

Ans. I have already stated that I never saw the draft of the specification for a patent of the invention covered by the patent in suit, after I gave it to Sawyer, just before he went to Ansonia, but at the time I saw Mr. Sawyer at the works of Wallace & Sons, in Ansonia, I asked him why he did not revise the specification I had given him and send it to me that I might perfect the application for the patent; to which he replied, that he had been very busy in getting the work at Ansonia started, meaning the manufacture of the lamps, and had had no time to do anything else, but he said he would look the paper up and go through it and send it to me. From that time I did not see Mr. Sawyer again till November or December, as I have mentioned, and I do not remember to ever have spoken again to him about that paper; I have an impression that about the time that I visited Mr. Sawyer with Mr. Man in November or December, 1879, at 54th street, that Mr. Man asked me about the application for a patent of the invention of the patent in suit, referring to the draft of the specification I had given to Mr. Sawyer, at which time I think I told him of my interview with Mr. Sawyer at Ansonia. After that I don't recollect of my saying anything further to Man on the subject, or he to me, until the Sunday morning succeeding the publication in the New York Herald of an article describing Mr. Edison's invention of his electric lamp, and the use of the fibrous or paper carbon. I found Mr. Man is his office, very much engaged with people upon the business of his office, and did not get an interview with him of more than a few minutes. I called his attention to the article in the Herald, and urged upon him the importance of the getting in the Patent Office an application 156 for the invention in question at the earliest possible moment. He replied that he was busy in carrying on some negotiations which he hoped would result in an application for the patent in question. That, I think, is the last interview I had with Mr. Man upon the subject, until the day the application for the patent in suit was executed at the office of Charles A. Cheever.

25 Q. What description, if any, did Sawyer and Man give you of their improved lamp, having the fibrous-carbon illuminant, at the time they first spoke to you about it, including the time when you first saw the lamp in operation?

A. The lamp they described to me, and a sample of which they brought to my office, was, as I now recollect it, exactly like the lamp "Complainant's Exhibit Sawyer-Man Broadnax Lamp No. 2," but in the lamp that they showed me there was set in the top of the two electrodes an arch-shaped carbon, one end of the arch of said carbon being set in one of the carbon electrodes that appears in this lamp, and the other end of said arch in the other of said electrodes. Whether this lamp was brought to me on the day that the assignment of Oct. 14, 1878, was made, or whether it was brought to me a few days after that, I cannot now remember; but I am clear that it was either at the time, or within a few days after that, that a lamp like this was brought to me, and I think with it was brought the lamp that is illustrated and described in their patent 210,809, and the distinction between that lamp and this was pointed out to me, as was also the advantage of this lamp over that, in that the connection between the electrodes and the two ends of the illuminant was a fixed close union of the two parts of the circuit, by which the possibility of the formation of the electric arc at the junction between the illuminant and the electrodes was avoided. The method of sealing the lamp, and of exhausting and filling the chamber of the lamp was also explained to me, as was also the method of making contact between the lamp and the lighting circuit in which it 157 was to be set. I do not see that I can describe any better or more accurately the method of making, sealing, exhausting, and filling of the lamp of the patent 210,809 than it is described in that patent; and this lamp, I mean the "Exhibit Sawyer-Man Broadnax Lamp No. 2," last referred to, was made, exhausted and charged precisely as was the lamp of patent 210,809; differing from that, however, in its interior construction, by leaving out of the chamber of the lamp all of its machinery excepting the leading-in conductors and the soapstone disc fixed to the top of said conductors. In place of the machinery above the soapstone disc in patent 210,809, the inventors used in this lamp two straight studs, in the top of which the arch-formed carbon made of paper was set and cemented with some sort of carbonaceous cement. The bottom end of the globe of the lamp was ground upon a glass disc and was fastened and sealed substantially as shown and described in patent 210,809 and in the patent in suit. The inventors at the time explained to me that they had used in the chambers of their lamps a vacuum in place of the gas or gases described in the patent 210,809. This was in response to a question of mine, why they did not use a vacuum in the chamber of their lamp instead of the gases; to which they explained that they had used a vacuum, and that it answered first-rate when they could get a good vacuum, but they had no pump with which they could get a vacuum that was at all effectual, as a rule, in the construction of their lamps, and that they had, therefore, adopted an atmosphere of pure nitrogen for the interior of their lamp, which atmosphere they could make more or less attenuated as practice might seem to require, to ensure a satisfactory lamp.

Adjourned till Wednesday, the 5th inst., at 11 a. m.

158 WEDNESDAY, *December* 5, 1888.

Met pursuant to adjournment. Present, counsel as before, and the examination of Mr. BROADNAX continued as follows:

Int. 26. State whether or not, in your intercourse with Sawyer and Man, or either of them, you observed any want of appreciation on their part of the value and importance of the invention of the patent in suit.

Ans. No, I did not; on the contrary, they expressed a very high estimate of its value, and Mr. Man was especially enthusiastic over it, and was very persistent in claiming a patent for it in the broadest language, both in the presence of Mr. Sawyer and in his individual interviews with me, and urged upon me the importance of getting the specification in good shape, and getting the application for the patent filed.

Int. 27. What, if anything, did you know of Sawyer's habits of sobriety, and their effects on his conduct during this period?

Ans. Mr. Sawyer was intemperate in his habits when I first made his acquaintance, and his habits in this particular grew worse up to the time he died. At intervals he would be sober, reasonable and manageable, and then again at intervals he would be half or wholly intoxicated, capricious and utterly unmanageable, and do and say all sorts of foolish and extravagant things. It was that, as

I understood it, that led to the disruption between him and Man, and to the closing of the workshop or laboratory of the Electro Dynamic Light Company, and to his dismissal from the works of Wallace & Sons at Ansonia. As solicitor for the Electro Dynamic Light Company, I was frequently brought in contact with Mr. Sawyer and know of my own knowledge how very capricious he was. One day he would talk a thing up, and the next day he would talk the same thing down. From what I knew of my own knowl-
159 edge, and from what I heard of Sawyer from others, in a general way, I made up my mind, and frequently told my clients, that notwithstanding Sawyer's great reputation as an electrician, it was utterly impossible to carry on any business enterprise with him at the head of it, or in any controlling position.

Adjourned till Thursday, to-morrow, 6th inst., at 11 a. m.

THURSDAY, *Dec.* 6, 1888.

Adjourned till Monday the 10th inst., at 11 a. m.

MONDAY, *Dec.* 10, 1888.

Attended and adjourned subject to new notice.

TUESDAY, *Dec.* 18, 1888.

Met pursuant to annexed notice. Present, Thomas B. Kerr, Esq., on behalf of complainant, and Richard N. Dyer, Esq., on behalf of defendant, and the taking of testimony herein was adjourned till January 7, 1889, at 11 o'clock a. m.

MONDAY, *Jan.* 7, 1889.

Met pursuant to adjournment. Present, counsel as before, and the cross-examination of Mr. BROADNAX by Mr. DYER proceeded as follows:

The following objections to questions and answers are made by counsel for defendant, with the consent of counsel for complainant, that said objections shall have the same force and effect as if made on the conclusion of said questions and answers, respectively.

6 A. What was told the witness by Sawyer and Man, objected to as hearsay.

8 Q. Objected to as assuming that the witness has testified that he saw lamps having carbons of paper or fibrous material.

13 A. What the witness says as to the material that was put into the retorts, and what the carbons that came from the retorts were made from, and how the retorts were packed and how or
160 where the carbonizing was done, and whether there was any carbonizing done by means of the retorts, objected to as hearsay.

16 A. Talks between Man and Sawyer, objected to as hearsay.

17 Q. Objected to as calling for hearsay.

17 A. Objected to as hearsay.

25 Q. Objected to as containing hearsay testimony so mixed up

with pretended statements of facts as to leave it uncertain as to which are facts and which hearsay.

Cross-examination *de bene esse*, without waiving objections:

28 X Q. Did you not on the 17th day of March, 1881, testify as a witness for Sawyer and Man in an interference case with Thomas A. Edison, involving the application of Sawyer and Man, upon which the patent in suit was subsequently issued?

A. I testified as a witness in an interference between Sawyer and Man and Thomas A. Edison, on the day in which was involved the application for the patent in suit. On what day, I don't recollect, but the record will show on what day the testimony was given, and what the testimony was.

29 X Q Was not the application of Sawyer and Man involved in that interference, the application on which the patent in suit was subsequently issued?

A. Yes.

30 X Q. Have you not records or memoranda in your office by which you can refresh your recollection as to the date when you gave that testimony?

A. I have what purports to be a printed copy of the record in that interference; I have no other memorandum in writing by which I could determine that date. It appears by that record that my deposition in that case was given on the 17th of March, 1881.

161 X Int. 31. You were acting as the attorney for Sawyer & Man in taking the testimony in the interference case, were you not?

Ans. I was.

X Int. 32. And you then produced yourself as a witness on behalf of Sawyer & Man to establish, so far as you knew, the facts of their claim to priority of invention upon the use of carbonized paper as the conductor for an incandescent lamp?

(Objected to as incompetent, as not cross-examination, and as not the best evidence, the production of the interference record being the proper evidence of the issue involved in said interference and the nature and object of the witness' testimony in such case, as the same may appear by the production of his deposition referred to.)

Ans. On the earnest solicitation of my client, Mr. Man, I gave the deposition referred to for the purpose of establishing the fact that Sawyer & Man made and used an incandescent conductor for an electric lamp in the fall of 1878.

X Int. 33. Was that the only object of your deposition in the interference?

Ans. The only object that I remember now. Generally, the object of my deposition, and that of the other depositions in the case, was to establish priority of invention in Sawyer & Man upon the issue involved in the interference.

X Int. 34. How would your testimony "that Sawyer & Man made and used an incandescent conductor for an electric lamp in the fall of 1878" help the case? Was the issue as broad as that?

(Objected to as incompetent, as not calling for the best evidence in regard to what the issue of the interference was.)

Ans. I have not got the record before me, and cannot,
162 therefore, swear what the issue was. I can only give you my best recollection of it. As I recollect it, the claim that was made the subject-matter of the issue was an incandescent conductor for an electric lamp formed of carbonized paper. How far my testimony went to support priority of invention in Sawyer and Man on that issue will appear by the record.

35 X Q. Your object in giving the deposition, however, was to assist in the establishment of priority of invention in behalf of Sawyer and Man by means of such facts as were within your own recollection?

(All after "Man" objected to as an assumption, and forming no part of the question.)

A. I take it for granted that that was my object, for I can see no other object that I could have had in making that deposition.

36 X Q. In that interference case you testified as follows, did you not?

"Immediately after November 5, 1878, I was at the shop of Sawyer and Man on the corner of Walker and Elm streets, in this city, in consultation with them about certain applications for patents which I was then preparing for them: that while there I saw illuminated an electric lamp substantially like that illustrated by the drawing "Sawyer Exhibit No. 4." The lamp was fitted with a section of carbon in the lighting circuit, that being the illuminating part of the lamp. The section of carbon was U or arch shape, resembling the letter U inverted. The carbon was held between the divided ends of the metallic part of the circuit in the lamp by clamps like that shown in the drawing. Mr. Sawyer told me that the section of carbon in the lamp, being the illuminating part of it, was made of paper, and expressed the determination to get a patent for it. Whether the carbon was made of paper or not, I do not know. I did not see it made nor did I have the carbon in my hand. The lamp was sealed up and in place and illuminated. I was probably in the shop half an hour—certainly not
163 more than that talking with Mr. Sawyer about his lamps and his carbon, while I was there Mr. Sawyer arranged the light so as to throw a shadow of it on a screen to show me that that form of burner cast no shadow. Mr. Broadnax adds that he was solicitor for the Electro Dynamic Light Company at that time, and was consulting Mr. Sawyer upon the subject of patents for which he was then applying, and fixes the date which he has mentioned of the time he called there by the date of the application for the patent 210,809, which application was prepared and filed by me."

(Objected to as incompetent, irrelevant and not the best evidence.)

Ans. I do not know whether I did or not. I swore to something to that effect, speaking in a general way. I cannot swear at this time what I stated then.

X Int. 37. Have you any doubt of it?

(Same objection.)

Ans. I have no doubt that what I signed and swore to at the time was the truth, but what that was I do not know now, excepting as it appears in the record which I have not got. I will be very glad to verify my statement in the record if you will present it.

X Int. 38. As a matter of fact, you examined your deposition in the interference case just before or at the time of giving your direct examination in this case?

Ans. No, I did not.

X Int. 39. When did you examine it last?

Ans. I cannot tell you exactly the date, but it was some time after my examination-in-chief here in this case.

X Int. 40. Then your direct examination in this case was given without refreshing your recollection by referring to what you testified to on the same subject-matter nearly eight years ago in the interference case?

(Objected to because it don't appear that the alleged testimony of the witness was about the same subject-matter.)

164 Ans. Yes. The facts about which I testified upon my examination-in-chief here have been kept so fresh in my mind since they occurred that I had no difficulty in stating them without refreshing my memory by reading up the deposition referred to. I did not even think of it until my examination-in-chief was concluded.

X Int. 41. Have you not in your possession memoranda by which you can refresh your recollection as to what you did testify in the interference case?

(Objected to as incompetent.)

Ans. I have only what purports to be a printed copy of the interference record in my possession.

X Int. 42. Have you not a certified copy of that record?

Ans. No, not now.

X Int. 43. Where is the one you did have?

Ans. In the possession of the printer.

X Int. 44. Have you not in your possession copies of the printed record which you retained as attorney for Sawyer & Man in the interference case.

(Objected to as incompetent.)

Adjourned for lunch.

Resumed after lunch.

Ans. I have not: although since our adjournment I have looked through my papers in that case. My recollection is that the last copy I had of that interference case I sent to the Patent Office to be certified as a part of the interference record.

X Int. 45. Are you not the solicitor for the complainant in a suit pending in the southern district of New York on the same patent against the Edison Electric Light Co. and Thomas A. Edison, commenced in 1885, after the issue of the patent in suit No. 35531 in equity?

Ans. I am.

X Int. 46. And is it not a fact that in that case, as solicitor
165 for the complainant, you have taken hundreds of pages of
testimony in order to carry back the date of the invention
by Sawyer and Man to a date anterior to the filing of the application?

Objected to as incompetent.

A. It is a fact that I have taken hundreds of pages of testimony in that case to prove, among other things, that Sawyer and Man made the invention, the subject of the patent in suit, long before the application for the patent was filed. Perhaps it would be nearer accurate to say that hundreds of pages of testimony have been taken, most of which is cross-examination, about matters not pertinent to the issue.

47 X Q. And in that case you put in evidence, did you not, a duly authenticated copy of the record in the interference case, including the record in your deposition given in March, 1881?

A. I did put in what purports to be a certified copy of that record, and I presume it contains or includes a copy of the deposition referred to in the question.

48 X Q. Has the record of that case yet been filed in the clerk's office?

A. No, the record is not completed.

49 X Q. It is a fact still in your possession as counsel for complainant?

A. Yes, it may be said to be so.

50 X Q. Will you then kindly refresh your recollection from that record which you yourself have offered in another case as a correct copy of the record, and give me an answer to cross-question 36?

A. I have not got the record in my office, as I explained this morning, it is at the printer's, but I suppose I can get it up here in the morning.

51 X Q. Will you kindly do so?

A. I will.

52 X Q. How long after the fore part of October, 1878, did you remain under retainer as solicitor for the Electro Dynamic Light
Co.?
166 A. I was solicitor for the Electro-Dynamic Light Co., if my
memory serves me right, down to the time that the patents of
the Electro-Dynamic Light Co. were transferred to the Eastern Electric Manufacturing Co., and indeed after that, and although I went into the service of the Eastern Electric Manufacturing Co., I still con-

tinued to be counsel for the Electro-Dynamic Light Co., at least in matters appertaining to their patents.

53 X Q. What were the relations — Sawyer and Man with the Electro-Dynamic Light Co., and the Eastern Electric Manufacturing Co., with regard to their joint inventions in electric lighting?

A. Sawyer and Man assigned all their inventions and patents to the Electro-Dynamic Light Co. and they both of them became officers in that company. After the patents were assigned to the Eastern Electric Manufacturing Co. Mr. Sawyer became a stockholder in that company. Whether he was an officer in that company or not, I don't know. Mr. Man also became a stockholder in that company. Whether he became an officer in it, I don't know.

54 X Q. The assignment to the Eastern Electric Manufacturing Co. is dated April 6, 1881, is it not?

A. It so appears by the assignment itself.

55 X Q. And at the date of the application for the patent in suit, viz., January 9, 1880, the Electro-Dynamic Light Co. was the owner of the inventions of Sawyer and Man relating to electric lighting, and you were retained solicitor of that company for the purpose of applying for patents for inventions owned by that company?

A. I was the solicitor of that company to do anything required of me that I might properly do, and I did apply for patents for all the inventions that were brought to me to be patented, or at least I prepared the papers for the applications. In some instances, however, the applications were not perfected and filed by me. I think it is proper for me to say that I did not prepare and file the 167 application for the patent in suit, although the Electro Dynamic Light Co. evidently regarded me as its solicitor at that time, because at the time the application was executed I was called upon by Man, who, I think, was the vice-president and acting president of the company at that time, to go with him to the office of Mr. Cheever and consult with him about the application, and I did go, and was present; but I took no part in the preparation of the application, although Mr. Man consulted me about the specification, or asked me what I thought of it, or something to that effect. I told him I thought the specification was rather crude, to which Mr. Baldwin replied, who was the solicitor for Mr. Cheever, that he had written the specification in great haste, and that it was his intention to immediately file an amended specification. After that I had nothing to do with the case until after the interference was declared.

X Int. 56. What was the first application you prepared for Sawyer & Man as solicitor for the Electro Dynamic Light Co.?

Ans. I really do not recollect. There were a lot of inventions brought to me by Sawyer & Man in the fore part of October, 1878, to be patented, but which application was prepared first I could not tell you.

X Int. 57. As a matter of fact, did you not, after your employment in 1878, prepare and prosecute all the applications made by Sawyer & Man for electric lighting, except the application for the patent in suit?

Ans. As a matter of fact I do not know. Sawyer & Man may have sent some applications to other solicitors about which I have no knowledge, but I did prepare several applications for patents for them right along, from the time I was first employed down to the time that Sawyer & Man, or Sawyer and the Electro Dynamic Light Co. got at loggerheads, and among the rest was a draft of a specification for the patent in suit mentioned by me in my examination-in-chief.

168 58 X Q. Judging from the patents issued to Sawyer and Man, with which I assume you are entirely familiar, do you know of any such application except the application for the patent in suit, which was not prepared and prosecuted by yourself?

A. I cannot say that I do so as to be able to distinguish them, but there were some applications prepared by Sawyer himself, but the numbers of those applications or the inventions described by them I cannot tell at this time, for the reason that I do not remember, but I know there were such applications filed by Sawyer, because after they were filed a power of attorney was given to me to prosecute them, and there were quite a number of them.

59 X Q. So far as you know, were there any applications for patents filed on behalf of Sawyer and Man, relating to electric light between the time of your employment in October, 1878, by the Electro Dynamic Light Co., and April, 1881, when the assignment was made to the Eastern Electric Manufacturing Co., except the application for the patents in suit, in which any other solicitor except yourself was employed, either to prepare or prosecute the applications?

A. I don't know of any application made by Sawyer and Man for joint inventions in which I was not employed as solicitor between the dates mentioned by you, excepting the application for the patent in suit. The application that was filed in that case I did not prepare and was connected with it only as I have stated.

Adjourned till Tuesday the 8th inst. at 11 a. m.

TUESDAY, *January* 8, 1889.

Met pursuant to adjournment. Present, counsel as before, and the cross-examination of Mr. BROADNAX continued as follows:

60 X Q. Have you obtained from the printer the authenti-
169 cated copy of the interference record which you offered in evidence as counsel for complainant in case 3553, in the southern district of New York?

Ans. I have.

X Int. 61. Will you refresh your recollection and tell me whether or not you testified in that case as stated in cross-question 36?

Objected to as incompetent, and as an effort to bring into the case
rbled portion of a record in another case, and as inadmissible in
sence of the production of the entire record in such case.
for defendant is notified that in following this line of ex-
he makes the witness his own, and that a motion will

be made to expunge all such examination from the record at or before the hearing of this cause.

Ans. I have read the deposition as it is printed in the certified copy referred to in the question, but whether that statement is a true statement of what I said in giving my testimony at that time in that case I do not know, as I have already stated, I recollect testifying in that case, and whatever I said was undoubtedly true, but whether that is a correct statement of what I said, I don't remember.

X Int. 62. Have you any doubt as to the correctness of this copy which you yourself offered in evidence in another case as a correct copy?

(Same objection.)

Ans. I put it in evidence in the case referred to, assuming the statement of what I said to be correct, but I can't swear now that it is.

X Int. 63. The matter quoted by me in cross-question 36 is your entire direct examination in the interference case, is it not?

(Same objection.)

Ans. Yes, if the statement quoted is a correct statement of what I said.

X Int. 64. And the direct examination quoted contains the only
statements in the deposition with regard to your knowledge
170 and information as to the making and using of paper carbons by Sawyer and Man?

(Same objection.)

A. What is contained in that statement in my deposition appears in that statement itself. Whether the statement contains all I said or not I don't know. The statement does not contain all the knowledge and information I had at that time about the making and using of paper carbons by Sawyer and Man. The object of the deposition, as I remember it, was to fix the date of their use of paper carbons. I very reluctantly made any deposition in the case at all, but the object was merely to corroborate the other witnesses as to the date, and I purposely omitted saying anything more than was just necessary to fix that date.

65 X Q. If however, you then knew of your own knowledge that the carbon in any lamp of Sawyer and Man you had seen was made from paper, you would have said so in the deposition in the interference case, would you not?

(Same objection.)

A. What I wanted to do, and did do, was to fix a date as nearl
as I possibly could by reference to some circumstance that I v
sure of at which time I had certainly seen their lamp illumi
with a paper-carbon illuminant. If there had been any ear
that I could have fixed with certainty, I think I would
tioned it without doubt.

66 X Q. And if you had known of your own knowledge of lamps made and used by Sawyer and Man, you would have said so instead of resting on the statement as you did, that Sawyer told you that the section of carbon in the lamp was made of paper?

(Same objection.)

A. If I had seen the paper carbon put in the lamp that was then sealed up and illuminated, I would undoubtedly have said so, but I did not see the paper carbon put in that lamp, and could 171 not, of course, swear that the illumi- was made of paper, although I had no doubt but that it was.

X Int. 67. And if at the time of so testifying you recollected having seen any other lamp of Sawyer & Man in which you knew of your own knowledge the carbon to be made of paper you would have said so, would you not?

(Same objection.)

Ans. Well, I don't know whether I would or not. I knew that they were making paper carbons and incandescent electric lamps, but I don't recollect that I ever saw either Sawyer or Man, or either of their workmen, take one of the carbons that I knew to be of paper and put it in the lamp. In that interference I had abundantly proved the fact by other witnesses that they did make paper carbons, and did put them in the lamps, and did illuminate them so that I made my own deposition as brief as possible, intending only to corroborate the other witnesses as to the date. If I had been examined by another counsel the deposition would probably have been very much fuller, but being counsel, I very reluctantly made any deposition at all. In the deposition that I did make, I said as little as possible, and satisfy Mr. Man, who insisted that I should at least swear to the date

X Int. 68. At the time of your visit to Mr. Man's office, as stated in answer 2, how many lamps like "Exhibit Sawyer-Man Lamp No. 1" did he show you?

Ans. Upon my visit to Mr. Man's office on that occasion, I followed him into his private office, and in my presence he opened his safe door, I standing directly in front of the safe, so that I could look right into it, and I saw there a number of lamps, I should say not to exceed three or four. He took one of them out and showed it to me, as I have stated, but he did not take any of the others out.

Adjourned till 1.30 p. m.

Resumed after adjournment.

172 X Int. 69. After being shown this lamp at Mr. Man's office, was the same lamp taken to the shop No. 2 Howard street?

Yes, I think it was.

Q. That lamp had a straight illuminant in it, did it not?

id.

Please explain how it was put in circuit?

A. They had strung alongside of a partition wall circuit wires, leading, as I was told, up to the shop of Arnoux & Hochhausen, and the circuit wires of the lamp were connected on that wire and hung wrong side upwards.

72 X Q. As I understand you, it was supported by the wires on the partition?

A. By the main circuit wires to which the lamp was hung.

73 X Q. How long did you see it remain lighted in that position?

A. Well, I can't tell you; not long. I went there to see it illuminated. Probably it was illuminated there fifteen minutes, perhaps half an hour. It was hung, as I have stated, and we stood there, Sawyer, Man and I, for some little time talking about it, and I expressed a desire to see the dynamo, which was something I had never seen before, as I recollect of. Man took me upstairs to the shop of Arnoux & Hochhausen and showed me a dynamo, and we lingered around there some minutes. Then we came down-stairs; the lamp was still illuminated, and Sawyer took it off the current wires and gave it to Man. I took it in my hands and looked at it again, handed it back to him, and he took it with him. We walked together as far as Broadway through Howard street, where we parted, he going to his office and I to mine. I should say that the lamp was illuminated altogether certainly half an hour.

74 X Q. How much of a shop did they have at that time, and what was in it?

173 A. Well, they had only a small shop, what I would call a laboratory, with one room, which, I should say, was about fifteen feet wide by about thirty to thirty-five feet long. I could tell you what was in it. There was a work-bench, at which Mr. Sawyer was at work fitting together some lamps, several parts of which stood around on the work-bench. I don't recollect that any one else was in the shop but Mr. Sawyer and his father; of the latter, however, I won't be certain.

X Int. 75. What amount of tools and apparatus did they seem to have at that time?

Ans. I cannot tell; at this date I can't recollect what they did have. I felt no interest at that time, of course, in their machinery, so did not take notice, and so really have no recollection of what machinery they had there.

X Int. 76. Is it your impression that the room was one full of machinery and apparatus, presenting the appearance of a busy workshop, or that it was quite bare of machinery and apparatus?

Ans. My recollection about it is—what recollection I have on the subject is—that the laboratory was quite bare of machinery, but was in immediate connection with the machine shop of Arnoux & Hochhausen, which was full of all kinds of machinery, to which they had constant access, as I understood it. There was a door leadin up from their room up a short stairway to the factory of Arnou Hochhausen, into which Mr. Man took me and showed me ar y-

X Int. 77. That is, the shop of Arnoux & Hochhausen w te by floor above? for the

Ans. That I don't recollect. I only recollect that short stairway leading from the laboratory of Sawyer and Man into the shop of Arnoux & Hochhausen.

X Int. 78. How many lamps did you see in the Howard St. shop at the time of your first visit?

Ans. The lamps that I saw there were lamps that were
174 either in process of construction or had been taken apart to
put new carbon in. I think the only lamp that was there that was in condition to illuminate was the one that Man took there from his office.

79 X Q. You saw no lamp with an arch-shaped conductor at that time?

A. No, I did not see any arch-shaped conductor in any lamps there, but Sawyer had some arch-shaped conductors in a paper box standing on the work-bench, which Man took in his hand and showed me, but what they were made of I don't know.

80 X Q. At the time of the visit to Mr. Man's office, and your visit with him to the shop, did Mr. Man tell you of the commercial character of the enterprise he had on hand?

A. I don't recollect now whether he did or not, we were together probably an hour, and during that time I don't think there was anything talked about except the lamps and incandescent electric lighting. The subject was entirely new to me at that time, and the lamps and general idea that he talked about of illuminating houses and cities, and all sorts of things, excited in me a good deal of interest, but what was said I don't know, except in a general way.

81 X Q. Did you understand that they had a perfected and commercial lamp, and that the one you saw like "Exhibit Sawyer-Man Lamp No. 1" was thats lamp?

A. The understanding with which I left Mr. Man, after talking with him about the lamp and the patent or patents, which they had already obtained for it, was that they had worked out a system of incandescent electric lighting, which they were going to introduce into public use as soon as they could perfect their arrangements to do so, and Man said, I recollect, when I left him, that they had a lot of improvements on the lamp that they were going to patent, immediately after vacation, and that as soon as they got ready they would come down and see me. He said that they would take the
patents out right then, before he went into the country, but
175 that they were about organizing a company, and they wanted
the company to pay the expense of taking out the patents. I don't recollect of seeing Man after that till after the summer vacation.

X Int. 82. Was the lamp which you saw illuminated the commercial form of the lamp that Mr. Man proposed to use, as he told you, or was some other lamp to be used?

Ans. I don't recollect now that he said anything about that.
showed me that lamp, and I don't recollect that he said any-
to me about whether he intended to use that particular lamp
cially or some other form of lamp; that they had a lot of
ents on their lamp which they intended to patent, and
ould come and see me when they got ready. I don't

recollect of seeing the lamp again until they brought it to me in the fore part of October, 1878, at my office.

X Int. 83. How many times did you visit this shop at No. 2 Howard street?

Ans. I cannot say now whether I was there again after this visit, of which I have been testifying, or not. I have a vague recollection, or rather impression, of going there and seeing Mr. Church there with Mr. Sawyer, but I do not feel certain enough about it to swear to it.

X Int. 84. When you next visited the shop of Sawyer and Man, it had been moved, as I understand you, to the corner of Walker and Elm streets?

Ans. Yes, it was then the shop of the Electro Dynamic Light Co. which had been organized in the meantime.

X Int. 85. How long was that shop occupied?

Ans. As I recollect it, the company commenced to work there, with Mr. Sawyer as superintendent, and with Mr. Sawyer and Mr. Man as general head and managers of it, about the first of October, 1878, and the shop was occupied by the company until some time in March or April, 1879.

176 X Int. 86. How much of a force did they have there, and what was the size of the shop and quantity of apparatus?

A. I could not tell you. They occupied the whole second floor of the building. What apparatus they had there I can't tell you. The shop was full of men and machinery. At least, the workshop was two rooms; the back room was used as the principal, and what I might call the secret workshop, the door of which was generally kept shut. The door of the outside workshop was also generally kept shut. I know I always had to ring the bell to get into the shop.

87 X Q. When Sawyer and Man called at your office, as stated in answer 4, did they bring any models or lamps with them?

A. They did.

88 X Q. What were they?

A. I think they brought two lamps and switches; I think they brought two varieties of switches.

89 X Q. In your answer to question 4, you do not say that they brought the lamps with them, but that you saw the lamps a few days after the visit you refer to. Please make it clear just what the circumstances were, as nearly as you can recollect?

A. They certainly brought the lamps with them, differing somewhat in the detail of their construction, and also models of switches. It seems to me that one of these switch models was one the frame of which was made of soapstone, and the other was a switch laid out on a block of wood. This whole business at that time was so entirely novel to me that in a very few days after that I visited Sawyer at the shop, and I talked with him about these inventio
and I explained to him that I was not an electrician, and the w by
subject was so entirely new to me that I thought it would for the
for him to write a detailed description of these lamps and
and so on, to enable me to fully understand what the

really were, and in obedience to my advice, he did write a
177 description of such of the machine as I did not understand,
and at this visit, which I have referred to, I saw these lamps
again at the shop.

X Int. 90. And one of these lamps, as I take it, had an arch-shaped conductor, which you were told was made of carbonized paper?

Ans. Yes, that is as I recollect it.

X Int. 91. Is that the lamp you refer to in your deposition in the interference case which has been quoted in X Int. 36?

Ans. I cannot state now which lamp it was that I referred to then. I saw so many of these lamps, either at my office or at their shop, that it is impossible for me to distinguish now which one I saw or referred to at that time. I was so unfamiliar with the subject at that time that I was continually sending to the shop for a lamp, or going there to see one, or something that appertained to the matters that I had in hand pertaining to this business.

X Int. 92. Did they seem to be making in quantity any particular type of lamp, if so, what?

Ans. They were making these lamps, the whole of which, in so far as their exterior and general appearance was concerned, were pretty much alike, differing somewhat in size. Some of them were quite small, the illuminating chamber being from an inch to an inch and a quarter in diameter, some of them being blown out in the form of a bulb at the upper end. The interior of the lamps differed somewhat in construction, those having the loop or U shaped carbons had nothing above the diaphragm or disc in the lamp I have produced, excepting the loop or bow shaped carbon set in studs or electrodes fixed in the disc and secured by some kind of carbonaceous cement. They made both types of these lamps; of which they made the most, or which they had adopted, or intended to adopt as
the best type, I do not know.

178 X Int. 93. The straight carbons produced by depositing on
a core from a hydrocarbon fluid, and then removing the
core, produced, as I understand you, straight, hollow or trough-shaped carbons made of a carbon deposited from the decomposed hydrocarbon fluid, such carbons were not carbons made of paper or fibrous material?

A. All the carbons referred to in the question were made by first making a carbon of fibrous or textile material, paper or willow wood, for example. That carbon was then put into the treating apparatus, by which it was coated by a deposited carbon obtained by the decomposition of a carbonaceous fluid or gas. The stick of carbon so formed would be quite long. It was then cut up in sections of the required length. A longitudinal section of this pencil of carbon reduced to the required length was cut out of the side of e pencil. The fibrous carbon was then dug out of the centre of pencil, the length of the section cut away, thus forming a trough- illuminant, composed wholly of deposited carbon, leaving ort section of the fibrous carbon in each end of the pencil e trough. In some instances, however, the fibrous carbon was bored out of the centre of the deposited carbon with a needle drill, forming a straight tubular carbon; of course it will be understood that where carbons were made in this way, in the form of a bow or arch, they were ground or filed off longitudinally down to the fibrous carbon, which could then be dug out.

94 X Q. Then, as I understand you, arch or U shaped carbons, as well as straight carbons, were made by depositing carbon from a carbonaceous fluid upon a core made of a fibrous carbon, and then removing the core so as to leave an illuminant of the deposited carbon. Do I understand you correctly?

A. Yes; most of the carbons, as I understand it, that were to be used in lamps of high luminosity, having a comparatively large illuminant, were made in that way.

95 X Q. Please look at the lamp Complainant's "Exhibit
179 Broadnax Sawyer-Man Lamp No. 1," does not the trough
remnant of the carbon which is loose in this lamp indicate to you that the illuminant of this lamp when intact was one of the straight-deposited carbons which you have described?

Ans. Yes.

Adjourned till Wednesday, the 9th inst., at 11 a. m.

WEDNESDAY, *January* 9, 1889.

Met pursuant to adjournment. Present, counsel as before, and the cross-examination of Mr. BROADNAX continued as follows:

X Int. 96. What is the foundation in facts of your own knowledge for the statement contained in answer 6, as follows:

"In some cases the original pencils were made of some fibrous material cut to size, carbonized and then treated as described in the patent to Sawyer and Man, 211,262, the fibrous part of the carbon being afterwards removed, leaving a straight shell either in the form of a tube or in the form of a trough of pure-deposit carbon"?

Ans. I know of my own knowledge that they made fibrous carbons, as stated in the answer referred to; I know that they treated those carbons as stated in the patent referred to. I do not recollect whether or not I saw the fibrous carbons removed after they had been treated, but I saw the carbons after they had been made and a central core of fibrous carbon taken out.

X Int. 97. Please state the facts upon which you base the statement that you know of your own knowledge that they made fibrous carbons as stated.

Ans. I saw the fibrous carbons taken out of the retort in which they were carbonized. I saw lots of blanks made of paper, and I
think some of them were made of willow, but of that I won't
180 be certain. I could very well tell that the carbons that were
taken out of the retort were made of paper, because some of them were only partially carbonized, or not carbonized enough t- destroy the appearance of the fibrous quality of the paper. by

98 X Q. The fibrous carbon cores that you speak of then or the part of the answer 6, you think were carbonized paper?

A. Yes.

99 X Q. How did you get the cylindrical shape of the core which appears from the trough-shaped straight carbons, such as the loose one in "Exhibit 1"?

A. I don't know that they were cylindrical, and I don't know that I noticed particularly whether they were or not.

100 X Q. You don't know, then, that they made these cylindrical cores of paper?

A. I don't recollect of seeing them make, or noticing that the paper filaments were cylindrical. It would have been a very easy matter to make them cylindrical, but whether they did so or not, I don't know.

(The second sentence of the answer objected to as volunteered and irresponsive.)

101 X Q. You don't know, then, as a matter of fact, that they used carbonized paper as the cores for these straight, trough-shaped carbons?

A. I think I have given all the knowledge I have upon the subject by actual observation. I have no further knowledge on the subject, except what I have by hearsay. I frequently saw them treating illuminants, both in the form of straight pencils, and in the form of an arch or loop.

102 X Q. These, you now assume, had been previously cut to shape and size from some fibrous material, and then carbonized by Sawyer and Man, or under their direction, but you do not know this?

A. Well, I have already stated, and I now repeat, that I
181 saw them have and cut filaments of paper. I saw those *those*
filaments, or others just like them, taken out of the retort, which retort had been in the furnace of the boiler, and made hot enough to carbonize the paper filaments to different degrees of perfection. I saw these carbons, or others just like them, treated according to their patent 211,262. Now, whether these same carbons were scarfed off, and the central core dug out, I don't know beyond what I was told, and acting, as I was, in a confidential relation to those gentlemen, I had no doubt that the information they gave me was the truth.

X Int. 103. Are you aware of the fact that Sawyer and Man, in making these trough-shaped carbons, or at least some of them, took artists' crayons, purchased on the market, reduced them to proper size, and then covered them with the deposit from the hydrocarbon fluid, and then removed the core?

Ans. I only know that by statements made to me of the fact by Sawyer and Man. I saw some little crayon pencils there, shown to me by them, but I never saw them make any use of them.

X Int. 104. How did you know of your own knowledge that the
eces of carbon which were receiving the deposit were the artists'
ons, or the fibrous material carbonized by them?

I saw them treat the paper carbons, Sawyer took some paper
hat were not, as he said, sufficiently carbonized. He took
ns for the purpose of showing me the effect of a current

upon them, and put them in the circuit. In his treating apparatus he ran the current through them, and as he expressed it, recarbonized them with the current, and took them out and showed them to me that I might see the effect of the oil and the current on the carbon.

X Int. 105. How do you know that these were paper?

Ans. Well, I know that the carbons he treated, as stated in
182 my last answer, were paper, because they were taken out of the retort in my presence along with a lot of others that had not been sufficiently carbonized to lose the appearance that partially carbonized paper would have.

106 X Q. How many were there of these pieces that Mr. Sawyer treated in your presence, as stated in answer 104?

A. On the occasion to which I refer there was but one, and I don't recollect that I ever saw him treat any carbons that I knew to be of paper from any other source than the statement of Sawyer and Man. I frequently saw them treating carbons which they said were paper, and I frequently saw them treating carbons which they said were French pencils.

107 X Q. This particular occasion, then, as I understand you, was the only time that you saw Sawyer or Man, or anybody acting under their direction, treat a carbon made from paper or other fibrous material, where the facts would warrant you in stating that you believe you knew the carbon to be of paper of your own knowledge?

A. I think I have given you all the information I have excepting this, that the paper carbons that I saw made and treated were really made for my benefit. I was called upon by them to get a patent for this paper, or fibrous carbon illuminant, and I wanted to see, as their solicitor, how these carbons were made and treated, and I went there accordingly, and was shown how the thing was done, as I have stated. After that I frequently saw them treating the carbons and cutting out blanks, as I have already stated.

108 X Q. Cannot you give an affirmative answer to cross-question 107?

A. My answer to the question referred to would be yes, but that should be taken in connection with the explanation I have made so as to convey a fair idea of the facts and circumstances exactly as they were.

109 X Q. What was the shape and size of this carbon before it was treated?

183 Ans. Well, I did not measure it, and any estimate that I may make of its size and length must be taken in connection with the fact that it is now some ten years ago since I saw it. The form was a straight pencil, I should say somewhere about two inches long. It may have been a little more. It may have been a littl less. Its cross-section, I should say, would be that of a good-siz knitting-needle.

X Int. 110. This was its appearance as it was taken from tort, as I understand you?

Ans. No, that was its appearance as it appeared in my hand after it had been treated.

X Int. 111. What was its appearance in size and shape as it came from the retort?

Ans. Well, its appearance was intensely black, but it did not appear to be so hard and stiff as after it had been treated, and its size I should think was practically the same—that is, its cross-section.

X Int. 112. Was it round like a knitting-needle, as you say it was, after it was treated?

Ans. I don't recollect that I observed it particularly in that particular, and I don't know whether I observed that it was absolutely cylindrical after it came out of the treating apparatus. What I observed more specially was the difference in the appearance of the carbon after it had been treated, I mean in its color especially. It then had a silvery appearance, such as characterizes silver after it has been worked or polished.

X Int. 113. Why did you not observe its shape in cross-section when taken from the retort?

Ans. Well, I probably had no motive in doing so, and I don't know but that I did, but I don't recollect now.

X Int. 114. Did you examine it very critically when it came from the retort?

Ans. As I recollect, only to this extent. I was comparing
184 the different pieces of carbon that came out of the retort, and
calling Sawyer's attention to the difference which Mr. Sawyer explained as being due to the different degrees of carbonization, and then he showed me that, as I have explained, that particular piece of carbon would be further carbonized by the current, and showed me that it could be, and how it would be changed, and it was done in the twinkling of an eye.

115 X Q. Did you examine the carbon with a microscope?

A. No, I only looked at it through my glasses.

116 X Q. This particular piece of carbon, I take it, was one of the well-carbonized pieces?

A. No, I did not so understand it. It was well carbonized after it had been in the treating apparatus; but Sawyer said that he could take any of those pieces that he took out of the box that had been sufficiently carbonized for him to get a current through, and carbonize them to any degree he chose to with a current.

117 X Q. The carbon, you have said, when taken from the retort, was inte-sely black. I assume, from what you have said, that some other pieces in the retort did not present the same intensely black appearance. Please state what the difference was.

A. That was not the idea I intended to convey. I meant merely to make a comparison between the appearance of the carbon before it went into the treating apparatus and its appearance after it had en treated, but as a matter of fact, some of the paper blanks were partially carbonized, leaving them a very dark-brown color, h any one could plainly see that the blanks were made of

Some of the pieces then were intensely black, and some were dark brown as you saw them in the retort, the particular piece that Sawyer afterwards treated for you was of the former color?

A. Some of them, as I have stated, a few of them, were of
185 very dark-brown color, a few of them seemed to be thor*thor*oughly carbonized so that they could be used as Sawyer said without treatment. Others again, while they were carbonized and thoroughly black, were not sufficiently carbonized, and it was these last that Sawyer said and showed me could be made thoroughly carbonized by running the current through them, and one of which he did run the current through and more thoroughly carbonize it.

X Int. 119. You, however, base your judgment that all the pieces were carbonized paper on the appearance of the brown pieces?

Ans. Yes.

X Int. 120. What experience had you had which would enable you to reach this judgment simply from the appearance of the pieces?

Adjourned till 2 p. m.

Resumed after adjournment.

Ans. At the time referred to I had no experience whatever in the carbonization of paper for any industrial purpose that I recollect of. Of course I knew what the appearance of partially carbonized paper was, but in so far as any experience in the carbonization of paper for use as illuminants for incandescent electric lamps is concerned, I had none whatever.

X Int. 121. How did you know that some of the carbons in the retort "seemed to be thoroughly carbonized."

Ans. Well, I only knew by the fact that some of the carbons were hard, and dense, and stiff, and others were less hard, less dense, and I judged that the hard, dense or stiff carbons were those that were most thoroughly carbonized. I recollect expressing my surprise to Mr. Sawyer that carbon could be made of paper, so hard and dense as some of them were.

X Int. 122. Then, as between those that you thought were thoroughly carbonized, and those that while thoroughly black,
were not sufficiently carbonized, you distinguished the de-
186 gree of carbonization by what seemed to be the difference in hardness, density and stiffness?

A. That is the way I understood it.

123 X Q. What experience had you had to enable you at that time to make such subtle distinctions of your own knowledge?

A. I have already stated to you what experience I had in the carbonization of paper for any industrial use. In drawing the distinctions I have mentioned, I merely exercised such judgment as any educated and intelligent man would be likely to exercise [illegible] such case. Of course I took it for granted that the paper-car[illegible] illuminant must be hard and dense to be fit for use in a lam[illegible] by that such density would be due to a proper carbonizati[illegible] for the paper.

124 X Q. What had been your experience in the carbonization of paper?

A. I don't recollect of ever carbonizing paper for any purpose, unless it was to make what long years ago we used to call tinder boxes, where there was a carbonization of paper for the purpose of lighting a fire with a flint and steel.

125 X Q. The tinder-box suggestion is a mere guess on your part as to possibilities?

A. No, I recollect when I was a boy, we always had a tinder box in the house, and I recollect of filling it very often with burnt paper, and of using it for lighting a fire, but the paper, of course, carbonized in that way was very soft and light.

126 X Q. With regard to this piece of carbon that Mr. Sawyer treated for you by passing a current through it while immersed in a hydrocarbon fluid, what was done with it after the treatment?

A. I don't know what they did with that particular carbon. I did not remain to see. When they got through with the experiment or operation that I came to see, I came away.

187 X Int. 127. This occurred at the shop on the corner of Walker and Elm streets, I take it?

Ans. Yes; and I think it was during the dinner hour, in the middle of the day, that it was done.

X Int. 128. Who else was present?

Ans. Old Mr. Sawyer was there; whether he remained during the whole operation of treating, I don't recollect.

X Int. 129. Your recollection is, though, that it was the dinner hour, when the men had left the shop, and the machinery had stooped?

Ans. I think so.

X Int. 130. How did they get the current to treat the carbon?

Ans. I don't know, probably the engine was kept going, or they may have started up after the dinner hour was over before the treatment took place. They had a little engine and boiler of their own, which they could start or stop whenever they chose, but whether they did so or not, I don't recollect. That was a thing that I did not particularly notice. I was there for a specific purpose, and when that purpose was satisfied, I did not take notice of anything else.

X Int. 131. Can you fix the day when this occurred by any papers, or patents, or applications for patents?

Ans. No, I cannot. It was certainly somewhere between the middle of October and middle of November, 1878. After the visit I testified about to see the carbons made and treated, I went up there again to see the carbons illuminated in the lamp, and to have a further talk with Sawyer about the switch patents, or mp patents, on the application for which I was then engaged, er for the European patent or the American patent, I don't t which, and probably a further discussion of the manner in ich, or of the best method of filing an application for a t for these paper carbons, about which there was a good f discussion between Sawyer and Man and myself.

132 X Q Now, please state precisely what took place on the occasion of your visit to the shop before the carbon was heated?

A. I have already stated, upon my examination-in-chief, and repeated, I think, in different language, on my cross-examination, substantially all that took place. I went up there to the shop as the solicitor of the Electro Dynamic Light Co., to see these carbons made and treated by preconcerted arrangement, either with Mr. Man or Mr. Sawyer. When I got there to the shop first, Sawyer and I got into a desultory conversation about all sorts of things appertaining to patents and electric light. After I had been there a few minutes, I don't know how long, old Mr. Sawyer, I mean Mr. Wm. E. Sawyer's father, called to me and said: "Mr. Broadnax, if you want to see these carbons (or something to that effect) come in here." He was in the workshop, Mr. Wm. E. Sawyer and I both went in there. Mr. Sawyer had the retort opened and took a piece of wire and took the carbons out of the retort, and showed them to me, as I have already stated. We looked at them, and talked about them, and the carbon was treated as I have stated, and when he got through with the treatment of the carbon I went back to my office. It does not seem to me now that I was there more than an hour, although I may have been. I was there long enough, however, to satisfy myself that the making of an incandescent conductor of carbonized paper was an accomplished fact.

133 X Q. You did not see the materials before they were put into the retort?

A. No.

134 X Q. You did not see the retort subjected to heat?

A. No; I don't think I saw the retort in the fire.

135 X Q. Had the retort been opened when Mr. Sawyer,
189 the father, called to you and Wm. E. Sawyer, the son, to come
in and look at the carbon?

Ans. Yes.

X Int. 136. Then when you first saw the retort on this occasion, it was open?

Ans. Yes; and it was hot.

X Int. 137. Is this the same occasion as testified to by you in direct answer 13?

Ans. It is.

X Int. 138. Then you do not want it understood that the statement is made of your own knowledge, in answer 13, "This retort was taken out of the furnace of the steam boiler used to drive the machinery in the Walker and Elm streets shop"?

Ans. No, I did not see the retort put in the furnace, nor did I see it taken out of the furnace. In fact, I did not see it — all, until old Mr. Sawyer called me to see the carbons, as I have stated.

X Int. 139. As I understand from your answer 132, you called the shop and entered into a desultory conversation with Mr. W. E. Sawyer in the outer room of the shop, and that you went by there into the inner room, or workshop, to see the carb or the Mr. Wm. Sawyer called you?

Ans. Yes; that is as I recollect it.

X Int. 140. Would you call the inner room, or the outer room, the exhibition-room?

Ans. The outer room is the room that I would call the exhibition-room, although, it was probably as much of a workshop as the other one was. In the outer room every one was admitted who went to see Mr. Sawyer, and whom Mr. Sawyer wanted to see. The door to the inner room was generally closed.

X Int. 141. I take it that at the time you gave your direct testimony in this case, your recollection was, that the retort, un-
190 opened and in a heated condition, was brought into the outer
or exhibition room, and there opened in your presence; while I understand from your cross-examination that the retort was in the inner room and had been opened before you saw it. Is your recollection as to the matter of what took place at this visit, entirely clear?

A. Perhaps upon my examination-in-chief I did not appreciate the importance of fixing exactly the place where the box was opened, but as I think of what took place in following the details of the matter I feel quite certain that Mr. Wm. E. Sawyer and I went into the inner room in answer to the call of the old man. I think I stated upon my examination-in-chief that the box was opened when the old man called to me. I think the only discrepancy between what I said on my examination-in-chief, and what I have said on my cross-examination is, as to the room in which the box was opened, or in which we went to see the box. The old man may have opened the box in the outer room, but I don't see how it is material whether it was opened in the inner or outer room, and I am perfectly clear now in reflecting upon the arrangement of the shop, that it was in the inner room that I saw the box after it was opened, because the box lay on the work-bench, near the corner of the room, and there was no work-bench in the outer room on that side of the shop.

Adjourned till Friday, the 11th inst., at 11 a. m.

FRIDAY, *January 11th*, 1889.

Met. Present, counsel as before, and the cross-examination of Mr. BROADNAX was continued as follows:

142 X Q. With reference to the carbons shown you on the occasion of your visit to the shop in Walker and Elm streets, and one of
which was treated for you by Mr. Sawyer, was an electrical
191 test made of these carbons to ascertain whether they differed
in resistance to the extent that has been indicated by you?

Ans. I do not remember of my saying anything about the resistance of that or any carbon, nor do I remember of any test having een made to show the resistance of any of the carbons shown to me that occasion.

nt. 143. Was any electrical test made of these carbons, or any tever, except mere handling and inspection, to show that ed in the degree of carbonization?

Ans. Nothing was done to the carbons beyond what I have stated that I remember of. No electrical measurement was made of any of them on that occasion to show the resistance or degrees of carbonization of any of them. It was some little time after that before I saw any of the carbons of Sawyer and Man subject to any tests of that kind.

X Int. 144. Was any electrical or other test made of the particular piece of carbon after it was treated?

Ans. None that I have any knowledge of.

X Int. 145. In comparing the pieces of carbon that were in the retort, as you recollect it, you judged that the stiffer and less elastic pieces were better carbonized?

Ans. No, that is not a fair way to put it. My judgment upon the degree of carbonization of the several pieces that I examined was based upon the comparative density, smoothness and hardness of the several pieces. I took the carbons that were most dense and smooth to be those that were best carbonized.

X Int. 146. You judged wholly from the appearance to the eye?

Ans. Yes.

X Int. 147. What makes you think that the treatment in the hydrocarbon fluid resulted in improving the carbonization of the particular piece subjected to treatment.

Ans. Well, the mere fact that the current was passed through
the carbon until is was raised to high incandescence, was
192 sufficient to satisfy my mind that the conductor subjected to
that degree of heat must be pretty th-roughly carbonized, and
my conclusion that it was more thoroughly carbonized was based upon the fact that the carbon was raised to high incandescence by a current.

148 X Q. However, no test was made to determine whether there had been any change in the degree of carbonization, and it was a mere matter of judgment on your part, from the fact that the carbon was raised to incandescence by the current while immersed in the hydrocarbon fluid?

A. Yes, it was a mere matter of judgment, based on the fact I have named.

149 X Q. You had no experience in determin-g the effect of the heat of an electric current upon a piece of carbon, had you?

A. I don't recollect that I had ever before seen a piece of carbon raised to incandescence by an electric current.

150 X Q. There is no foundation, except in your judgment, formed without experience, for the statement contained in answer 116, that "It was well carbonized after it had been in the treating apparatus"?

A. The foundation for that statement is, as I have already said, based upon the fact that the carbon was raised to high incandescence.

151 X Q. What was the treating apparatus employed by Sawyer on this occasion when he treated the carbon for you

A. I don't know that I am able to describe it in detail. glass receiver connected to a gas pipe and to the elect

The carbon was held between the ends of the conductors leading into the receiver.

152 X Q. Please describe the shape and size of the retort and its
cover and what the appearance of its contents was when
193 you first saw it? I refer to the retort that you saw after it
was opened, and from which a piece of carbon was taken
and treated by Mr. Sawyer.

Ans. As I recollect the retort, it was what I think is called a small-sized sand retort, such as are used for melting metal in by jewelers and others. I did not measure it, and I can only guess at the size. I should think it would be somewhere about two or three inches in diameter, and I should say it would be four or five inches deep. There was a flange about its upper end. How the lid or cover was fastened on I did not notice. The retort was in the shape of a shallow frustum of a cone. It lay on its side on the bench, and the contents were raked out on the bench with a wire. The contents were composed of what appeared to be powdered carbon and the carbonized pieces of paper.

X Int. 153. The statement contained in your answer 6, that you "saw blank illuminants taken out of the box in which they had been carbonized," is based, I take it, upon the circumstances of the occasion that you have been testifying about when Mr. Sawyer took the piece of carbon out of the retort and treated it for you?

Ans. Yes.

X Int. 154. What is the basis in fact for the statement contained in answer 6, that you "frequently saw the carbons treated," which, I take it, you intended to refer to paper carbons?

Ans. The basis of that statement is my experience in seeing the carbons treated.

X Int. 155. I take it the occasion that you have been testifying about when Mr. Sawyer treated the carbon for you is one basis for the statement quoted in my last question.

Ans. Yes, that was the first time I saw the carbons treated. Afterwards I very often saw them treat carbons.

X Int. 156. But that was the occasion when you followed the matter most closely?

Ans. That was the first and most interesting, because
194 it was then entirely novel to me. After that I saw Sawyer
treat carbons very often, but I had no special interest after
that in taking particular notice of the carbons, and the apparatus
in which they were treated.

X Int. 157. That was the occasion on which you had the best opportunity for determining of your own knowledge the character of the carbon treated, was it not?

Ans. No, I can't say that, because I had lots of opportunities, if I had chosen to avail myself of them, to go very fully into an inves-
gation.

X Int. 158. But this was the occasion on which you took advan-
f your opportunities, and on which you were best informed,
wn knowledge, of the character of the carbon treated?

at is the occasion upon which I went to see a thing done about which I have been talked to a good deal, and I took, therefore, personal cognizance, as I have already stated, of the carbons, the carbonization and treatment. I went to see what an incandescing conductor for an electric lamp made of carbonized paper was like, both before and after it was treated. That being done, my mind was satisfied, and I made no further special examination of the matter. I frequently saw the treating afterwards, and carbons that had not been treated and those that had been treated, and had them in my hand, and talked about them a good deal to Sawyer and Man.

X Int. 159. But you think you have reason to believe that you knew of your own knowledge what the character of the carbon treated was better on this occasion than on subsequent occasions?

Ans. I knew of my own knowledge on that occasion what the carbons were made of. I knew that they were made of paper, and I saw them treated, and I frequently after saw carbons treated that were made of paper, or at least I have no doubt but that they were paper, although I did not see them put in the carbonizing
195 box, nor did I see them taken out, but I am as well satisfied that they were paper as if I had seen the blank cut out of paper, carbonized and treated; as if I had stood by and witnessed the whole operation, because all the information I got upon the subject was from those in whose employ I was, in whose interest I was acting, and whose interest it was to tell me the truth, to the end that I might act intelligently in patenting their invention.

160 X Q. My last question was based upon matters of your own knowledge. Cannot you give me a simple affirmative answer to it?

A. I know what my own knowledge was, without believing or reasoning upon the subject at all, and I have repeatedly stated what I know of my own knowledge. I know of my own knowledge what was done on the first occasion, but I do not know of my own knowledge how the paper was carbonized on any other occasion, or to what degree it was carbonized, nor how many of them were treated. A simple affirmative or negative answer to your question would infer that all I knew of my own knowledge about this matter was based upon what I saw on that first occasion, which would not be the whole truth, because, in addition to what I saw on that first occasion, I frequently saw paper blanks that had not been carbonized. I saw the same blanks repeatedly afterwards or blanks that looked just like them, that had been carbonized and afterwards treated, but on no other occasion did I stand by and see the carbons taken out of the retort, examine the lot of them before they were treated, and see them afterwards treated, all at one time. With this explanation, I answer your question directly in the affirmative.

Adjourned till 2 p. m.

Resumed after adjournment.

161 X Q. Have you any distinct recollection of the circum
of any later or subsequent occasions on which you sa
treated?

196 A. None that I can distinguish especially. I frequently saw them treated as an incident of my visit to the works on some matter of business, but I cannot distinguish any particular time.

162 X Q. Can you recollect the circumstances?

A. I don't know that I can. I recollect being there once. I think some time in December, 1878, to see Mr. Sawyer, to get from him the operation of a dynamo-electric machine that I was going to patent for him, and at that time seeing them treat carbons, but I did not go there especially to see the carbons treated or worked with in any way. I had a special object in going there, and that object was to see Mr. Sawyer and get him to explain his dynamo, and I don't recollect that I noted anything about the carbons or lamps that they were then making.

163 X Q. Do you refer to the dynamo machine described in Sawyer's patent No. 237,632, dated February 8, 1881, application filed December 20, 1878?

A. Yes, that is the one.

164 — Q. You were preparing, or about to prepare, the application for the patent, I presume?

A. Yes, I think so, I did prepare that application.

165 X Q. You don't recollect investigating the matter of the treatment that was going on at the time of that visit in December?

A. Not by personal observation.

166 X Q. Did you not see the flask or vessel in which the treatment was being made?

A. I probably did, but I did not specially observe it. I knew they were treating carbons, but I don't know that I ever went over and looked at the apparatus. It was a thing I felt no interest in just then, and did not give it any attention.

167 X Q Do you recollect any other occasion, except the first one, on which your observations were closer and more critical than on the occasion you have referred to in December, 1878?

197 Ans. No, I don't recollect of any.

X Int. 168. You understand the fact to be, do you not, that Sawyer and Man treated by their hydrocarbon treatment other kinds of carbons than carbons from paper or fibrous material?

Ans. I understand that to be so, yes.

X Int. 169. What do you recollect, of your own knowledge, as to the actual putting of carbons into lamps by Sawyer and Man?

Ans. About the only knowledge I have of that consists of seeing old Mr. Sawyer put carbons in the lamps in assembling the several parts of the lamp. I saw him put carbons in the lamps, I think, on two or three occasions, but when these occasions were I cannot tell the dates, or what took me to the shop at the time it was done.

X Int. 170. What kind of carbons were they?

Ans. They were straight pencils at one time, and U-shaped, or -shaped carbons, at another. What the carbons were made of t know, of my own knowledge. I merely inferred that the d carbons were all fibrous carbons. That inference is due that, as I understand it, they did not make any bow-shaped carbons of anything excepting fibrous material at that time, I mean the fall of 1878.

X Int. 171. What were the straight carbons made of?

Ans. I don't know; I don't recollect of ever asking the question. I mean, of course, subsequent to the first time I saw them made and treated, as I have stated. I mean, of course, the first time I visited the works to see the paper carbons, and did see them taken out of the retort carbonized, and one of them treated.

X Int. 172. The bow-shaped carbons, I take it, were of the dug-out character that you have described as being made by depositing carbon upon a core of fibrous carbon and then digging out the fibrous carbon?

198 A. Your question infers that all of the bow-shaped carbons were made in that way, an inference that has no foundation in fact. A few of them, or some of them, were made in that way, undoubtedly, but there were a great many of them made that were not dug out at all, and some of them, as I understand, were not even treated. I saw bow-shaped carbons that had not been treated at all, but whether they were treated before they were put in the lamps or not, I do not know, nor do I know whether those I saw put in the lamps were of the dug-out variety. I do not recollect of observing whether they were dug out or not.

173 X Q. Are you quite certain that you saw any bow-shaped carbons put in lamps?

A. Yes, quite. I recollect distinctly of rallying old man Sawyer about the big clumsy clamps he had to hold the carbons.

174 X Q. What was the character of the clamps?

A. These particular clamps were made of two pieces of carbon set vertically on the top of a leading conductor, and held together by a screw passing transversely through the two parts that composed the clamp and drawing them together on the ends of the illuminating conductor substantially as described in the patent in suit.

175 X Q. Do I understand that you now desire to change the position taken on your direct, and as stated in answers 6 and 7, that you did not see the paper or fibrous carbons "put in the lamp," and, as you expressed it in other words, "did not see them (the different parts of the lamp) assembled"?

A. No; the thought that I intended to convey in my examination-in-chief, and that I intend to convey now, is that I never saw any paper carbons or fibrous carbons put in the lamps, that I knew to be fibrous carbons, excepting as I was informed by Sawyer and Man, or old Mr. Sawyer, William E. Sawyer's father, and when I said that I did not see the lamps assembled, I meant to say
199 that I did not see them assembled as a whole, that is, put together and sealed up. The lamp was made in two principal parts, the leading-in conductors, and, indeed, all the machinery inside the lamp was fixed on a glass disc that closed t
lower end of the globe. The carbons were put in the leading
ductors so as to complete the circuit before the lamp as a wh
assembled, so that putting the carbons in the illuminati
was only a part, or the assembling of a part, of the lar

in my examination-in-chief. I said I did not see the lamp assembled, I meant all the parts of the lamp ready to put on the circuit.

X Int. 176. Then you mean by the expression, putting the carbon in the illuminating or lighting circuit, only the mounting of the carbon upon the leading-in conductors, and not the placing of the leading-in conductors within the lamp globe?

Ans. Yes, that is about what I meant. I suppose if I had remained I would have seen old Mr. Sawyer put all the parts together, that is, complete the assembling of the lamp.

X Int. 177. Am I right then in assuming that you did see Mr. Sawyer's father attach carbons to the leading-in wires, or place them in the lighting circuit, as you have expressed it, but did not see him complete the assembling of the lamps by placing the leading-in conductors and carbons within the lamp globes and sealing such globes?

Ans. Yes, that is substantially correct. The lamp could not be considered as assembled until all its parts necessary to make the lamp were brought together in their right relation. All that I saw the old man do was to put the U-shaped carbons on the electrode leading into the lamp. Before these electrodes were put in the chamber or globe of the lamp they may have been altered, but whether they were or not, I don't know, I assume that they were not, but I don't know.

X Int. 178. Do you wish to be understood that any of the
200 carbons which you saw old Mr. Sawyer or anybody else *selves*,
attach to the leading conductors, or in other words, put in the lighting circuit, were paper or fibrous carbons?

A. Yes, the old man told me that they were fibrous carbons. I don't know whether he said they were willow carbons or paper carbons.

179 X Q. Your position on that matter then is, that you did not see paper or fibrous carbons put into the lamps by Sawyer and Man or anybody for them, but that you did see such carbons attached to the leading conductors or put into the lighting circuit by old man Sawyer, who was working for Sawyer and Man?

A. That is substantially correct.

180 X Q. Has your recollection of this matter changed since you gave your direct examination? You say at the beginning of answer 7 that "I did not see the illuminant put in the lighting circuit."

A. No, my recollection has not changed. What I said in the beginning of my answer to question 7 is exactly as it was in what I say now. I said then, "I mean that I did not see the illuminant put in the lighting circuit, and the lighting circuit put in the lamp. In short, I did not see the lamp made, but I did see the different parts of the lamp before they were assembled, and did see them ter they were assembled, but did not see them being assembled," that is exactly as it was.

X Q. You mean to say now that you did see the illuminant lighting circuit, but that you did not see the lighting in the lamp, and that you think is the meaning of answer 7, when all the matter quoted in your last answer is taken together?

A. Yes, I think so.

182 X Q. Speaking of the bow-shaped carbons which you saw old man Sawyer attach to the wires, you say in answer 172 that you do not recollect observing whether they were dug out or not. Was your observation any closer with respect to the straight carbons which you saw put into the lighting circuit? 201

Ans. No; I don't think it was.

X Int. 183. In answer 7 you make the following statement:

"I desire to add also, that in the case of the straight pencil, it was a common practice for them to make the illuminants, by simply treating it slightly preparatory to using it in the lamp, leaving the fibrous carbon intact as a part of the illuminant."

I take it from what you have said on cross-examination, as to your actual knowledge of the treating of carbons that was done by Sawyer and Man, and also, from what you have said on cross-examination as to your actual knowledge of the putting of carbons into lamps, that this statement is not made of your own knowledge; am I right?

Ans. The exact fact about that is this: Upon one of my visits at the shop some time during the period heretofore referred to by me; I mean between the middle of October and middle of November, or thereabouts; I saw some of these carbons that had the dug-out appearance, and I asked what it was, and how it was done, and it was explained to me, I think by Sawyer himself, how those carbons were made as I have already stated. I did not see any of them dug out, and there were only a few of them that were "dug out." The rest of them were intact, most of them had been treated, some very little, some a good deal. Those that had been treated only a little were not dug out. I will add that I did not see these carbons made, and I did not see the operation of digging out the core.

X Int. 184. This then is the basis for the statement quoted in my last question?

Ans. Yes.

X Int. 185. Did you examine these carbons very carefully?

202 A. I looked at them with a great deal of curiosity.

186 X Q. Did you see any use made of them?

A. I don't remember that I did. I saw straight pencils of carbon that had evidently been made in that way in some of the lamps that had been used. But I don't recollect of seeing that particular kind of carbon illuminated in one of the lamps.

187 X Q. Did you see these carbons before they were treated?

A. These particular carbons I never saw until I saw them in the condition I mentioned, but I saw a good many carbons that had not been treated.

188 X Q. And you did not see these particular carbons treated

A. I have just said so.

189 X Q. And you had no means of telling of your ow edge what the cores of these intact carbon pencils were

A. No; only as I have stated.

190 X Q. That is from what Mr. Sawyer told you?

A. Yes.

Adjourned till Saturday, the 12th inst., at 11 a. m.

NEW YORK, *January* 12, 1889.

Met pursuant to adjournment. Present, counsel as before, and the cross-examination of Mr. BROADNAX was continued, as follows:

191 X Q. What was the explanation made to you by Mr. Sawyer which is referred to in your answer 183?

A. He explained to me how they were made.

192 X Q. Was the entire explanation relating to these carbons of this character—*i. e.*, an explanation of how they were made?

A. The explanation that he made, as I recollect it now, 203 was merely that the carbons in question were made by first carbonizing a piece of paper, or other fibrous material, so as to make an illuminant complete in itself of fibrous material, to take that illuminant and treat it according to the Sawyer-Man patent 211,262, until they had upon it as thick a deposit of carbon made by that process as they wanted; that a longitudinal section of the deposit carbon was then cut away from the illuminant, sufficient to expose the fibrous carbon core, which was then dug out, by which there was left an illuminant of deposit carbon in the form of a trough. That is the substance of the explanation, without pretending to give the language used by Mr. Sawyer in making the explanation.

X Int. 193. And is that the substance of the entire explanation, or substantially all of it?

Ans. That is the substance of the whole explanation, as I now recollect it, and it was sufficient to convey to my mind how the carbon was made.

X Int. 194. The only occasion on which you saw carbons introduced into the lighting circuit by Sawyer and Man, or attached to the conductors, were the occasions about which you have testified in answer to cross-questions 169 to 182, inclusive?

Ans. I cannot say that those were the only occasions. I recollect of seeing old Mr. Sawyer put the bow-shaped carbons in lamps having carbon clamps on the upper ends of the leading-in conductors, like the patent in suit, and I recollect, also, seeing the same kind of carbons set in the upper ends of the leading-in conductors, the holders being made like those in "Exhibit Lamp No. 2." I was at the shop quite often, and saw them working on different parts of the lamp. How often I cannot say, nor can I say just how often I saw them putting carbons in the lighting circuit.

X Int. 195. Referring now to "Exhibit No. 2," introduced in your direct answer 18, this structure has the brass cup not fitted pon the bottom of the lamp, and not filled with any sealing material. Am I right?

A. The brass cup, or cap, which is intended as the final ling of the lamp, has been fitted to the base, but it is not to its proper place. The cup is not filled, nor does it

286

contain any sealing material, but is simply stuck on the base of the lamp.

196 X Q. This, then, is not a completed lamp in its present condition?

A. No.

197 X Q. There is no carbon illuminant within the lamp?

A. No; there is none.

198 X Q. And no loose pieces of carbon within the lamp to show that it was even provided with an illuminant?

A. There are no loose pieces of carbon in the lamp that I am able to discover.

199 X Q. And the blocks of carbon above the soapstone disc are not burnt or discolored in such a way as they would be if an illuminant had been burnt out between them?

A. The carbon-holders in this lamp do not seem to be discolored but very little around the edges of the creases cut to receive the carbon illuminants.

200 X Q. There are no evidences of a carbonaceous or other cement having been used to attach an illuminant to the blocks of carbon in this lamp?

A. I don't see any carbon cement upon the carbon-holder.

201 X Q. What are the holes in the periphery of the soapstone disc intended for?

A. They are intended, and the lamp was so made as a rule, to receive spiral springs to keep the soapstone disc from knocking against the globe of the lamp.

202 X Q. Has this "Exhibit No. 2" any such springs?

A. I don't see any.

203 X Q. You did not intend by your answer to question
205 18 to state that this lamp No. 2 has an illuminant in it of
bow shape or any other shape?

Ans. No, I did not, I merely produced that lamp as one of a kind in which I saw the U-shaped carbons put. I did not intend to say, and don't think I did say that I had seen the U-shaped fibrous carbon in this particular lamp. I produced this lamp because it was the only one I had of the kind of lamps or type of lamps in which the bow-shaped carbon was used; whether there was ever a carbon illuminant in this particular lamp I don't know.

X Int. 204. And there is nothing in the appearance of this "Exhibit No. 2," to indicate that a carbon illuminant of any character has been secured to the carbon blocks by means of a carbonaceous cement or any other kind of a cement, is there?

Ans. Well, I am not willing to swear that there has never been any carbon illuminant in this lamp secured by a carbonaceous cement, because I don't know what the appearance of the lamp would be if there had been. I am not sufficiently familiar with the appearance of the illuminant-holders and the glass globe of the lamp in which illuminants have been placed to make my judgm of any value in that respect.

Adjourned till Tuesday, the 15th inst., at 11 a. m.

NEW YORK, *January 15th*, 1889.

Met pursuant to adjournment. Present, counsel as before, and the cross-examination of Mr. BROADNAX continued as follows:

X Int. 205. As I recollect, your testimony in cross-examination as to the particular occasion when Mr. Sawyer treated a straight piece of carbon for you, you do not recollect the construction of the apparatus used by him in the treating operation?

206 A. Only in a general way, as I have stated; I could not
give a detailed description of it.

206 X Q. And, as I understand from your answers to cross-questions 161, 162, 166 and 167, you did not afterwards observe the treating process and apparatus as critically as on this first occasion, and have no better recollection about the treating apparatus subsequently employed?

A. No, I don't know that I could describe it. In fact I know I could not give any better description of it than I have already done.

207 X Q. Your recollection, I take it, as to the treating apparatus used on the first occasion, when you examined it especially, is only general, that it was a glass vessel with a gas connection and some arrangement for holding the piece of carbon within the vessel filled with the gas?

A. I think I described it in my examination-in-chief as consisting of a glass receiving chamber having a glass bottom or enclosing cover in which there was fitted a receiving nozzle or pipe through which the gas entered into the chamber, and a exit pipe through which the gas escaped from the chamber, and also conducting wires leading to and from the chamber, having on their upper ends a device for holding the carbons to be treated. That, I think, is the whole apparatus substantially. Just what the detail of the fitting was I can't describe, because I don't remember.

208 X Q. The apparatus of that first occasion was not the same as Complainant's Exhibit Sawyer-Man Treating Apparatus, which you described in direct answer 12, and which is introduced in evidence after direct answer 19, was it?

A. It was similar to this, but not exactly like it, I think the lower
part of it was the same. The upper part of it for holding
207 the carbon to be treated was different. Some arrangement
was made, that I don't now recollect, for holding the straight
carbon vertically, one of the metallic electrodes being longer than the
other. I recollect the carbon standing vertically in the receiver,
but I cannot remember how it was fixed.

X Int. 209. That exhibit then is not the apparatus, in all respects at least, which you saw used for treating?

Ans. Substantially it is, all except the little mechanical detail for holding the straight carbon. This is the apparatus, or one like it, which was used for treating the bow or U-shaped carbons.

X Int. 210. The holders or clamps of that exhibit are not so located relatively as to be suitable for holding a straight pencil two inches long or thereabouts, such as you have testified you saw treated?

Ans. No, I think not.

X Int. 211. Do you wish by your answer to cross-question 209, to recede from the position taken in answers to cross-question- 161, 162, 166 and 167, that you did not observe the character of the treating apparatus on occasions subsequent to this first occasion?

Ans. No, I don't mean to recede from any position I have taken. I have not specified the particular occasion upon which I saw this apparatus, Exhibit Sawyer-Man Treating Apparatus, used for treating U-shaped carbons. I recollect seeing them treat with an apparatus like this, or something like this, the U-shaped carbons.

X Int. 212. In answer to cross-question 166, you state, referring to a definite visit to the shop in December, 1878, "I knew they were treating carbons, but I don't know that I even went over and looked at the apparatus," and in answer to cross 167, you state that you do
not recollect any occasion, except the first one, when Sawyer
208 treated the straight carbon for you, on which your observa-
tions were closer and more critical than at the time of the
December visit. Do I understand that you now mean to say that there were after occasions, besides the first one, when the straight carbon was treated, on which other occasions you did not go over and look at the apparatus?

A. I don't recollect just now of any occasion subsequent to December when I paid any attention to any particular treating apparatus, although I may have done so. I have a very distinct recollection of seeing Sawyer treat the straight carbon pencil, as I have stated, and I recollect, also, of seeing the U-shaped carbons treated in apparatus something like this exhibit. Whether it was exactly like that I could not tell, but it was substantially that. When I said in the previous answer that I did not recollect of observing particularly on any other occasion the treating apparatus, I meant subsequently to that visit in December. In fact, it is impossible for me now to distinguish the times when I saw these things done at the shop of Sawyer and Man.

213 X Q. Did you recollect at the time of answering cross-questions 161 to 167 inclusive any time, whether before or after December, 1878, on which you did see the carbons treated and did look at the apparatus?

A. No, I don't know as I had the element of time just then in my mind at all, not thinking it was of any importance whether I saw it before or after my December visit. I know that I saw these things take place, but the order of them I don't recollect at all.

214 X Q. If, as you now state, you did not at the time of answering questions 161 to 167, think it was of any importance whether you saw the treating before or after your December visit (as you were justified in thinking since those questions call for all occasions, and not for occasions after or before any particular time), why did you by your answer to cross-question 212 attempt to avoid the
effect of your answers to cross-questions 161 to 167 inclusive,
209 by — in answering cross-question 167 you were referring to oc-
casions subsequent to your visit in December?

Ans. I don't know that I quite understand the question, it is so very involved, but I had no idea in answering the question I understand you to refer to, of seeking to evade the effect of anything I have said. I merely meant to explain, or rather to state, what occurred to me in connection with the question at that time. It occurred to me then that I did not recollect, at least, I could not call to mind, any special occasion that I saw him treating them, or observed any treating apparatus subsequent to my visit in December, because, as I now recollect it, my visits to the works were quite infrequent towards the latter part of December and January.

X Int. 215. Do you now wish to recede from the position taken in answer to cross 213, that in answering cross-question- 161 to 167 inclusive, you did not have the element of time in mind, and did not think it of importance whether you saw the treating before or after your December visit?

Ans. No, I don't mean to recede from anything.

X Int. 216. Your answer to cross-question 213, then is correct?

Ans. Generally speaking, I think my answers are all correct. I recollect, as I have already stated, and now repeat, of observing, in a general way, the treatment of the carbon that I first saw treated by Mr. Sawyer, the straight pencils, and I recollect, also, of seeing treated (whether Sawyer did it or not, I don't now recollect, but I don't think Sawyer did it, I think it was somebody else) the U-shaped carbons, and I recollect of being there in December when they were treating carbons, but I don't recollect that I went to look particularly at the apparatus or method of treating. The fact of these things being done, I recollect, but the order in which they were done, I don't recollect, nor do I recollect the minute detail of any of the apparatus. When I said that I did not recollect
210 of any other occasion when I had examined more minutely the apparatus, I did not have in my mind at all the apparatus that I described in my examination-in-chief.

217 X Q. Then, it is true, as stated in your answer to cross-question 213, that when you answered cross-questions 161 to 167 inclusive, you did not have the element of time in mind, and did not think it important for the purposes of those questions, whether the occasions were after or before your December visit?

A. No; I don't see how it could be important in any *re*spect of the matter whether it was before or after my December visit. I certainly don't recollect so as to be able to distinguish them of seeing any treating done that I specially noticed subsequent to December, nor do I recollect. If I said that I did not have the element of time in my mind when I answered any question, it is true.

Adjourned till 2 o'clock.

Resumed after adjournment.

218 X Q. I still take it that your answers to cross-questions 161 to 167 are substantially correct, and your examination of the apparatus when Sawyer treated the straight carbon for you, was more thorough and critical than any subsequent observations of the treating apparatus?

A. Whatever I have said is intended to be exactly right, and to avoid the possibility of appearing to mislead, I will state that there are only t-o occasions that I recollect of upon which I observed at all the treating apparatus, and on neither of those occasions did I make a critical examination of them. I saw, in a general way, what they were. One of those occasions I described on my examination-in-chief, where I described the treatment of the U-shaped carbon and the apparatus in a general way, used in treating them, and the other was the treatment of the straight carbon by Sawyer, that I described on my cross-examination, that did not occur to me when I was testifying in chief, and when I was asked by you
211 whether there was any other occasion on *casion on* which
I had more carefully observed the treating apparatus, I took it for granted that you intended to ask me whether there was any other occasion than those which I had referred to, on which I had more carefully examined the treating apparatus, to which I answered in the negative, but I did not then intend to exclude the occasion referred to on my examination-in-chief.

X Int. 219. What is there in cross-question 167 which led you to believe that I excluded any occasion referred to in your direct?

Ans. I don't know that there is anything in terms in the question, but it seems fair to assume that after I had testified about the occasion mentioned in my examination-in-chief, you did not intend to exclude that occasion from your question, and I answered the question rather to meet the substance, perhaps, of the question than its terms.

X Int. 220. Please point out where, in your direct examination, you have testified to any particular occasion on which you saw carbons treated?

Ans. In answer to question 12, in my examination-in-chief, I described an occasion on which I saw an apparatus used in treating U-shaped carbons, substantially like that which I have produced. I did not state any particular time when I saw that, because I could not recollect exactly the time when it occurred, but it is plain from the examination that it was on a different occasion, or at a different time from that mentioned on the cross-examination, when the straight carbon was treated by Mr. Sawyer.

X Int. 221. Where, in answer 12, is any mention made of the U-shaped carbon?

Ans. I don't know, and do not find in the answer referred to that the word U-shaped carbon is used, but in the apparatus produced only U-shaped carbons could be treated, as I understand it, and I stated in that answer that in "these clamps the two ends of the carbon to be treated were secured so as to complete the circuit in the lamp."

212 222 X Q. Could not a straight piece of carbon be secured by the clamps of this Exhibit Sawyer-Man Treating Apparatus?

A. I don't see how a straight pencil could be treated in that apparatus, although it might be possible.

223 X Q. What would prevent the clamps being opened and a

straight piece of carbon laid right across them, and then being secured by the tightening of the nuts of the clamps?

A. The carbon-holders are very near together, so that no straight pencil could be treated in them, unless it might be a very short one, unless the structure of the apparatus was changed.

224 X Q. That is, a straight piece of carbon could be readily secured by the clamps of the exhibit, but its exposed incandescent body would be in length equal only to the distance between the clamps?

A. Yes, that is among the possibilities, but I have no idea that such a thing was ever done with this apparatus, or that the apparatus was made of anything of that kind, and it certainly was not used by Mr. Sawyer in treating a straight pencil as I have described. He had some sort of a device in which he held the pencils vertical in the lighting circuit.

225 X Q. As I understand, and from your cross-examination, you do not know that this Exhibit Sawyer-Man Treating Apparatus was ever seen by you in use, but that you believe it to be substantially the same in construction as the corresponding part of the treating apparatus that you did see in use?

A. Yes, that is substantially what I mean. I don't know that I saw that particular apparatus in use.

226 X Q. And you do not wish your answer to question 12 to be taken as going any further in that direction than your last answer?

A. What I meant to say was, that I had seen the U-shaped
carbons treated in an apparatus that was substantially like
213 that. Whether that is the identical apparatus in which I
saw them treated or not, I do not know.

X Int. 227. How did the "Exhibit Sawyer-Man Treating Apparatus" come into your possession, and when?

Ans. Mr. Albon Man gave it to me in the early part of last summer, or in the latter part of the spring of 1888, as the apparatus in which he and Sawyer treated their U-shaped carbons. He gave it to me at his house, I was there looking over a lot of apparatus of different kinds that he and Sawyer had used in making their electric lamps.

X Int. 228. You were taking testimony at that time in a suit on the same patent which is involved in this suit, brought by the complainant against the Edison Electric Light Co. in the U. S. circuit court for the southern district of New York No. 3553?

Ans. We either were taking testimony in that suit, or had been. My impression is that I got that exhibit before the complainant in that case closed their affirmative proofs.

X Int. 229. Referring to the Sawyer-Man lamps which you saw in 1878 and 1879, were such lamps ever sold or used commercially?

Ans. I don't know whether they were or not.

X Int. 230. Your association with the officers and directors of the Electric Dynamic Light Co. was an intimate one, was it not?

Ans. With some of them, Mr. Man, Mr. Sawyer and Mr. Jacob Hays, I had a good deal of intercourse, but my intercourse was limited to such matters as appertained to the patents of the company. In short, it was a professional one, and more with Mr. Man than any of the rest, although I was in frequent intercourse with Mr. Sawyer.

X Int. 231. If that company had done a commercial business it would have come to your attention, would it not?

Ans. Well it might, and it might not. They may have
214 made and sold lots of lamps without my knowing anything
about it.

232 X Q. How long did you see any of the lamps lighted at any time?

A. I don't know how long, I saw the lamps lighted, more or less of them on almost every occasion when I went to the works, but I don't remember to have ever been there more than an hour or an hour and a half at any one time when the lamps were illuminated. I was there upon one occasion when there was a number of other gentlemen, when there was a number of lamps illuminated. That probably was the longest time I ever saw the lamps illuminated, and looking at it from this length of time, I don't think it was over an hour.

233 X Q. What was this occasion, when was it, and who were present?

A. I don't know who all were present, Mr. Hays, Mr. Myers, Mr. Man, and I think Mr. Judd and others, whose names I don't know. At least I don't recollect them if I ever did know. There was an exposition of the lamps there, broad shutters were put over the windows of the outside room, and a very brilliant illumination of the lamps was had. It was some time in the fall of 1878. I should think it was some time in November, it might have been in December.

234 X Q. What was the purpose of the exhibition, if you know?

A. I don't know that I ever asked what its purpose was, and I don't know that I was ever told what its purpose was, but I inferred that it was to show the lamps to the gentlemen interested, and to others who were invited to see it. I think it was mentioned in the newspapers of the day.

235 X Q. This exhibition was in the outer room of the shop, I take it?

A. Yes.

236 X Q. Please state how the lamps were arranged and
215 supported and how many of them were lighted at one time.

Ans. There was a chandelier hanging pendent in the center of the room, on which there were three lamps, two standing upright and one hanging pendent, and there were around the walls of the room a number of lamps supported in brackets. I don't know how many there were. I don't recollect now, but I have an impression, but it is only an impression, that there were eight lamps in circuit altogether, and they were all illuminated at one time, that were in circuit, and continued to be so illuminated during my stay there.

X Int. 237. Referring to your answers to direct questions 9 and

10, did you know how long the Sawyer and Man lamps would last without burning out the carbons?

Ans. No.

X Int. 238. Or how long they would last without requiring a recharging of the globes?

Ans. No, all the knowledge I have on that subject is mere hearsay information.

X Int. 239. Or whether such lamps were capable of being economically operated?

Ans. I do not know anything about the economy of their operation.

X Int. 240. Or did you know whether they were capable of being used for practical illumination without requiring conductors of such large size as to make their use commercially prohibitive?

(Objected to as incompetent.)

Ans. Those are things about which I had no knowledge at that time.

Adjourned till Wednesday, 16th inst., at 11 a. m.

216 NEW YORK, *January* 16, 1889.

Met pursuant to adjournment. Present, counsel as before, and the cross-examination of Mr. BROADNAX proceeded as follows:

241 X Q. Referring to the following patents granted to William E. Sawyer and Albon Man:

Number.	Date.	Title.
205,144.	June 18, 1878.	Electric lamp.
205,303.	June 25, 1878.	Electric lighting system.
205,305.	June 25, 1878.	Regulator for electric lights,

the applications for which patents were all filed in May, 1878, did you prepare or prosecute these applications for patents?

A. No, I did not prepare them, nor did I prosecute them, or have anything to do with the prosecution of them. The patents referred to were all issued before I was retained by the Electric Dynamic Light Co., or by Sawyer and Man.

242 X Q. Referring to the following patents granted to Wm. E. Sawyer and Albon Man:

Number.	Date.	Title.
210,152.	Nov. 19, 1878.	Switch for electric light.
210,809.	Dec. 10, 1878.	Electric lamp.
211,262.	Jan. 7, 1879.	Carbons for electric lights.
229,335.	June 29, 1880.	" " " "
229,476.	" " "	Electric switch.

The applications for all of which patents were filed in 1878; did you prepare or prosecute these applications?

A. I prepared and prosecuted the applications for all the patents mentioned in the question.

243 X Q. Did you prepare and prosecute the application for the reissue of said patent 205,303, which reissue application was filed May 14, 1881, and resulted in reissue patent No. 10134, dated June 6, 1882?

A. I did.

217 X Int. 244. Do you know of any other patents granted upon joint inventions of Sawyer and Man, or applications for patents filed upon joint inventions of Sawyer and Man other than those mentioned in my last three questions, and excepting of course, the patent in suit?

Ans. I do not recollect of any just now.

Counsel for defendant offers in evidence the patents of Sawyer and Man, referred to in questions 241, 242 and 243, and the same are marked respectively, "Defendant's Exhibits Sawyer-Man Patent No. 210,152, 210,809, 211,262, 229,335, 229,476, 205,144, 205,303, 205,305 and Reissue No. 10134, all of Jan. 16, 1889."

It is stipulated between counsel that ordinary Patent Office copies of the specifications and drawings of said patents, may be marked in evidence, with the same force and effect as certified copies of such patents, subject to correction if any mistake should be discovered in such copies.

X Int. 245. Then, so far as you now recollect you prepared and prosecuted all applications for patents upon the joint inventions of Sawyer and Man, except the application for the patent in suit, and except the three patents which were applied for and granted before you were retained?

Ans. Yes, that is correct. My connection with the preparation and prosecution of the patent in suit, I have already explained.

X Int. 246. I understand that you drew the assignment of Sawyer and Man, to the Electro Dynamic Light Co., dated October 14, 1878, and marked as an exhibit in this case?

Ans. I did.

X Int. 247. I take it that that assignment was intended to cover the inventions which had been described to you at the interview, you have testified about occurring before the date of this assignment, and upon which you had prepared, or intended to prepare, applications for patents?

218 Ans. Yes, that assignment was intended to convey the inventions of the switch, of the carbons, and of the method of treating the carbons. It was made before the applications for the patents were made, and it was intended to cover all their inventions in carbons, as well as in their methods of treating carbons, as well as in electric lighting apparatus, and circuits. The language of the assignment was made broad and general, being made before the applications were made; the plan being to make additional assignments of the patents as soon as they were issued, or at the time the applications were made for each patent, to authorize the Commissioner of Patents, among other things, to issue the patents to the assignee.

248 X Q. The application for patent No. 211,262 was prepared at least as early as the date of this assignment, was it not?

A. It was somewhere about that time. I don't recollect exactly the date. I think the application was prepared before the assignment was made.

249 X Q. It appears that the title of the first improvement mentioned in the assignment is an exact quotation of the title which you gave the invention in the preamble of the specification of patent No. 210,152. Was not this application prepared, or at least its preparation commenced, to a sufficient extent to determine the title you would give the invention, before the execution of the assignment?

A. Yes, I think so.

250 X Q. And, I take it, that the titles are quoted in the assignment from the titles which you had given the applications?

A. Well, I presume so, although I have no recollection of the fact at this time.

251 X Q. It is a fact, is it not, that the title quoted in the assignment in the paragraph beginning "secondly," at the beginning of the assignment, is the precise title that is found in the preamble of the specification of patent No. 211,262?

219 Ans. Yes, the title of the patent referred to, as it appears in the first paragraph of the specification, is in the following language: "Improvements in carbons for electric lights."

X Int. 252. And it is a fact, is it not, that said patent No. 211,262 describes not only improvements in carbons for electric lights, but also in the treatment thereof?

Ans. Yes, I think it does, but of course the best evidence of what is in the patent will appear by the patent itself.

X Int. 253 It is a fact, is it not, that when the application was filed upon which patent 211,262 was granted, the application claimed not only the invention of treating carbon, but also the invention of the carbons themselves, as a new article of manufacture, and that before the patent issued, the claim or claims upon the latter invention were erased, and were embodied in the application which afterwards became patent No. 229,335?

Ans. It is a fact that at the time that application was prepared the process of treating the carbon was described and claimed, and so also was the product of that process, and there it stopped. The idea of making carbon for electric lights in any other way than that described by the patent is not even referred to. Subsequently to the filing of the application it was divided, and another and separate application was filed for the product of the process, making two separate patents for the subject-matter described in the original specification, filed October 15, 1878.

X Int. 254. And that separate application resulted in patent No. 229,335?

Ans. Yes.

Adjourned till 2 o'clock.

Resumed after adjournment.

X Int. 255. Did you retain any copy of the specification prepared by you on the fibrous carbon in April, 1879, or memorandum of claims you made in that specification?

220 A. No, I did not. That specification was, as I think I have stated, in lead pencil, on buff drafting paper, and was a draft submitted to Sawyer for revision.

256 X Q. How complete was it?

A. It was a complete specification.

257 X Q. I take it that it was simply a pencil draft of the specification and claims, and did not include the petition and oath which are necessary for a complete application?

A. Yes, that is correct. It was not an application submitted for execution, but a specification submitted for examination and revision.

258 X Q. Did you ever prepare complete papers for an application on that invention?

A. No.

259 X Q. You did not know whether that pencil draft was employed to any extent in the preparation of the application for the patent in suit?

A. I do not.

260 X Q. Why did you not prepare this application and have it executed and filed in October, 1878, as you did the applications upon which patents No. 210,152 and 211,262 were issued?

A. The application for that patent was delayed primarily for the reason that I was not able to understand how a carbon made of paper or wood was patentable in itself without reference to any combination that it might be united into. Man was very strenuous in his insistance that the invention, by which I mean the carbon itself, was patentable broadly. I recollect of taking down and reading the decision of the Supreme Court in the case of Hotchkiss *vs.* Greenwood, at the time I was discussing with Sawyer and Man the patentability of this invention. A good deal of discussion grew out of the question then between Man and I as to whether that was a parallel case. I cannot tell now what the arguments were
221 that were advanced *pro* and *con.*, but it resulted — poning the
matter for further reflection, consideration, and investigation on my part, and so the thing, being postponed, ran along from time to time, I visiting their workshop and seeing the carbons made, until finally I made the draft of the specification, which I gave to Sawyer, as I have already stated, not thinking that there was any danger in the short delay that would ensue before I could make up my mind what shape to put the application in, I mean the specification. I was very busy in the meantime on the business of the Electro Dynamic Light Co. and others in applying for patents and prosecuting them, both in this country and in Europe.

X Int. 261. In that draft did you attempt to overcome the obstacles raised in your mind by the decision in Hotchkiss *vs.* Greenwood?

Ans. I do not like to swear to what I put into that specification at this time, because I do not recollect what all was in it. I went over the case pretty freely, putting into it all that I thought might possibly be made available. I made up my mind, as I recollect, in a general way now, that I would claim the invention and its application as broadly as I could, and see what would come of it on examination in the Patent Office, knowing, of course, that I could cut it down or revise it, if that should be necessary.

X Int. 262. You held the opinion at that time, and insisted upon it in your arguments and briefs afterwards in the interference case, that the material, independent of the form, was not patentable, did you not?

Ans. I did, but I did so in my ignorance of the properties possessed by such carbons which made it available as an illuminant above all other carbons, so far as I know. Of course I speak of it now as a carbon illuminant, made from carbonized paper or other fibrous material, and in the light of information subsequently acquired.

222 X Int. 263. But at the time of the disclosure of the invention to you, in the fall of 1878, and continuing through the arguments in the interference case as late as 1884, you held the opinion that the carbon of paper or other fibrous material of itself was not patentable, but that such a carbon in the form of an arc or loop was patentable?

A. From the time this invention was first brought to me to patent, down to the time that I finally argued the issues upon the interference case before the Commissioner of Patents in person, I believed that the U-shaped, or loop-shaped carbon illuminant included in the lighting circuit of the lamp was new, irrespective of the kind of carbon it was made of, and I took the ground, in my ignorance of the properties that this particular material as an illuminant possessed, that it was a substitution of one carbon for another, that is, without taking into account the U-shaped form of the carbon, and considering the matter broadly without reference to its form or combination.

264 X Q. When were your views on this subject changed?

A. After the decision of the Commissioner of Patents of the interference, awarding priority of invention to Sawyer and Man, I resumed the prosecution of the application, insisting upon our right to the claims that had been once rejected by the examiner, among which was one for the U-shaped, or loop carbon illuminant. My attention was then called for the first time by the examiner to the British patent of Konn, in which is shown an arch-shaped carbon illuminant, and which, as I thought, anticipated broadly the claim for the U-shaped, or arch-shaped carbon illuminant, and then, in the discussion of the case with the examiner, my attention was called to the patentability of the fibrous-carbon illuminant as such, on account of the properties such carbon possessed, which made it available for electric lighting above all other carbons.

265 X Q. About when was this?

A. It followed very soon after the decision of the Commissioner

223 of Patents upon the question of priority, or as — as I could in the ordinary course get the case before the primary examiner again, according to the practice in the Patent Office. My best recollection is that it occurred in February, 1885.

X Int. 266. What is the name of the examiner with whom this discussion was had?

Ans. I think the name of one of the assistant examiners was Lyon, with whom I discussed that matter, and I discussed it also with one of the other assistants, as it seems to me, whose name I don't now recollect, and also with the examiner in charge of that class. I think his name was Kintner.

X Int. 267. You have stated that the preparation of the application on the U-shaped fibrous carbon was delayed to give you further time to consider and investigate the matter. Do you recollect the fact that Albon Man, one of the joint inventors named in that application, has testified that you advised them not to apply for the patent in the fall of 1878, when you were consulted, but advised them to make further experiments?

Ans. I have not the deposition of Albon Man before me, and I cannot, therefore, know exactly what he said, but it is a fact that I advised the postponement of the application until I could have time to see the carbons made and tried, and further time for reflection; and I can't conceive of Albon Man's swearing to anything that was not corroborative of that statement, but whatever he did say will appear by the record.

X Int. 268. Do you not recollect of Mr. Man's giving the testimony I have referred to?

Ans. I recollect of Mr. Man's testifying upon the matter, and now that you have put in my hands the deposition of Albon Man, I do not see anything in it that is repugnant to or contradictory of my statement. We had a great many interviews upon the subject, but what was said at these several interviews I cannot remember, 224 and I don't think that Albon Man can; but the broad fact that I wanted the application postponed, as I have stated, until further light could be obtained by me upon the matter, by observation and investigation, seems to be clearly remembered by Mr. Man as well as myself.

269 X Q. In a suit brought by complainant against the Edison Electric Light Co., in the U. S. circuit court for the southern district of New York, on patent No. 211,262, you acted as counsel for complainant, did you not?

(Objected to as incompetent.)

A. In equity suit No. 3406, in this court, I appeared as counsel for complainant. That suit was founded upon the patent referred to in the question, and against the Edison Electric Light Co.

Adjourned till Wednesday, the 17th inst., at 11 a. m.

NEW YORK, *January 17th*, 1889.

Met, pursuant to adjournment. Present, counsel as before, and the cross-examination of Mr. BROADNAX continued, as follows:

270 X Q. And in that case you took the testimony of Albon Man for the complainant?

(Objection continued.)

A. I did.

271 X Q. Do you recollect that the witness, Albon Man, in answer to the following questions, on cross-examination, made the following answers:

"353 X Q. Are you able to remember a single instance in which counsel was consulted in regard to obtaining a patent on any invention, and advised you not to apply for it?

(Same objections.)

A. Yes, sir.

225 "X Int. 354. Was that counsel Mr. Broadnax?

(Same objections.)

Ans. Yes, sir.

"X Int. 355. What were his reasons for advising you not to apply for the patent?

(Same objections.)

Ans. One case I have specially in mind had reference to a proposed application for fibrous carbon, particularly fibrous carbon made from paper, in regard to which he was consulted early in the fall of 1878, as to which he advised at the time further experiments; afterwards further postponements of the subject-matter.

X Int. 365. Why did he advise further experiments?

(Same objections, and further, as calling for a confidential communication between counsel and client, and the witness is instructed not to answer. Further objected to as incompetent, immaterial and not cross-examination; that the question is not material, either as cross-examination or examination-in-chief to any of the issues in this case, and the same is true of the whole of the so-called cross-examination; the witness is submitted for cross-examination and will answer fully and fairly any and all questions in cross-examination.)

Ans. I am directed by counsel not to answer."

Ans. I recollect Albon Man's testifying in the case referred to, but what questions were asked him by the cross-examining counsel I do not remember, nor do I remember what answers he gave to any questions propounded to him. The record in the case will, of course, show what questions and answers were made.

X Int. 272. Do you not recollect that Albon Man testified in that case that he consulted you with regard to applying for a patent for the fibrous carbon in the fall of 1878, and that you advised him to delay applying for the patent, and to make further experiments?

226 A. No, I don't recollect it out of my own memory, but I see it here printed as part of Albon Man's deposition in the case referred to, and I have no doubt that the questions were propounded and the answers made, as stated in this printed copy of the record, and as quoted by you therefrom, but I can hardly be expected to remember any particular question or answer in a deposition covering over 300 pages of printed matter.

273 X Q. Do you not recollect giving the instruction to the witness, Albon Man, not to answer, which occurs after X Q. 365 of that record, and which is quoted in answer to my question 271 in this record?

(Objected to as incompetent.)

A. I recollect of instructing Mr. Albon Man not to answer on several occasions during that cross-examination, but I don't recollect any particular occasion. Upon reading this record, I have no doubt I did give this instruction therein recorded.

274 X Q. You have stated that you do not think that after the great lapse of time, either you or Albon Man can recollect "what was said at these several interviews" with regard to the reasons for delaying applying for the patent upon the fibrous carbon. You, yourself, have testified in this case as to some reasons which you recollect. Do you consider the reason given by Albon Man, in his testimony quoted in cross-question 271, as inconsistent with the reasons which you have given as a part of your recollection?

A. No; I do not consider that there is any inconsistency between Mr. Man's testimony and mine on that point?

275 X Q. It would be a fair interpretation of Mr. Man's testimony, and of your own, that you have given some reasons whicl you recollect, while Mr. Man has given additional reasons which h recollects, would it not?

A. No; I don't think it would be. I think that the s
227 stance of Mr. Man's testimony is, that I advised postpo
ments and further experiments for the purpose of obtainin
for me further light and knowledge of the subject under considera
tion. That is the substance of my own testimony, and that is th
fact.

X Int. 276. Please state your entire connection with the prepar tion of the application which was filed on January 9, 1880, and r sulted in the pending suit.

Ans. I had absolutely nothing to do with the preparation of th application, unless my presence in the office of Mr. Cheever, whe the application was executed by Mr. Man might be said to be a participation.

X Int. 277. Were you not consulted by Mr. Man?

Ans. I was not consulted by Mr. Man, nor any one else about that application, and I did not know anything about it more than two hours before it was executed.

Adjourned till 2 o'clock p. m.

Resumed after adjournment.

X Int. 278. Why were you present at Mr. Cheever's office?

Ans. Mr. Man called at my office and requested me to go there with him, and I went with him, and Mr. Man told me what he was about to do on the way from my office to Mr. Cheever's office.

X Int. 279. What did he want of you?

Ans. Well, I don't know, unless it was to read the specification, as that is all I did that I recollect of now.

X Int. 280. Did he not ask your advice as to the arrangements he was entering into with regard to the application?

Ans. I don't recollect that he did; the arrangements were all made.

X Int. 281. Did he not tell you what those arrangements were?

Ans. He did not surely until after the transaction was closed.

228 X Int. 282. You knew that there was something unusual in the matter; that is, that it was not to be simply for the benefit of your client, the Electro Light Dynamic Co., which controlled the inventions of Sawyer and Man?

A. I did not know, nor did I hear a single thing about it until it was all done, or about to be done. The motive for the doing of it was entirely unknown to me, until I went with Mr. Man to Mr. Cheever's office to execute the papers.

283 X Q. What was it that became known to you then?

A. Well, nothing, except that they were about to make an application for a patent, and that Mr. Sawyer had consented to join in the application; subsequently Mr. Man told me what the arrangement was.

284 X Q. What was the arrangement?

A. He said that the Electro Dynamic Light Co. had made an arrangement to sell the invention of the patent in suit to Mr. Che-ver, contingent upon Mr. Cheever's paying to the Electro Dynamic Light Co., I think, a hundred thousand dollars for this invention, within certain time, and failing to pay the money within the time agreed upon, all the rights agreed to be given to Mr. Cheever were to revert to the Electro Dynamic Light Co., I think that is a general statement in substance of what he told me; that in the meantime Mr. Cheever had stipulated that he was to employ his own counsel, nd bear the expenses of obtaining the patent.

285 X Q. Was Mr. Cheever also to bear the expenses of an expected interference?

A. That I do not know anything about.

286 X Q. Do you not know that it was expected that there would be an interference with Mr. Edison in the Patent Office?

A. No, I did not know that.

229 287 X Q. Did you ever see the contract with Mr. Cheever?

Ans. No, I don't recollect that I did.

X Int. 288. Have you any papers in your possession of the Electro Dynamic Light Co., such as contracts, minutes of meetings of directors or officers of the company, &c.?

Ans. No, I have not.

X Int. 289. What is the character of the papers of the Electro Dynamic Light Co., that you have in your possession, if any?

Ans. I have the assignments to the Electro Dynamic Light Co. of Sawyer and Man. I think the whole of them have been put in evidence in one case or another.

X Int. 290. Have you at any time had other papers of that company in your possession. If so, what has become of them?

Ans. Yes, I have had papers of the company in my possession, a good many papers. Some of which belonged to the company, and some of which belonged to Mr. Jacob Hays, for whom I took out the foreign patents, but I returned them all to Jacob Hays, who was an officer of the company, and at that time, as I understood it, had possession of the papers.

X Int. 291. Who is the Mr. Cheever you have spoken of?

Ans. I refer to Mr. Charles A. Cheever, of New York city.

X Int. 292. Who was his attorney on the application?

Ans. As I understand it, Mr. William D. Baldwin, of Washington.

X Int. 293. He prepared and filed the application for the patent in suit, did he not?

Ans. It appears so by the record, of my knowledge I don't know, I did not see him prepare it or file it.

X Int. 294. It appears that an interference was declared with an
application of Edison, September 25, 1880, and that on De-
230 cember 4, 1880, you were appointed attorney in the applica-
tion for the patent in suit, all former powers of attorney
being revoked. Please state the circumstances under which you
were appointed attorney in this case.

Objected to as not cross-examination, also because it does not appear from this record that Edison filed any application, nor do any of the other facts stated in the question appear from the record. If any other record is referred to, such record is the best evidence of the facts stated, and should be offered in evidence, if the counsel desires such facts to appear.

Counsel for defendant states that the record referred to by him in his question, is the file-wrapper and contents in the application for the patent in suit.

A. Albon Man came to my office, and as vice-president of the Electro-Dynamic Light Co., said to me that Mr. Cheever had failed to keep his agreement with the company; that is to say, he had not paid the money agreed upon, and that all the rights of the company to the invention in question had again reverted to it, and that the company desired that I should appear for it and prosecute the application and thereupon a power of attorney was given to me, or sent to me, I don't remember which, to take charge of the case. All the rest appears in the record.

295 X Q. Did you draw the power of attorney itself, and secure its signature by Thomas Wallace, president of the Electro-Dynamic Light Co.?

Same objection.

A. I really don't recollect whether I wrote it and sent it down to the office for execution, or whether it was sent to me. I know I had a power of attorney, and I know I filed it, and that thereafter I appeared in the case to the close thereof.

296 X Q. Who are F. L. Gaylord and W. G. Benham, if you know?

Same objection.

231 (*Same objection.*)

Ans. Now, that you have called my attention to that, my impression is that they were men in the employ of Wallace & Sons, at Ansonia, and that the power was sent up there for Tom Wallace to sign.

X Int. 297. What was said at the interview which you had with Mr. Man at his office, after seeing the Herald article, which has been put in evidence in this case?

Ans. Without undertaking to repeat the words which were used by Man and I in our conversation on that occasion, I asked Man if he had read the article in the Herald referred to, and he replied in the affirmative. I asked him if he could not get Sawyer then to join in an application for the patent, to which he replied that he was engaged in some negotiations by which he hoped to be able to bring it about. I don't recollect that there was anything further said. He was very busy with a lot of men about some real-estate matters for some of the Lorilla*nd*s, and, as he did not seem to have anything further to say to me, I turned and left the office.

X Int. 298. That was the entire conversation, or substantially all of it?

Ans. Certainly; there was nothing more said that I remember of.

X Int. 299. After the interference between Sawyer and Man had been decided, and the application for the patent in suit was returned to the primary examiner for action on the merits of the invention, what then happened in the prosecution of the application?

(Objected to as not cross-examination and incompetent, the record of the proceedings in the application in the Patent Office being the best evidence.)

Ans. Well, I went on and prosecuted the application until I got the patent. The several steps taken by me in that prosecution I do not now remember, but they are all matters of record, and can be proved by the record.

232 300 X Q. You recollect very distinctly that an interference was declared with an application for a patent upon the same invention of Walter K. Freeman?

Same objection.

A. There was an interference declared with some man by the name of Freeman. I don't recollect his initials.

301 X Q. Did it come to your notice what electric light interest was represented by the Freeman application?

A. Yes.

302 X Q. What was it?

A. I think that this man Freeman was assignor to the United States Electric Lighting Company, but that is only as I understood it. I don't recollect of ever seeing the assignment.

303 X Q. What made you think it was the U. S. Electric Lighting Company?

A. Because I think Mr. Parker W. Page appeared as solicitor for Freeman, and he was solicitor for the U. S. Electric Lighting Company, and I know that he and Mr. Marcellus Bailey, of Washington, were associated as solicitors for the U. S. Electric Lighting Company.

304 X Q. And both Page and Bailey represented the Freeman application?

Last objection continued.

A. That is the way I understood it.

Adjourned till Friday, the 18th inst., at 10 a. m.

FRIDAY, *January* 18, 1889.

Met pursuant to adjournment. Present, counsel as before, and the cross-examination of Mr. BROADNAX continued as follows:

305 X Q. What became of this interference with Freeman?

233 (Same objections.)

Ans. The interference, as I recollect it now, was allowed to go by default on behalf of Freeman. At all events, it was not prosecuted on his behalf.

X Int. 306. Why was it not prosecuted on his behalf?

(Objected to as not cross-examination, and immaterial and incompetent.)

Ans. As I recollect it now, the U. S. Electric Lighting Company, as I understood it, was the owner of the invention claimed to have been made by Freeman, and that company proposed to submit the question of priority of invention to arbitration, and in the event, that the arbitrators decided that Freeman was the first inventor, that the patent should issue to Freeman, instead of to the assignees of Sawyer and Man for such parts of the invention as Freeman claimed. The question of priority was submitted to arbitration, and priority was awarded to Sawyer and Man, and thereupon the application of Freeman was abandoned, and a patent issued to Sawyer and Man or their assignees.

X Int. 307. What benefit did the U. S. Electric Lighting Company get from the arrangement?

(Same objections.)

Ans. That I do not know.

X Int. 308. How did the proposed arrangement first come to your attention, and who brought it to your attention?

(Same objections.)

Ans. I really do not remember whether the matter was first brought to my attention by Mr. Curtis, one of the attorneys for the U. S. Electric Light Co., or by Mr. Garden, the then vice-president of the Consolidated Electric Light Co., but it was from *of one* them that I first heard of the proposal to arbitrate.

234 309 X Q. What was the proposal in detail that you then heard?

(Same objection, and this objection is continued to all questions that may be asked in regard to the so-called Freeman interference, and any proceedings connected therewith.)

A. As I recollect it, the purpose on the part of the Consolidated Electric Light Co. was to avoid being tied up in the Patent Office in another interference. That was the moving cause, I think, on behalf of the Consolidated Electric Light Co., and the moving cause on behalf of the U. S. Electric Light Co. for getting that application filed and entering upon the arbitration, was to get a license under the patent that had been allowed to us for the invention. So the two companies agreed to submit the matter to arbitration, and that the party in whose favor priority of invention was awarded, should grant the other party a license under the patent on some terms which had been previously agreed upon.

310 X Q. Did you have anything to do with the drawing of the agreement?

A. Yes, I think I did—that is, the agreement for arbitration, I don't recollect whether I drew the license or not.

311 X Q. You drew the agreement to arbitrate then?

A. I don't recollect whether I did or not. I have an impression that Mr. Curtis made the first draft, or somebody in the interest of the U. S. Electric Lighting Co., and that I revised it. And then, I think, it was still further revised by Mr. Garden or Mr. Curtis, or somebody, perhaps Gen. Duncan.

312 X Q. Was it submitted to you before execution?

A. I do not recollect whether it was or not, but I should take it for granted that it was.

235 X Int. 313. Was it submitted to you after execution for approval as to its manner of execution?

Ans. No; I don't remember to have seen it at all after its execution.

X Int. 314. It was, however, an agreement between the complainant herein and the U. S. Electric Lighting Co. owning the invention of Freeman, and relating to the disposition of the interference between the Freeman application and the application for the patent in suit?

Ans. Yes.

X Int. 315. About when was it executed?

Ans. I don't know.

X Int. 316. When did you do your work upon it?

Ans. I don't recollect even that. It was some time, I think, in 1885. It was somewhere between the time of the declaration of the interference of Freeman and the decision of that interference in favor of Sawyer and Man.

X Int. 317. Did you not talk with more than one person about the matter of this agreement?

Ans. I don't recollect of having any talk with any one about it, excepting Mr. Garden and Mr. Curtis.

X Int. 318. As the attorney for Sawyer and Man in the application, you received a notice from the Patent Office that the interference with Freeman had been declared, did you not?

Ans. I did.

X Int. 319. Did you know before that time, or had it been intimated to you, that there would be such an interference?

Ans. No; I never heard of this Freeman till I got notice of the interference from the Patent Office. After I got through with the prosecution of the application of Sawyer and Man, that is, after all the claims had been allowed by the examiner, he told me that he could not issue or send out the formal notice of allowance for the reason that there was an application pending by some one, he
236 didn't say who, that might be put in interference with us, and a short time after that I got the notice of interference, and knew then for the first time who the applicant was and his assignee.

320 X Q. After receiving the notice of interference did you inform your client the complainant?

A. I think I sent the notice to Mr. Garden.

321 X Q. With a letter?

A. Well, I don't know.

322 X Q. Your recollection is, however, that you did not take it to him personally, and discuss it at that time?

A. No; I have no such recollection, because, in fact, I don't recollect whether I sent it to him, or went with it to him. He may have been in my office and I handed it to him there, or I may have taken it to him at his office, or I may have sent it by letter, I don't recollect as to that.

323 X Q. Will you look at your letter book and see if you sent it by letter?

A. Upon an examination of my letter book, covering the whole of March, 1885, I do not find that I sent any letter to Mr. Garden during that period that bears in any way upon this subject-matter, and it is not at all likely that I would have written him a letter upon that subject, as we had personal intercourse almost every day.

324 X Q. Were you in Washington or New York when the interference was declared?

A. I was in New York to the best of my recollection.

325 X Q. But you do not recollect the circumstances or occasion of handing or sending the interference notice to Mr. Garden?

A. I do not.

326 X Q. Do you recollect the first conversation you had with Mr. Garden with regard to this interference with Freeman?

A. No; I do not.

327 X Q. Did you not tell him during some conversa-

237 X Int. 327. Did you not tell him during some conver-ation that the interference with Freeman would delay the issue of the patent to Sawyer and Man?

Ans. I have no recollection of having done so, nor can I see why I should, as he *he* knew that of his own knowledge.

X Int. 328. Do you recollect any conversation that you had with Mr. Garden on the subject of this interference?

Ans. I doubtless talked with him, and he with me on the subject of this interference, but I have no particular interview in my mind that I can distinguish from any of the rest,

X Int. 329. Kindly tell me what you can recollect about these interviews, how many there were, when they took place, and what was said?

Ans. I cannot tell you how many there were, what was said at any of them, nor when they took place. Of course there was a good deal of talk between Garden and I about it, and we agreed pretty generally that it was a put-up job to wring a license out of us, and we discussed on various occasions the question of policy, as to whether it was best for us to submit to the extortion or to spend another year or two in interference in the Patent Office, and finally we reached the conclusion that it was best to submit.

X Int. 330. The result was that you and Mr. Garden concluded it would better for the complainant to purchase the release from the annoyance, risk and delay of another interference by giving the U. S. Electric Lighting Co. a license, which was done?

Ans. I don't think either of us had any doubt after the investigation of the matter, such as we were able to make, about our success in the interference, but the situation of our company at that time made it desirable for us to have the patent issue without further delay, and to avoid the delay which would inevitably occur in fighting the interference, we thought it best to succumb and 238 give the U. S. Electric Lighting Co. a license under the patent, which was done.

331 X Q. Do you recollect the terms of the license agreement?

A. I do not.

332 X Q. Those term-, I suppose, were substantially stated in the agreement which you have called the agreement to arbitrate, and which you helped in the preparation of?

A. I presume that they were.

333 X Q. Did you not also draw the license agreement*ment* or assist in drawing it, or have it submitted to you for approval?

A. I do not recollect whether I drew it or revised it, or whether it was submitted to me merely. The probabilities are that I drew it.

334 X Q. By the agreement was the U. S. Electric Lighting Co. to pay royalty for the use of the invention of Sawyer and Man?

A. Yes.

335 X Q. A substantial or a merely nominal royalty?

A. I don't recollect the amount of the royalty. I think it was so much a lamp, but how much I don't now remember.

336 X Q. Was any distinction made as to the character of the lamps that were to be included or excluded in the payments of royalty?

A. I don't recollect. All I recollect is that there was a license, and that they were to pay royalty; but how much royalty, and what the circumstances or conditions were, I don't recollect. In fact, it is impossible to swear to the contents of the paper, because I don't recollect it.

337 X Q. Do you not recollect that lamps having carbons
239 made from the material known as tamadine were, by *by* the
license agreement, not to be considered subject to the payment of royalty?

Ans. There is some provision in the paper about tamadine, I think, but what it is, I don't know.

X Int. 338. Is it your recollection that the tamadine lamps were made subject to royalty?

Ans. No, I have no recollection about it.

X Int. 339. After the agreement which you have termed the agreement to arbitrate was settled upon, please state what was actually done, and who did it, with regard to the arbitration?

Ans. I think I appeared at the arbitration as counsel for the Consolidated Electric Light Co., and I think Gen. Duncan appeared for the U. S. Electric Light Co., and Mr. Garden was arbitrator for our side, and Mr. Quimby was arbitrator for the U. S. Electric Light Co., and a third arbitrator was to be called in in case they could not agree, and on behalf of the Consolidated Electric Light Co., the records of the interference between Sawyer and Man on the one side, and Thomas A. Edison on the other, about the subject-matter of the patent in suit, was submitted in support of our case, and the *ex parte* affidavits of Mr. Freeman and others taken in support of Mr. Freeman's claim, were submitted in support of Mr. Freeman's case, and thereupon the matter being duly argued by counsel, and considered by the arbitrators, they unanimously decided that Sawyer and Man were the first inventors.

X Int. 340. It did not become necessary then to call in the third arbitrator?

Ans. No.

X Int. 341. When did this take place, where, who were present, and how long did it last?

Ans. The arbitrators met in the office of Mr. Curtis, Mr. Leonard E. Curtis, one of the attorneys for the U. S. Electric Lighting Co.
He was present, Mr. Duncan was present, Mr. Garden was
240 present, Mr. Edward E. Quimby, the gentleman who appears
as expert in patent causes, was present. I was present, and that was all there were present. We were together there probably the best part of an hour, in presenting the case, and I don't know, I think it was two or three days before the arbitrators made their report. I think they made their report in writing. This meeting

was before the decision in the interference was made in the Patent Office, I think, but I cannot give the date, because I don't recollect it.

342 X Q. Do you recollect that it was some time after the interference with Freeman was declared, and before the decision of that interference by the Patent Office?

A. Yes; I should think so.

343 X Q. To whom was the report of the arbitrators made?

A. I suppose that it was made to the U. S. Electric Lighting Co., and to the Consolidated Electric Light Co., but I don't remember to have ever seen it.

344 X Q. You were told the conclusion of the report, I suppose, by somebody?

A. Yes, undoubtedly. I think when the hearing was over Mr. Garden said that he was willing to leave the decision to Mr. Quinby, and after Mr. Quinby decided in favor of Sawyer and Man, Mr. Garden merely concurred.

845 X Q. What became of the record and affidavit submitted to the arbitrators?

A. The record submitted upon our part was the same printed copies that were used before the Commissioner of Patents on the final hearing of the interference with Edison, and those were afterwards returned to me. What was done with the affidavits submitted on behalf of the U. S. Electric Lighting Co., I do not know.

356 X Q. After the interference with Freeman was disposed of you continued the prosecution of the application of Sawyer and Man in the Patent Office, did you not?

241 Ans. I don't recollect whether I did anything further or not after that, but I presume I followed it up until I got the patent. The record will, of course, show what I did, but I do not recollect it of my own memory.

X Int. 347. Did you not consult with the attorneys for the U. S. Electric Lighting Co. as to the form which the application should be finally given before the patent should be issued?

A. No, sir; I did not. I recollect going to Mr. Curtis for some information about some patent, but what it was now I do not recollect.

X Int. 348. Who suggested the amendments in the paper filed by you in the application, April 21, 1885?

Ans. I did, and wrote it, and it is now as I wrote it.

Counsel for defendant requests counsel for complainant to produce the two agreements between the complainant and the U. S. Electric Lighting Company, relating to the invention of the patent in suit, and described by the witness as an agreement to arbitrate the interference between Sawyer and Man and Freeman, and the license agreement under the patent in suit, also, the report of the arbitrators based upon the agreement to arbitrate.

AMOS BROADNAX.

Adjourned till Thursday, the 24th inst., at 11 a. m.

THURSDAY, *January* 24, 1889.

Adjourned till Thursday, the 31st inst., at 11 a. m.

242 NEW YORK, *January* 31*st*, 1889.

Met pursuant to adjournment.

Present: Thomas B. Kerr and L. E. Curtis, Esqs., on behalf of complainant, and Richard N. Dyer, Esq., on behalf of defendant.

It is hereby stipulated that Edison Electric Light Co. is a corporation existing under the laws of the State of New York, and is the vendor of the lamp "Complainant's Exhibit Defendant's Lamp." offered in evidence by complainant's counsel at the end of the direct examination of the witness F. L. Pope, and that this suit is being conducted for and on behalf of the defendant by the counsel and at the expense of the said Edison Electric Light Company; and it is also stipulated that the said Edison Electric Light Company is the successor and the assignee of all the inventions and patents and other property owned by the Edison Electric Light Company, and that the said The Edison Electric Light Company was the owner of the application of Thomas A. Edison involved in the interference referred to in the cross-examination of the witness Broadnax between said application and the application for the patent in suit, and conducted said interference by its own counsel and at its own expence.

Defendant's counsel admits that William E. Sawyer, named in the patent in suit, and one of the applicant's therefor, and his father, William Sawyer, died before the commencement of this suit. This admission is based upon the information and belief of defendant's counsel to that effect, and he reserves the right to withdraw this admission and offer proof to the contrary at any time before the hearing of this case in case he finds he is mistaken as to the fact; otherwise, the admission to stand.

243 Complainant's counsel offers in evidence a copy of the proceedings in the Patent Office in the matter of the application for the patent in suit, certified by the Commissioner of Patents under ten certificates, entitled as follows:

(1.) "File-wrapper and contents of the letters patent granted to William Edward Sawyer and Albon Man, assignor to Electro Dynamic Light Co., May 12, 1885, No. 317,676, for improvement in electric light," which is marked "Complainant's Exhibit Patent Office Proceedings No. 1," January 31, 1889.

(2.) "File-wrapper, contents and drawing down to December 15, 1880, in the matter of the application filed by Thomas A. Edison, December 11, 1879, for improvement in electric lamps and method of making the same," which is marked "Complainant's Exhibit Patent Office Proceedings No. 2," January 31, 1889.

(3.) "Petition for permission to amend preliminary statement and accompanying affidavits, filed in behalf of Edison, in the matter of the interference, Sawyer and Man *vs.* Edison, for improvement in carbons for electric lamps," which is marked "Complainant's Exhibit Patent Office Proceedings No. 3," January 31, 1889.

(4.) "File-wrapper and contents in the matter of the interference William E. Sawyer and Albon Man *vs.* Thomas A. Edison, for improvement in electric lamps or lights," which is marked "Complainant's Exhibit Patent Office Proceedings No. 4," January 31, 1889.

(5.) "Certain papers in the matter of the interference, Sawyer and Man *vs.* Thomas A. Edison, for improvement in electric lights," (the said papers being the depositions in said interference) which is marked "Complainant's Exhibit Patent Office Proceedings No. 5," January 31, 1889.

(6.) "Motion papers and affidavits filed in behalf of Edison, on motion to reopen the case in the matter of the interference Sawyer and Man *vs.* Edison, for improvement in carbon for electric
244 lamps," which is marked "Complainant's Exhibit Patent Office Proceedings No. 6," Jan. 31, 1889.

(7.) "Affidavits of W. E. Sawyer, Robert Street, *et al.*, filed April 3, 1882, in the matter of the interference, Sawyer and Man *vs.* Edison," which is marked "Complainant's Exhibit Patent Office Proceedings No. 7," January 31, 1889.

(8.) "Decision of the Commissioner, July 24th, 1882, in the matter of the interference, Edison *vs.* Sawyer and Man, for improvement in electric lamps," which is marked "Complainant's Exhibit Patent Office Proceedings No. 8," January 31, 1889.

(9.) "File-wrappers and contents in the matter of the appeal to the examiners-in-chief, of Thomas A. Edison, filed June 21, 1883, numbered 79851, for improvement in electric lamps," which is marked "Complainant's Exhibit Patent Office Proceedings No. 9," January 31, 1889.

(10.) "File-wrapper and contents in the matter of the appeal to the Commissioner, filed by William Edward Sawyer and Albon Man, August 3, 1883, for improvement in carbon for electric lighting," which is marked "Complainant's Exhibit Patent Office Proceedings No. 10," January 31, 1889.

Said proceedings are offered in evidence for the following purposes:

(1.) To show that the article published in the New York Herald, which has been offered by the defendant as an anticipation of the patent in suit, was brought before the Commissioner of Patents by the real defendant herein, to wit: The Edison Electric Light Company, as a bar to the granting of the patent in suit, and was fully considered by the Commissioner of Patents, and that the patent in suit was granted, notwithstanding said publication, on the
245 ground that the invention was made by Sawyer and Man prior to the date when said article was published.

(2.) To show that the issue raised by the defendant, in offering the said Herald article in evidence, has been adjudicated in favor of the complainant in a litigated proceeding between the same parties in the Patent Office.

(3.) To explain the delay of five years in the granting of the patent in suit, after the application therefor was filed.

Exhibits and statement by counsel for complainant objected to by counsel for defendant as incompetent, immaterial and irrelevant, and in particular as to "Exhibit No. 2;" that it is only a partial copy of the record, and to the statement that the Edison Electric Light Company is the real defendant herein, or that the Herald article was offered by said company as a bar to the granting of the patent in suit, or that the proceedings in the Patent Office were between the same parties, or that the issues involved were the same as involved in this suit, defendant's counsel insisting that such are not the facts.

Complainant's counsel also offers in evidence certified copies of the depositions of William E. Sawyer and William Sawyer, taken in the said interference. Said depositions being contained in the said "Complainant's Exhibit Patent Office Proceeding No. 5," pages 43 to 59 and 65 to 80 both inclusive of the printed record, entitled "Testimony on behalf of Sawyer and Man" forming a part of said exhibit as depositions of deceased witnesses, taken in a prior judicial proceeding between the same parties or their privies, and involving the same issue as in the present suit, and at the same time makes part of this offer, certified copies of the interfering applications, the declaration of interference and the decisions of the Patent Office in said interference, all of which are contained in the said exhibits making part of the said proceedings already offered in evidence, for the purpose of showing the parties and the subject-matter of said proceeding in which said depositions were given. 246

(Exhibits and statement of counsel for complainant objected to by counsel for defendant as incompetent, immaterial and irrelevant, and the depositions further objected to, because it does not appear that they were taken in a prior judicial proceeding, or in a proceeding between the same parties or their privies, or that the issue in said proceeding or involved in said depositions was the same as in this suit.)

Adjourned till Saturday, February 2, 1889, at 11 a. m.

SATURDAY, *February* 2, 1889.

Met pursuant to adjournment. Present, counsel as before, and also Walter K. Griffin, Esq., for defendant.

Testimony of J. Edgar Bull.

J. EDGAR BULL being called on behalf of complainant and duly sworn, testifies as follows:

Questions by Mr. CURTIS:

1 Q. What is your name, age, residence and occupation?

A. J. Edgar Bull, 31 years of age; I reside in the city of New York; I am a counsellor-at-law.

2 Q. Please examine the paper now handed you, "Complainant's Exhibit Patent Office Proceeding No. 5," and state what, if anything, you had to do with the taking and printing of the deposi-

tions of William Sawyer and William E. Sawyer, which appear at pages 43 to 59 and 65 to 80 inclusive, of the printed record forming part of this exhibit, and entitled "Testimony on behalf of Sawyer and Man?"

A. I was present when those depositions were taken and I personally transcribed the depositions at the time they were
247 given. I was also present when the oath was administered to William Sawyer and William E. Sawyer, and I saw them sworn. The questions and answers were read over to the witnesses by me before they signed their depositions. I also saw both of said witnesses sign their depositions. I compared the original depositions with the proofs of the printed matter found between the pages mentioned in the question, and I know of my own knowledge, that those pages contain a correct transcript of the original depositions.

Int. 3. Where are the original depositions now, so far as you know?

Ans. I believe them to be on file in the office of the Commissioner of Patents at Washington.

Int. 4. Where did you last see them, and under what circumstances?

Ans. I saw them on or about the 22d day of June, 1885, on file in the Patent Office. I went to Washington four or five days before the 22d of June, 1885, for the purpose of obtaining certified copies of these depositions, and other papers in the same interference case. I saw them when I was in Washington at that time, and I presume they are there still.

Int. 5. How do you fix the date referred to in your last answer?

Ans. I see by the certificate of the Commissioner of Patents attached to these depositions "Exhibit Patent Office Proceedings No. 5," that they were certified by him on June 22, 1885. My recollection is that these papers were certified by the Commissioner while I was in Washington, and that I brought them to New York with me when I returned.

Int. 6. Were you familiar at the time with the proceedings in the interference of Sawyer and Man *vs.* Thomas A. Edison, in which these depositions, together with the others forming the printed record in which they are contained, are entitled?

248 A. I was.

7 Q. Were the d*is*positions of William Sawyer and William E. Sawyer, to which you have referred, filed in the Patent Office before the first hearing on the merits before the examiner of interference?

A. They were.

8 Q. Were they used as a part of the proofs in the various hearings had in that interference?

A. They were, to the best of my knowledge and belief.

9 Q. When the depositions were taken, did counsel for Edison attend and cross-examine, as stated in the printed copy, forming part of said "Exhibit Patent Office Proceedings No. 5," already referred to?

A. Yes, he did.

The foregoing deposition objected to by counsel for defendant as relating to the offered exhibits already objected to, and as immaterial.

J. EDGER BULL.

Complainant's counsel offers in evidence the pages of the paper already marked Complainant's "Exhibit Patent Office Proceedings No. 5," referred to in the preceding testimony of the witness, Bull, the same being the deposition of Wm. Sawyer, contained on pages 43 to 59 inclusive, and the deposition of William E. Sawyer, contained on pages 65 to 80 inclusive, of the printed record, entitled "Testimony on behalf of Sawyer and Man," and the same are marked, respectively, "Complainant's Exhibit Deposition of William Sawyer," and "Complainant's Exhibit Deposition of William E. Sawyer," Feb. 2d, 1889.

Complainant's counsel also makes a part of this offer the file-wrapper and contents of the application of Sawyer and Man already marked "Complainant's Exhibit Patent Office Proceedings No. 1,"
the file-wrapper and contents of the application of Thomas A.
249 Edison, already marked "Complainant's Exhibit Patent
Office Proceedings No. 2," the file-wrapper and contents of the interference already marked "Complainant's Exhibit Patent Office Proceedings No. 4," and the various decisions contained in the file-wrapper and contents in the matter of the appeal, already marked "Complainant's Exhibit Patent Office Proceedings No. 10."

Complainant's counsel requests the examiner to enter the said depositions of William Sawyer and William E. Sawyer in full on the record at this place.

In the United States Patent Office.

WILLIAM E. SAWYER and ALBON MAN
vs.
THOMAS A. EDISON.
} Interference—Electric Lighting.

NEW YORK, *March* 17, 1881.

Parties met, pursuant to adjournment.

Present: Amos Broadnax, counsel for Sawyer and Man; and Dyer and Wilber for Edison.

Testimony of William Sawyer.

WILLIAM SAWYER, witness produced on behalf of Sawyer and Man, was called and sworn:

Int. 1. State your name, age, residence and occupation.

Ans. My name is William Sawyer, age, 59 years; reside at Earle's hotel, in the city of New York; am a machinist.

Int. 2. State, if you please, where you were employed in the spring of 1878.

Ans. At 43 Centre street, in the city of New York.

Int. 3. By whom were you employed?

Ans. By Mr. A. Man and my son, William E. Sawyer.

Int. 4. About what time in the spring, or latter part of the winter, did you go in their employ?

250 A. In February or March of the same year.

5 Q. Please state what you were employed to do for your son and Mr. Man.

A. Employed in constructing what we call an incandescent electric lamp; about our first was in producing a carbon suitable for our purpose, *i. e.*, to be used in a lamp; amongst others were other materials; we experimented upon different papers in various manners.

6 Q. Please state what you yourself had to do with making carbons for the electric lamps—of carbonized paper.

A. Merely to assist them in their work.

7 Q. Did you, as an assistant to them, cut the paper into the form that you wanted the carbon to be, and then put it in a box and carbonize it?

(Question objected to as being leading.)

A. I assisted in that; yes.

8 Q. Describe how you made carbons—or carbonized paper for electric lamps?

A. Our first attempt was by paper—say blotting paper—by putting graphite or plumbago, and then rubbing and working in this graphite until it is permeated with it. We then applied the two poles of an electric machine to it to see if we could get the current through. It went through imperfectly, but not satisfactorily. We then put that paper into the lamp filled with common illuminating gas. Then we sealed the lamp and applied the electricity. The result was, we got an imperfect current. We took the lamp apart, examined it, and virtually went through the same operation again. That was the first attempt at carbonizing paper.

9 Q. What shape were the pieces of paper which you tried to carbonize in that way? Please to look at Sawyer Exhibit No. 1, and state if you recognize any of the forms shown on that drawing as being the same as those used by Sawyer and Man, to make carbons for their lamp.

A. I recognize from Nos. 1 to 7 inclusive.

251 Int. 10. As I understand you, they used straight strips of paper?

Ans. Our first attempt was with them.

Int. 11. And some arched pieces of different forms?

Ans. Yes, sir.

Int. 12. After they got through with their efforts to carbonize the paper with the current of electricity, what other way did they adopt to carbonize the paper?

Ans. By putting it into powdered carbon and subject it to heat; sometimes saturated paper with a solution of acid, or with solution of powdered carbon and water.

Int. 13. In preparing the paper for carbonization, did they first wet it?

Ans. As a general thing, in a solution of some sort of carbonaceous matter.

Int. 14. What did they put the pulverized carbon in?

Ans. In an iron box.

Int. 15. Always in an iron box?

Ans. Not always. My impression is in a tin box first, but that was melted out. Afterwards in an iron box, which I got out, or made.

Int. 16. How did they arrange the paper to be carbonized in the box with the pulverized carbon?

Ans. With alternate layers of carbon and paper. First carbon, then paper; carbon again, then paper, till — box was filled; and pressed down with a follower in the box, so to get it as compact as possible. Last layer was carbon.

Int. 17. After you got the box filled, did they put a cover on it, and how was it fastened?

Ans. Cover was put on and fastened down with wire.

Int. 18. Did you see the paper and carbon put in the box?

Ans. Yes. My impression is I put them in myself. I know I put some of them in.

252 19 Q. Did you see the box put in the fire and heated?

A. Not the first, but I did afterwards. The first box that was filled Mr. Man took home and brought it back in the morning. He could not open the box on account of the iron having been fused, and I put a pressure on it and opened it.

20 Q. Did you put the lid on the box and wire it down?

A. Yes, we together did, he assisted.

21 Q. Did you open that same box the next morning?

A. I did.

22 Q. Were the wires still on it the same as you had put them on the night previous?

A. Still on; but in different places fused together, so as considerable effort was required to cut them without destroying the material inside.

23 Q. After you got the box open, did you take out the carbonized paper?

A. We took them—I at least saw them taken out.

24 Q. What condition were they in?

A. Various. Some perfect; others broken or destroyed.

25 Q. Did you put any of those carbons that were in that box in a sealed lamp and try them?

A. Yes, sir.

26 Q. How did it do?

A. With varied success.

27 Q. What do you mean?

A. Some would run longer than others. Some would fail. Some would do very well. Some would fail from imperfections of the lamp; from sealing, or, as we judged, from imperfect contacts or mechanism.

253 28 Q. State, as near as you recollect, how long the best of them was used in the lamp in a state of incandescence?

Ans. Should judge anywhere from one, to three or four days, or perhaps a week, at different times. Have no distinct recollections of the exact time any one burned. I can positively state it was more than one day or two.

Int. 29. How long have you seen any one of the best of them burn continuously?

Ans. We would put on the current and run it as long as the machine ran, and then take it off. That would be, say from four to five hours at a time, as nearly as I can recollect, and then when the engine commenced again, we would put it on, the power being furnished by the building in which we rented the room.

Int. 30. After you had run it that way, and took it off, how did they appear?

Ans. Some would seem to be in perfect order and some imperfect—principally owing to the defective mechanism in the lamp.

Int. 31. How often was the iron box charged with carbon and paper, and carbonized as you have described, in Centre street?

Ans. Can't state the number of times, but was used quite a number of times.

Int. 32. Did you see it (the box) put in the fire, and the paper carbonized, after the instance you mentioned of Mr. Man taking the box home?

Ans. Yes; put it in myself and took it out.

Int. 33. Saw the papers put in, and saw the carbons taken out?

Ans. Yes.

Int. 34. Was the result about the same?

Ans. Yes, sir.

Int. 35. All this, I understand, took place in Centre street?

Ans. Yes.

254 36 Q. When was it that you quit work in Centre street?

A. Can't say.

37 Q. Where did you go from Centre street?

A. To Nos. 2 and 4 Howard street.

38 Q. When did you go to Nos. 2 and 4 Howard street?

A. I think in the summer of 1878.

39 Q. Do you recollect what time in the summer?

A. Should judge, as near as I can recollect, in June.

40 Q. Did you use any carbons made of carbonized paper there?

A. We might have done it, but my impression is we did not. I think after we left Centre street we began on a different kind of carbon, but afterwards returned to paper.

41 Q. After you got through at corner of Howard and Centre streets, where did you go?

A. Corner of Walker and Elm.

42 Q. When did you go to the corner of Walker and Elm streets?

A. October, 1878, I think.

43 Q. Can you recollect what time in October?

A. Couldn't state positively; probably some time between the first and the 15th of the month.

44 Q. Do you recollect whether or not you returned to the use of carbonized-paper carbons corner of Elm and Walker streets?

A. I do; yes.

45 Q. Were the carbons of carbonized paper, that you used corner Walker and Elm streets, made in the same way that they were at 43 Centre street?

A. Virtually so, but we added at different times several other treatments; by solidifying the paper; pounding it, and subjecting it to hydraulic pressure.

46 Q. Was the results of the carbonization about the same as in Centre street?

255 Ans. Was better.

Int. 47. Do you recollect of cutting the carbon burner to the desired form out of the carbonized paper, after its carbonization?

Ans. Yes.

Int. 48. How did you do that?

Ans. Done by a knife and file; that is, was worked down to the form we wanted them by these tools; were delicate things to handle; used to stick them to a piece of glass with balsam or cement, and cut them down. By merely warming the glass we could take them off by subjecting the glass to a blaze—heat; we could take all the superfluous or foreign coating from the carbon.

Int. 49. How much of the time did you use carbons made of carbonized paper, while at the corner of Walker and Elm streets?

Ans. I think we were at work upon them several weeks.

Int. 50. Did you see them put in the lamps and illuminated?

Ans. Yes; I put them in.

Int. 51. State how long you saw any one of the carbons made of carbonized paper illuminated continuously at the corner of Walker and Elm streets, as near as you can recollect.

Ans. My answer is about as before. We ran them from day to day.

Int. 52. Did you take occasion to examine them after they had been thus illuminated?

Ans. Yes; some seemed as perfect as when they went in; others were fractured.

Int. 53. How many lamps did you have in circuit in Elm and Walker?

Ans. The highest number, I think, was eight.

256 Int. 54. Was that as many lamps as your electro-dynamo machine would supply with the necessary current to illuminate the lamps?

A. Don't think it was; but the size of our engine limited us. We didn't have power enough to run the dynamo machine up to its capacity.

55 Q. What was the size of the engine?

A. Normally six-horse-power engine, and six-horse-power boiler. I don't think it was a six-horse-power boiler, however.

56 Q. You say you had as many as eight lamps in circuit at one time?

A. Yes, to the best of my recollection.

57 Q. State if you know how many of those lamps were filled with carbonized-paper burners?

A. Can't say positively, but think all were furnished with such burners.

58 Q. Did you put the carbonized-paper burners in the lamps yourself?

A. Yes.

59 Q. In Centre as well as Walker streets?

A. Yes; I made them all.

60 Q. Please to look at the drawing making part of the patent granted to William E. Sawyer and Albon Man, June 19, 1878, No. 205,144, and state, if you please, whether you recognize that as an illustration of either of the lamps to which you have been referring in your examination?

A. I do.

61 Q. In which of the shops to which you have referred in your examination were lamps like that made?

A. I think in Howard street, and I know corner of Elm and Walker streets.

62 Q. Look at drawing making part of the patent granted to William E. Sawyer and Albon Man, December 10, 1878, No. 210,809, and state whether the drawing making part of the patent
257 last mentioned respresents either of — lamps to which you have been referring in your examination?

Ans. Yes, I recognize it.

Int. 63. In which shop was that made?

Ans. I think corner of Walker and Elm streets. I know we made them there.

Int. 64. Please look at drawing which I hand you, making part of the application for the patent involved in this interference, and state whether that drawing represents any one of the lamps to which you have referred in your examination.

Ans. Yes, I recognize it fully.

Int. 65. Can you state where lamps of that style were made?

Ans. Corner Walker and Elm streets.

Int. 66. What kind of a lamp was it in which you used the paper-carbon burners, at No. 43 Centre street?

Ans. Like Fig. 7, Exhibit Sawyer No. 1.

(The drawing marked Sawyer Exhibit No. 4, and referred to by witness in answer to question 64, is admitted by counsel for Edison to be a copy of the drawing, making part of the application of Sawyer and Man, involved in this interference.)

(This drawing is offered in evidence, and marked "Sawyer Exhibit No. 4.")

(Counsel for Sawyer and Man gives notice to counsel for Mr. Edison, that upon the hearing of this interference, he will use in evidence the file-papers, making part of the application for patent on behalf of Sawyer and Man, and also on behalf of Mr. Edison, and also the patents which are of record in the Patent Office, No. 210,809, dated December 10, 1878, and No. 205,144, dated June 18, 1878, both of which were granted to Sawyer and Man, numbered and dated as aforesaid.)

Int. 67. Referring now to the lamp shown in the patent No. 205,144, to which I have referred, state whether you saw any carbons made of paper used in that lamp.

258 Ans. I don't recollect that I did.

Int. 68. State if you recollect of seeing carbons made of paper used in the lamps illustrated in the patent 210,809, to which we have referred.

Ans. Don't recollect that I did.

Int. 69. State, if you recollect, of seeing carbons made of paper used in the lamps shown by the drawing, "Sawyer Exhibit No. 4."

Ans. I do recollect it.

Int. 70. State whether or not that substantially represents the lamps in which you used these paper carbons at the corner of Walker and Elm streets, New York.

Ans. I do.

Int. 71. How soon after you moved to corner Elm and Walker streets, was it that you commenced to use this lamp with the paper-carbon burners?

Ans. Immediately.

Cross-examination by GEORGE W. DYER, Esq., counsel for Mr. Edison:

X Int. 72. About the box which you got up for carbonizing paper at Centre street, when did you get it up, and how was it constructed; answer fully.

Ans. We commenced work on this paper immediately after we went into the shop; a box was constructed out of either American or Russian sheet iron, to the best of my recollection; box was oblong and rectangular; judge it was three or four inches—probably four—long, and about two and a half, or two and three-quarters inches wide, about two inches deep; it was cut out of a single piece of sheet metal, making the bottom and sides and ends—sides and ends being turned up at right angles; it was secured at the corners by lapping over and pounding together, or brought up in close contact; a counterpart of the same, made of sheet metal, but not so deep as the first, slipped over it and constituted the cover.

259 73 X Q. How long was that box used?

A. Don't think more than once; think Mr. Man fused it together the first time it was used.

74 X Q. Describe the next box you got up?

A. Was about the same as this one; indeed, we made several like it; I think I improvised one of these boxes out of a piece of cast iron.

75 X Q. When was the cast-iron box made, and describe it?

A. Couldn't say when it was made, but about that time; its shape was circular—a section of a hollow tube—about 2½ inches in diameter, inside dimensions; was made of cast-iron tubing, such as might be found in any junk shop; the top and bottom were made of flat pieces of cast-iron metal to cover the ends; the ends fitted so tightly that powdered carbon would not sift out; the ends were secured by winding wire lengthwise over the whole.

76 X Q. Is this the box that was principally used after this?

A. No; this one was only used once.

77 X Q. How many did you make after that before you got the one you used principally?

A. Did not use any "principally;" we would generally destroy the boxes in using them once or twice; we made new ones whenever they were needed.

78 X Q. Were those you made subsequently any different from the ones made of pipe?

A. We never made but that one out of pipe; we made no others of cast iron.

79 X Q. You said, in answer to a question in the examination-in chief, that you, yourself, saw one or more of these boxes of carbonization packed and unpacked after they came from the furnace; when you opened such box what did you see in the interior?

A. Powdered carbon and the pieces that we put in.

260 80 X Q. Were the boxes just as full when unpacked as when packed?

A. Don't think they were.

81 X Q. How much waste was there of the powdered carbon in the box?

A. Couldn't say; didn't measure it or weigh it.

82 X Q. Apparently, how much?

A. The best I can say is some waste; part of it looked like ashes.

83 X Q. In what part of the box did you find the ashes?

A. On the top or at the edges.

84 X Q. How large were the papers for carbons you put in such boxes?

A. Generally cut out for our immediate purpose; sometimes we would change the shape, as I described in my examination-in-chief. I should judge the straight ones were from ¼ of an in. to ⅜ in. in length; these were about ⅛ in. in width, I think, and about the thickness of ordinary blotting paper; those of the arch form were about the same in width and length (that is, across the base); the straight one extended about ¼ in. over the loop.

85 X Q. Were these all cut of ordinary blotting paper?

A. No.

85½ X Q. What was the thickness of them?

A. Ordinary blotting paper was used when we used such paper, except that the blotting paper could be compressed, whereas the other could not, with the means we had at hand. I did not measure them, and do not state this as an expert.

86 X Q. How much would these papers shrink in becoming carbonized?

A. Don't know.

87 X Q. You say that some of the paper carbons were
261 *were* used at the Centre-street shop in a lamp like figure 7 of "Exhibit No. 1;" is that so?

Ans. Yes; used them in two ways.

X Int. 88. Was this lamp a bottle, and if so, what kind of a bottle?

Ans. No.

X Int. 89. What was it?

Ans. If I am right about it, they are called Florence flasks in the market.

X Int. 90. How was the mouth of it stopped?

Ans. As a general thing by a glass stopper; then, again by a metallic stopper; tried them both ways; also used cork stoppers.

X Int. 91. How did you fill these flasks with illuminating gas?

Ans. By centre hole in the stopper; then we put our tube in there and put on the force of the gas and drove the air out, this tube not being close fitting in the hole; and also by exhausting the air from the flask and applying a close-fitting tube.

X Int. 92. How did you stop this tube hole after you had finished putting in the illuminating gas?

Ans. By a plug.

X Int. 93. By pulling tube out, then putting a plug in?

Ans. Yes; there was no other way.

X Int. 94. When you exhausted the air from the flask, how did you do that?

Ans. By applying an air pump, in some instances; in others we used quicksilver.

X Int. 95. Explain how you applied the air pump and how you removed it.

Ans. Mr. Man did that; he took the flasks out and exhausted
the air out of them by an air pump; will not state that this
262 was on this one particular form of flask; can't state what particular form of globe it was on; we have more than a dozen or
twenty forms.

96 X Q. Do you know of your own knowledge that the air was ever exhausted from one of those flasks, bottles or lamps used in the Centre shop?

A. I know we attempted it with quicksilver; whether we exhausted it or not is another matter.

97 X Q. How did you attempt it with quicksilver?

A. By filling the tube with quicksilver, and by letting it run out through a plug; also used water in connection with it, I think, how I can't tell; Mr. Man and Ed. (Wm. E. Sawyer) always did this, and I stood by and assisted in various ways; just how it was done I cannot now explain.

98 X Q You mean to be understood that you have forgotten about this part of the experiment?

A. I do not; some of the minor details do not strike me forcibly.

99 X Q. Did Mr. Man and Wm. E. Sawyer, in using quicksilver for exhausting the air, put the quicksilver first into the flask, bottle or lamp, then put in the mouth-piece with a tube in it, and then pour out the quicksilver through the tube?

A. Can't state that positively, but my impression is it was filled through a tube let out through a tube. My impression is the quicksilver as it went in forced out the air.

100 X Q. How long was this tube?

A. I couldn't state.

101 X Q. Can't you tell whether it was an inch, or a foot, or six feet long?

A. Can't answer.

102 X Q. When the quicksilver went into the flask, bottle or lamp, how was the carbon conductor protected from destruction?

263 A. I don't think in this particular flask, Fig. "Exhibit 1," we ever exhausted the air except by introducing gas. I don't think they ever used the quicksilver to exhaust the air, where a paper carbon was employed; in all such instances they filled the lamp with illuminating gas. The lamp they used quicksilver in is, I believe, "Fig. 7, Exhibit 1." We used other carbons besides paper in this lamp, and held them (the other carbons) by the spring of the post——

(The former question, X Int. 102, objected to by counsel of Sawyer and Man, on the ground that it is not cross-examination, and on the ground that the witness has already stated that he did not understand the details of the exhausting of the air out of the lamps, or making vacuum in the lamps.)

Witness, resuming, says he has no further answer to make to the question.

X Int. 103. In these experiments at Centre street, what kind of apparatus produced the electricity employed?

Ans. We had at that time an Arnoux & Hochhausen machine, which was the one used. Afterwards we had other machines at Centre street. I believe we had a Weston. Had no others to my recollection, except a machine to charge up with, which was of the same kind as the other one, *i. e.*, an Arnoux & Hochhausen machine.

X Int. 104. Which machine was used in the experiments where light was produced in electric lamps with paper-carbon conductors?

Ans. Arnoux & Hochhausen.

X Int. 105. Give the dimensions, as near as you can, of some parts of that machine?

(Objected to as not cross-examination, and not bearing on the matter in issue.)

Ans. My impression is that it is one of Arnoux & Hochhausen's No. 2 machine—the armature runs in water.

X Int. 106. Do you know about its resistances?

(Same objections.)

264 Ans. I do not; am not an expert in that matter.

Redirect examination:

Int. 107. In answer to cross-question 100, you say you couldn't state how long the tube was used in putting quicksilver into the lamp chamber, and further on you say, in answer to question 101, you could not tell whether it was a foot or six feet long?

Ans. That was what Mr. Dyer said. Presumably it did not exceed a foot.

Int. 108. Have you any distinct recollection as to how long it was?

Ans. I have not.

Int. 109. X Int. 101 was as follows: "Can't you tell whether it was an inch, or a foot, or six feet long?" and your answer is: "Cannot answer." Do you mean by that answer that you couldn't tell how long the tube was, or you couldn't tell whether it was one inch long, or a foot long, or six feet long?

Ans. Couldn't tell how long it was, but presumably not exceeding a foot in length.

Int. 110. Have you any distinct recollection as to how the air was exhausted from the chamber of the lamp?

Ans. Have not.

Int. 111. Did you have an air pump in the shop for that purpose?

Ans. I have no recollection of one being brought into the shop.

Int. 112. Was the lamp taken away from the shop for the purpose of exhausting the air out of it?

Ans. It was.

Int. 113. Then you don't of your own knowledge know the air was exhausted from the lamp, or whether it was exhausted?

Ans. From my own personal knowledge, no.

265 114 Q. But you saw the lamp after it was sealed and saw it burning?

A. Yes.

115 Q. Did you seal any of them yourself at the shop in Center street?

A. I did.

116 Q. And the air was exhausted after the lamp was sealed?

A. Yes.

117 Q. Referring to the lamps exhibited by figure 7, Exhibit Sawyer No. 1, how many holes were made in the glass stopper?

A. In some cases we had three, and in some four.

118 Q. The conductors went through two of the holes?

A. Yes.

119 Q. And when the lamp was filled with gas it was either put in it through a tube in a central hole, the tube being smaller than the hole to allow the gas or atmosphere to escape through the hole around the outside of the tube, or in cases where there were four holes in the stopper of the lamps the gas was put into one hole and escaped through another?

Objected to as outrageously leading under the circumstances.

A. That was the arrangement as nearly as I can remember.

Cross-examination resumed:

120 Q. What kind of sealing was that referred to in your answer to question 115?

A. We used the glass stopper; sometimes we used nothing but the ground stopper. Then, again, we used Canada balsam on the stopper. Some other kinds of lamps had a flat piece of glass to come right
against the nose or bottle that we used that was brought right
266 up in contact and bolted to a wooden or metal flange on
top of the flange on the muzzle, as shown in the patents
already referred to.

121 X Q. How did you seal the holes in the stoppers?

A. Was done by a plug—some by simple plug; others by a nut and bolt, one inside and the other outside, jammed up.

WILLIAM SAWYER.

NEW YORK, *April* 12, 1881.

Parties met pursuant to adjournment.

Present: Amos Broadnax, counsel for Sawyer and Man, and Dyer and Wilber for Edison.

Testimony of William E. Sawyer.

WILLIAM E. SAWYER, a witness produced on behalf of Sawyer and Man, being duly sworn and interrogated by Mr. BROADNAX, testified as follows:

1 Q. What is your name, age, residence and occupation?

A. My name is William E. Sawyer; my age 31 years; my residence is Hotel Devonshire; my occupation is an electrician.

2 Q. Please state whether you are the Wm. E. Sawyer one of the parties to this interference?

A. I am.

3 Q. The subject-matter of this interference, as given by the Patent Office, is: "The incandescent conductor for an electric lamp formed of carbonized paper;" please state whether or not you, in conjunction with Albon Man, have at any time made and used such a conductor?

A. We have; a great many times.

4 Q. State, as near as you can recollect, when it was that you
and Mr. Man first made such a conductor?
267 A. Almost immediately after we went to 43 Centre street;
should think about the 6th or 7th of March, 1878; might
have been a little earlier or later.

Int. 5. Give the circumstances that gave birth to that invention.

Ans. Before I became associated with Mr. Man I was associated with a Mr. Jas. Flannagan at the coal and iron exchange, where I made a number of experiments in electric lights; I had a theory that the most perfect incandescent lamp would be one having the highest resistance and the least transverse mass, and I filed an application in the Patent Office for a chalk or some similar material held between two conductors, and containing in a little groove, run-

ning across from conductor to conductor, a powdered graphite or carbon to carry out this idea; I don't remember the exact wording of the specification, but the patent was never granted, but is probably on file in the Patent Office now; I spoke to Mr. Man of this idea, and sat down at my desk, 43 Centre street, and drew pencil marks on some ordinary foolscap writing paper, rather heavy, and I took two small copper wires and held them with my fingers on that while the generators were running; when he brought the wires very close together, we could only get a little spark; then Mr. Man and I went around to a place where they deal in pure graphite, and got some samples; I'm not exactly sure what kind of paper we used, but think we laid the same kind of a piece of paper, or a piece of blotting paper, and drew a heavy line with a pencil, so as to make a creasing; then we filled the crease with powdered graphite, and then brushed it off of the top so as to leave only what was in the crease; we had had some trouble getting the current through that, but when we succeeded, we charred or burnt the paper; I recollect that in looking at that, I suggested to Mr. Man the charred parts that were left were so fine that it would probably make a good carbon; Mr. Man then took a piece of blotting paper; at first they were simply straight strips one eighth to three-
268 sixteenths in width, and perhaps one-half inch to one inch in length. Mr. Man worked over them, rubbing and pounding them with graphite, till he got them full of it. But the resistance was higher than what we had laid in the crease of the paper, and it was some time before we succeeded in making the current go through it. Of course, this destroyed the paper. Am not sure at whose suggestion, but to prevent that, we put the strip in a sealed globe filled with ordinary illuminating gas. I should not think it took over a minute to carbonize them. That blackened the globes. We treated those carbons in globes, *i. e.*, we passed the current through the carbons, while a stream of illuminating gas was flowing through the globes, we concluded that that was a rather expensive way of making carbons. Concluded that the best way to do it was to burn it out, the way as we done in carbonizing any material. We had no facilities there, there being neither a stove or a furnace. Mr. Man and father hunted around, found two old pieces of thick cast iron. One looked as if it might have been the foot of some heavy piece of furniture or machinery. Had a hollow in it. The other, if I recollect rightly, was merely a flat piece of iron. We cut out pieces of blotting paper, and, I believe, an old drawing we had. Mr. Man packed them into that with some common powdered gas-retort carbon, which he got from Charles T. Chester in Centre street. Mr. Man took the box home (should say the made-up trap), and brought it over the next morning with the paper carbonized. I would take those, treating them, and puting them in lamps. Most of the experimenting after that was done by Mr. Man himself. My own idea was that a much harder carbon would be better than those thin, fragile paper carbons, but Mr. Man preferred the paper. I think he does till this day.

6 Q. After you had the paper carbons made, state whether you

treated them electrically in the presence of hydrocarbon, for the purpose of consolidating and enlarging them?

269 Ans. Yes. I did.

Int. 7. In making the carbons of the form you wanted them to use in your lamps, did you do that before or after the paper was carbonized?

Ans. Almost entirely before. When we wanted to expose the broad side to the light, we had to cut them out before, but when exposed edgewise, we could bend them after they were carbonized.

Int. 8. Of what form did you make the burners of carbonized paper?

Ans. Generally in the form of a half circle or circle, but experimented with all conceivable shapes. Anything that would suggest itself as capable of allowing for the expansion and contraction of carbon.

Int. 9. Can't you specify some of the different forms besides a circle and a half circle?

Ans. We also used a straight piece; a V-shaped piece. These sketches which I hand you represent some of the forms of carbon which we made of paper. (Witness makes a sketch.)

(Sketches offered in evidence as part of the witness' testimony, and is marked "Sawyer Exhibit No. 6, April 12, 1881," W. H. B., notary public.)

Int. 10. Referring to this sketch you have made, state whether the letter "*a*" represents the enlarged part of the carbon that was used to hold the burner by in the supporting conductors.

Ans. It does in Figs. 1, 2 and 3; in the others it does not.

Int. 11. How were the carbons represented in Figs. 4 and 5 held in the connecting conductors?

Ans. By clamping the ends; frequently we slit the ends of the conductors, which were sometimes of carbon and sometimes of metal.

Int. 12. Do Figs. 1, 2 and 3 represent a side elevation
270 of the carbon held in the lamp, and the others a kind of perspective?

A. Figs. 1 and 2 represent a side elevation; Fig. 3 was made with the flat side up, as shown in Fig. 6, in which "*b*" is an oblong square piece of carbon, screwed to metallic upright, "*c*" by screw "*d*;" "*e*" is a piece of carbon cut in the shape shown, with a square slot through the lower jaw, through which an oblong carbon, "*d*" passes. The connection with the carbonized incandescent part was made by the pressure of the weight of "*e*" on "*b*."

13 Q. Fig. 6, as I understand you, represents but one conductor, and one side of the connection between the conductor and the carbon section?

A. Yes, the other end of the incandescent conductor was held in precisely the same way, object was to get a very light, though sure contact; the carbons shown in Figs. 4 and 5, were held as shown in Fig. 7; in some made in that form. I think, my father made a square cavity, which was packed with powdered carbon after the burner was put in; some of them were held as shown by the drawing "Sawyer Exhibit No. 5;" the wire shown in the bottom of the clamp, Fig. 4, was only used occasionally, when the carbon was thin and the clamp imperfect in shape, to bring the clamp up against the carbon burner.

14 Q. Does this drawing, "Sawyer Exhibit No. 4," represent the lamp substantially in which you used those paper-carbon burners?

A. That represents the lamps as finally used, but it was only one of the many forms of lamps we used; and it particularly represents one of the lamps I took down at 94 Walker street, in the winter of '79–'80, to give to a friend of mine Mr. Arnoux—of Arnoux and Hochhausen—on the Monday morning after the announcement of Mr. Edison's discovery, to show to him that we had previously invented that; this was, I think, on the 20th of December, 1879, that the Herald published that account about Edison;
as soon as I got to my shop on Monday morning, which was
271 *got to my shop on Monday morning, which was* about 9 o'clock,
I took this lamp to Mr. Arnoux, and requested him to hand it to Mr. Shanks, of the Tribune, to keep as an evidence, that Mr. Edison was not the original inventor—to satisfy him; and I did it thus early, that it could not be said that we possibly could have had time to manufacture it after Edison's announcement; this lamp was taken down in January or February, of the same year, eleven months previous, having been broken; it might have been as early as December, 1878; Mr. Lawrence Myers saw this lamp in operation, and I think, saw it broken; it was taken down, I know, during Mr. Myers' stay there.

Int. 15. Referring now to the paper carbons, some of which are represented in the sketch, "Sawyer Exhibit No. 6," state whether or not you put them in a sealed lamp and tested their practicability.

Ans. Yes, sir; we did.

Int. 16. Did you try any of the carbons illustrated by the drawing "Sawyer Exhibit No. 6," and if so, which of them?

Ans. The carbons shown in figures 1, 2 and 3 and the half circle, were positively used; were sealed up and run; the great trouble with them was when we raised the temperature till we could get a bright light they would break; for this reason I preferred the harder carbons; we finally made them hard enough by treating them in hydrocarbon gas by the Sawyer-Man process.

Int. 17. How long did they last in the lamp?

Ans. Untreated by the Sawyer-Man process, would last from one second to ten minutes, if run up to give a good bright light; if run at a low temperature, they would run anywhere from an hour to one hundred hours; it depends entirely upon the temperature.

Int. 18. State, as nearly as you can recollect, how long the best
of the paper carbons you made at 43 Centre street would last
272 in the lamp when raised to a temperature high enough to
give a good bright light, after having been treated by the Sawyer-Man process.

A. Run at a power of about 25 candles they would last from 5 to

100 hours; once in awhile we would get a lamp so perfect in every respect that it would seem to undergo no change after a long use; but generally they would fracture in from 5 to 20 hours, run at that temperature; the difference in the duration of the burners was due to both imperfections in the lamp and in the carbon; where the fracture alone occurs it must be due either to imperfection in the carbon or the effect of unequal expansions; when consumption occurs it is due to the imperfect charging of the lamp.

19 Q. State as near as you can recollect, about how long you and Mr. Man continued your experiments at 43 Centre street.

A. Should think about two months; all the time we were there.

20 Q. After you got through there, did you resume your experiments at any other place?

A. We moved from there to 2 Howard street, where I don't think we made any experiments on lamps, not having facilities for such experiments; we then moved in the fall of the year to 94 Walker street; I have got memoranda to show all these things; we moved to 94 Walker street during the 18th and 19th of October, 1878.

21 Q. State what, if any experiments you made with carbonized-paper carbons at 94 Walker street.

A. We employed an assistant who is dead now (Edwin L. Myers), and Mr. Man and I divided our work. Mr. Man experimenting with carbons, and partly assisted by Mr. Myers; Mr. Myers conducting the charging of the lamps and myself designing the different apparatuses connected with lamps such as switches, dynamo machines and electrical measurements, &c., &c. I knew that Mr. Man continued carbonizing paper and live willow twigs, and a good
deal of such work generally, but I took no active part in it
273 myself. He *but I took no active part in it myself. He* made
the carbons and I used them. I don't think I ever did another thing in the manufacture of those carbons after I came in Walker street. We divided up our work, and I had a general knowledge of what was going on. Almost every day Mr. Man would have some new carbons to offer. Made a good many by taking artist crayon (called the French willow carbon). He carbonized all kinds of woods. Mr. Lawrence Myers brought him in, I think, a willow twig, which he carbonized. Among other forms of carbon Mr. Man made one of willow twig, like figure 8, Sawyer Exhibit No. 6. What Mr. Man did not do in carbonizing different things can't be imagined, for he did nothing else but work on that about all the time.

Int. 22. Please state whether or not you began and perfected the invention of the paper-carbon burners while you and Mr. Man were at 43 Center street?

Ans. Yes, sir.

Int. 23. State, as near as you can recollect, when it was, while you were at 43 Center street, that you got the invention of the carbonized-paper burner perfected?

Ans. It was within two or three weeks after we got in 43 Centre street.

APRIL 13, 1881.

Parties met pursuant to adjournment.
Same counsel present as before.

Cross-examination of WM. E. SAWYER by GEORGE W. DYER, Esq., of counsel for Mr. Edison:

X Int. 24. Can you give the date when you moved to 43 Centre street?

Ans. About the first of March, 1878.

X Int. 25. Who were the premises hired from?

Ans. From the engineer of the building. Am not positive, but think his name was Porter.

274 26 X Q. What power did you use in that building in your experiments?

A. The regular power furnished to the building was shafting motion in the shop when I took it.

27 X Q. What kind of electrical engine did you use at that place?

A. Had several engines there. Arnoux and Hochhausen had put one of their machines for electric lighting down in the engine-room, and they gave us permission to run wire from the shop down in the engine-room. Then, afterwards, I had a Hochhausen electro-plating machine, which I bought, and another Hochhausen machine like the plating machine, but wound with a finer wire, which I borrowed. Then there were two or three machines set in there for us to try. I think all of these were Weston machines, (electro-plating), but we could not do anything with these Weston machines.

28 X Q. What was the electric power or capacity of each of these Arnoux and Hochhausen machines?

A. The light machine in the engine-room had a high electromotive force, comparatively, had, I should judge, two ohms internal resistance. I never measured this, but judge from another machine of the same make which I now have. That was the very first machine of that design which Arnoux and Hochhausen ever made. When put in there it was incomplete. They put it in for trial, to satisfy themselves of its capabilities. I think this machine was about equal to the intermediate size which they were making a year or two ago. I don't think they make just such a machine now. They said that the machines gave a light by the arc of 20,000 candles, but I should judge it only gave about 5,000 candles. The plating machines had a low electro-motive force; I don't think had more than one-half ohms resistance; would give no voltaic at all; was driven at 1,500 revolutions a minute. The third machine was charged up by the plating machine. The armature was wound with fine wire, and was driven at a speed of about *and was*
275 *driven at a speed of about* 4,000 revolutions a minute; only the armature coil being connected with the lamps. Is nothing to be said about the Weston machines; could not do anything with them. I mean they did not have electro-motive force enough to overcome the resistance of the lamps.

X Int. 29. How long did you occupy that shop?

Ans. I went from there to Washington, and gave it up, after being there two months, and not over three; should think about two months—perhaps three months.

X Int 30. What force did you have in that shop?

Ans. Nobody employed in the shop but my father, William Sawyer. We had work done outside. We had some of the mechanical parts of the lamps made outside to save time in the shop; not very much done outside of the shop.

X Int. 31. By whom was this outside mechanical work done?

Ans. Is difficult to answer. My father would have it attended to. One man in the same building did a good deal of it. Pearce & Jones, of William street, did some work. Generally, father would go in some shop, take a man off his work and put him on a little job. I can't tell you the date Pearce & Jones did work. It was while I was with Mr. Man. I get it from an account with Mr. Man, in which the dates do not appear. I think it was about the time we were in this shop—while I was first associated with Mr. Man.

X Int. 32. In your answer to the fifth question, you say: "I had a theory that the most perfect incandescent lamp would be one having the highest resistance and the least transverse mass." What effort did you ever make to develop that theory, and when?

Ans. The first effort was in an application for a patent, the idea
of which was a thin layer of powdered carbon on a refractory
276 base. (Witness here makes a sketch, which is made a part
of his evidence, marked "Sawyer's Exhibit 7, April 13th,
1881, W. H. B.", and proceeds as follows:)

Fig. 1 is a top view. Fig. 2 is a side view. A is a refractory base, and a narrow groove running along the top, opening in an enlarged space at the ends, up into which the two conductors B B come. The carbon (powdered) was laid in the groove and packed in the end space; this may not be exactly in the form of the application, but is substantially the same. This was a frequent subject of conversation—with some other applications I put in with Mr. Man.

33 X Q. Was this application to which you refer, first in your own name, or was Mr. Man associated with you?

A. Was in my own name—made some time before I knew Mr. Man. Think the application was not made earlier than October, 1877, and not later than January, 1878; I was continually filing applications, and as this was rejected it cleared my desk of all record of it.

34 X Q. What became of this application?

A. Was rejected, and don't recollect the grounds.

35 X Q. Have you made any effort to amend it or keep it alive?

A. Undoubtedly it was amended, but I don't recollect what was done about it. Probably I considered the examiners' objection as good.

36 X Q. Did you prepare that application yourself?

A. I did.

(Counsel for Edison gives notice that the production of this application will be required at the hearing of this interference.)

37 X Q. What other effort did you make to develop the theory inquired of in 32 X Q.?

A. The effort to develop that theory and put it in practice was made with Mr. Man at 43 Centre street.

277 38 X Q. Has that theory ever been stated in any of your patents for electric lights, or in those of Sawyer and Man?

Ans. I can't recollect whether it has been stated or not in any of the patents.

X Int. 39. In another portion of your fifth answer you speak of carbonizing paper in what you call a "made-up trap" in which you packed the paper with "powdered gas-retort carbon;" what effect would that carbon have upon the paper?

Ans. No effect whatever. This carbon which was sold by Mr. Chester was purified carbon, which he sold at about $1 per pound. It was used to surround the paper and protect it from the air; more for this than any other purpose.

X Int. 40. What effect did the subsequent treatment of these carbons in the presence of the hydrocarbons, have upon the carbons themselves? I refer to the 6th Int. and answer.

Ans. Two quite different effects. In some cases the whole mass of the original carbon would be hardened, and become homogeneous with the further deposit. In other cases the original would remain unchanged and the deposit carbon could, perhaps, be broken off from it. This was due probably to difference in the manipulation. If the original carbon was heated up so as to drive out included gases, but not sufficient to decompose the hydrocarbon surrounding it, its pores will become permeated by the hydrocarbon which a quick impulse of current will decompose in the mass of the carbon, thus hardening it, and so on. But if the carbon is heated so hot as to decompose the surrounding hydrocarbon in the first place, then the original carbon will remain unchanged. By combining the two processes, the original and deposit carbon, may be made one and substantially the same.

X Int. 41. What effect did this treatment have upon the resistance of the carbon conductors?

278 A. Would reduce the resistance in proportion to the extent of the treatment.

42 X Q. As a matter of fact, about how much was the resistance reduced?

A. Mr. Mann's idea and mine upon that question of resistance began to differ. That is to say, my theory that the most perfect electric lamp would be one in which the incandescent conductor had the highest resistance and the least tra-verse mass was gradually abandoned by myself while largely retained by Mr. Man, my present theory being that the most perfect electric lamp is one in which the incandescent conductor has not only the least transverse mass, but the least resistance. I soon began to reduce the resistance of my carbons to as low as an ohm; at present I make them only $\frac{1}{4}$ ohm, therefore, I would treat the carbons so as to obtain a heavy deposit. Judging from the difficulty in getting the current through some of Mr. Man's carbons, treated according to his ideas, they must have had as high as 100 ohms resistance, but I don't recollect whether we made measurements of any particular ones. Answering the question directly, I should say that Mr. Man reduced the resistance in his carbons from fifty to seventy-five per cent. by the treatment referred to. This is an estimate, and not the result of measurement.

43 X Q. Did this diminution of resistance in the carbon conductors greatly increase the heat within the lamp?

A. Increased the heat, but not in proportion to the diminution of the resistance.

44 X Q. Did this increased heat require the use, in some of your patented lamps, of radiators to convey away the surface heat?

A. In some of them; but don't use them in my present lamps, as they will stand the heat without.

45 X Q. Referring now to your answer to the 14th question,
279 and that part of it relating to publication in the Herald of
about 20th December, 1879, did you make one or more replies to that article and publish them?

Ans. I believe something was said, but I don't recollect what now.

X Int. 46. What newspapers did you publish the replies in?

Ans. I don't know any particular newspaper. I believe I wrote to several newspapers. I think the very day that account of Edison's was published I sent the same article to every newspaper in New York.

X Int. 47. Do you remember what newspapers published your article?

Ans. I think the Sun and the Tribune, or some other paper, but am not certain. I was continually writing to the papers. Can't remember any particular article published in any particular paper.

X Int. 48. Did you subsequently and in a short time furnish one or more additional articles upon the same subject, which were published in the Sun?

Ans. Very likely I did. Refer to my previous answer with regard to my constantly writing to the newspapers.

X Int. 49. Referring now to your 17 answer, could a lamp, as described there, which would burn from one second to ten minutes, be used in competition with gas or other commercial lights?

Ans. It could not; and at that time the invention was not so perfected in all respects, including the inclosing globe and mechanism, as to make the lamp suitable for any practical purpose. By mechanism, I mean the general construction of the lamp, method of sealing, conductors, &c. That is all the attachments of the lamp and the general mechanical construction of the lamp.

X Int. 50. Referring now to your 18th answer, could a lamp as described there, which would burn from 5 to 100 hours be used in competition with gas or other commercial lights?

280 A. I think not.

51 X Q. Have you ever produced an electric incandescent

lamp with a paper-carbon conductor, which could be used in competition with gas or other commercial light?

A. We have produced a lamp of the kind described, as capable of competing with gas as any other electric lamp produced with an incandescent paper carbon; I refer to heated carbons.

52 X Q. When, and where did you produce such a lamp?

A. At 94 Walker street, substantially the same as in Exhibit No. 4, (Sawyer exhibit), referring to the copy of the drawing, making part of the application for the patent. This was between the 20th October, 1878, to the 20th January, 1879. We had this lamp perfected before Mr. Lawrence Myers left.

53 X Q. How long did any of the lamps referred to in the previous answer, actually burn?

A. One or two of them burned, I think, about 100 hours. The majority of them would fracture in about 5 hours Nineteen-twentieths of them would fracture in about 20 hours. That is, of course, run up to the temperature which would give about 25 candle light. That is about 5 times the light the Edison and Maxim lights were usually run at.

Redirect examination by Mr. BROADNAX:

54 Q. Referring now to the lamps referred to in answer to 53 X Q. Please state whether or not those lamps are fitted with the same kind of paper carbons that you made at 43 Centre street?

A. Some of them were, and some were treated with gas-retort carbon. Most of them were fitted with paper carbon. We were treating those lamps to get the greatest durability possible. The treatment was the same, except we substituted liquid hydrocarbons for gaseous.

281 Int. 55. During your experiments at 43 Centre street, was Wm. H. Church a frequent visitor there?

Ans. Yes.

Int. 56. Did he witness those experiments with a prospect of interest in the invention?

Ans. I can't say what experiments Mr. Church witnessed He was there every day, in and out. Don't remember what his prospective interests in inventions were.

W. E. SAWYER.

Counsel for complainant offers in evidence printed Patent Office copies of the specifications and drawings of the following letters patent of the United States granted to Thomas A. Edison on the dates hereinafter given, to wit:

214,636,	dated	April 22, 1879.
214,637,	"	" " "
218,866,	"	August 26, 1879.
219,628,	"	Sept. 16, 1879.
224,329,	"	Feb'y 10, 1880.
227,227,	"	May 4, "
227,228,	"	" " "
227,229,	"	" " "

and the same are marked, Complainant's Exhibits Edison Patents Nos. 1 to 8, February 2, 1889. It is hereby stipulated that the production of copies of the grant of said patents and certifications of said copies is waived, and that the same may be used with the same force and effect as duly certified copies, subject to correction at or before the hearing by the production of certified copies.

Each and every said patent objected to as immaterial and irrelevant by counsel for defendant. Defendant's counsel objects to the offer of the alleged depositions of William Sawyer and William E. Sawyer as incompetent, immaterial and irrelevant, and for the further reasons stated at the end of the previous offer of these same depositions. 282

The offer of Exhibits No. 1, No. 2, No. 4, and No. 10 objected to as incompetent, immaterial, and irrelevant, and because it does not appear that said Patent Office proceedings were between the same parties, or their privies, as in this suit, or that the issue was the same, and because said exhibits appear in the offer to be but a partial record of the proceedings referred to.

Complainant hereby closes its evidence in reply.

283 United States Circuit Court, Western District of Pennsylvania.

THE CONSOLIDATED ELECTRIC LIGHT COMPANY *against* THE MCKEESPORT LIGHT COMPANY.	In Equity. No. 5. May Term, 1888.

To Amos Broadnax, Esq., and Leonard E. Curtis, Esq., of counsel for complainants.

GENTLEMEN: Take notice, that on Wednesday, February 20th, 1889, at 11 o'clock in the forenoon I shall proceed to take (*de bene esse*) the testimony of George W. Sawyer, as a witness for the above defendant, before William T. Farnham, notary public, at the Mitchel house, corner of Broadway and Forty-second street, in the city of New York, according to the statutes in such case made and provided, said George W. Sawyer being a resident of the city of New York, living at a greater distance from the place of trial than one hundred miles, and being infirm. The examination will be continued from day to day until completed. You are invited to be present at the time and place named to cross-examine the said witness.

Dated New York, February 19th, 1889.

RICH'D N. DYER,
Of Counsel for Defendant.

Service of a copy of the above acknowledged February 19, 1889.

LEONARD E. CURTIS,
Of Counsel for Compl't.

AMOS BROADNAX,
Of Counsel with Complainant.

284 United States Circuit Court, Western District of Pennsylvania.

THE CONSOLIDATED ELECTRIC LIGHT COMPANY
against
THE MCKEESPORT LIGHT COMPANY.
In Equity. No. 5. May Term, 1888.

To Thos. B. Kerr, Esq., solicitor for complainant:

SIR: Take notice, that on Wednesday, February 20th, 1889, at 11 o'clock in the forenoon, I shall proceed to take (*de bene esse*) the testimony of George W. Sawyer, as a witness for the above defendant, before William T. Farnham, Esq., notary public, at the Mitchel house, corner of Broadway and Forty-second street, in the city of New York, according to the statutes in such case made and provided, said George W. Sawyer being a resident of the city of New York, living at a greater distance from the place of trial than one hundred miles, and being infirm. The examination will be continued from day to day until completed. You are invited to be present at the time and place named to cross-examine the said witness.

Dated New York, February 20th, 1889.

RICH'D N. DYER.

Service acknowledged February 20th, 1889, at 10:20 o'clock a. m.

THOMAS B. KERR,
Solicitor for Compl't.

285 United States Circuit Court, Western District of Pennsylvania.

THE CONSOLIDATED ELECTRIC LIGHT COMPANY
vs.
MCKEESPORT ELECTRIC LIGHT COMPANY.

United States Circuit Court, Southern District of New York.

THE CONSOLIDATED ELECTRIC LIGHT COMPANY
vs.
THE EDISON ELECTRIC LIGHT COMPANY and THOMAS A. EDISON.

STATE OF NEW YORK,
City and County of New York, } *ss:*

Be it remembered that on this 20th day of February, in the year of our Lord one thousand eight hundred and eighty-nine, I, William T. Farnham, a notary public in and for the city, county and State of New York, under and by virtue of the statutes of the United States in such cases made and provided, did call and caused to be and personally appear before me, George W. Sawyer, pursuant to the annexed notice, at the Mitchell house, on the corner of Broadway and Forty-second street, in the said city of New York, in said county and State, to testify and the truth to say on the part and in behalf of the defendant in certain suits, or matters of controversy, now depending and undetermined 286 in the circuit court of the United States for the western district of Pennsylvania, wherein The Consolidated Electric Light Company is complainant and The McKeesport Light Company is defendant, and in a suit or matter of controversy now depending and undetermined in the circuit court of The United States for the southern district of New York, wherein The Consolidated Electric Light Company is complainant and The Edison Electric Light Company and Thomas A. Edison are defendants.

Present: Thomas B. Kerr and Amos Broadnax, counsel for complainant, The Consolidated Elec. L't'g Co., Walter K. Griffin, Esq., and Richard N. Dyer, Esq., for the defendants The McKeesport Electric Light Company and the defendants The Edison Electric Light Co. and Thomas A. Edison.

Also present: Albon Man.

And the said GEORGE W. SAWYER, being about the age of twenty-seven years, and having been by me first cautioned and sworn to testify the truth, the whole truth and nothing but the truth in the matter of controversy aforesaid, I carefully examined the said George W. Sawyer, and he did thereupon depose, testify and say as follows, viz:

Counsel for complainant requests counsel for respondent to permit Dr. Charles A. Bucklin, residing at 206 West Forty-second street, and who is now present, to examine the witness on behalf of the complainant with reference to his physical and mental condition before the examination proceeds.

Counsel for defendants accede to the request.

(Dr. Bucklin was then permitted to enter the room and examine into the witness' condition, being in the presence of counsel for both the complainant and defendants.)

287 Examined by Mr. GRIFFIN:

1 Q. What is your name, age and present place of residence?

A. My name is George W. Sawyer; age twenty-seven; I am at present residing in the Mitchell house, New York city, under medical treatment.

2 Q. Are you the George W. Sawyer who is the brother of William Edward Sawyer, one of the joint patentees of the patent in suit, and are you also the George W. Sawyer who, before this, testified in certain interference proceedings between Messrs. Sawyer and Man and Mr. Edison in the Patent Office?

A. I am.

3 Q. Please look at the book marked for identification "Defendant's Exhibit A, Feb. 20, 1889," and state whether you recognize the same, and whether you have examined it (handing book to witness)?

A. Yes, sir.

Defendant's counsel requests of record that the notary mark the book for identification, as stated in the question to the witness.

4 Q. With the exception of pages 49 to 56 inclusive, and the first

eight lines of page 57, in whose handwriting are the various entries in the book?

A. The other handwriting is my brother's, William E. Sawyer.

5 Q. Please look at the entries on pages 123 to 129 of the book, and state in whose handwriting the entries on those pages are?

The question is objected to as immaterial and incompetent, unless the book is going to be offered in evidence.

A. It is all my brother's writing.

6 Q. Have you seen this book before, and if so, how did you first see it?

288 A. It came to me through my brother, in some way, at some different times; it was left in my care; anyway, I came by it, and I have had it.

7 Q. How long, how many months or how many years?

A. I have had the book since before 1880 or 1881.

8 Q. How long were you employed with your brother William Edward Sawyer in his experiments on electric lamps and similar things?

A. On all of his electrical experiments?

9 Q. Yes.

A. About 1871 or 1872—until 1881 or 1882. I won't be quite sure; there were lapses of about a year, in the meanwhile, when I might not have been with him. I first commenced with him in Washington.

10 Q. When were you with your brother in Washington?

A. In 1871 or 1872.

11 Q. Were you with your brother all the while during these years you have named, or from time to time?

A. With him most of the time—lived with my mother, my sister and myself; as a rule, most of the time.

12 Q. After you left your brother, whose employment did you go into?

A. I never was in any one's employment but his, or where he was employed.

13 Q. Were you with your brother before he became acquainted with Albon Man?

A. I was.

14 Q. And after you became acquainted with him?

A. Yes, sir.

15 Q. What part did you take with the various experiments that your brother made in electric lights, or electric lamps?

A. I was with him in most all of his experiments, assisting him, bringing apparatus to him such as he would want to use and assisting him in any way that I could.

16 Q. Do you know Hiram S. Maxim, S. D. Schuyler, James Flannigan, J. G. Smith, and others?

A. I do.

289 17 Q. Had these gentlemen any association with your brother in his experiments in a business way?

A. Yes, sir.

18 Q. Had your brother and Mr. Schuyler and Mr. Maxim any business connection?

A. Yes, sir.

19 Q. In what class of business was this?

A. In electric motors and postal telegraph.

20 Q. Do you remember any experiments made by your brother at the Coal and Iron Exchange?

A. Coal and Iron Exchange?

21 Q. Yes?

A. I do.

22 Q. How much apparatus had your brother at the Coal and Iron Exchange, for making electrical experiments?

A. A very little, only a few cells of battery, a couple of flasks with stoppers, or tubes running up through, which held a piece of carbon, and we would charge the flask with illuminating gas; that is all.

23 Q. Prior to the time that Mr. Man became acquainted with your brother, had your brother, or any one connected with him, made anything that you could call an electric lamp?

A. No, sir.

24 Q. How far had your brother got—what had he done in experimenting that way?

A. Nothing more than heating up pieces of carbon to incandescence in the air.

25 Q. What sort of carbon was this?

A. Generally lead pencil; held it up in the air.

26 Q. Do you remember E. P. Benjamin, dealer in chemical apparatus, in Barclay street, New York city?

A. I do.

27 Q. Did you ever purchase anything from him for your brother?

A. Yes, sir.

28 Q. What did you purchase?

A. Florence flasks.

29 Q. How many?

A. I don't think more than two at a time; I don't know
290 as I ever purchased more than two while he was at the Coal and Iron Exchange.

30 Q. What did your brother do with these flasks at the Coal and Iron Exchange?

A. As I said, we had a couple of uprights put up in them—conductors—to hold the piece of carbon; I think we tied the carbon around with copper wire, so as to make a connection, and there was a rubber cork in it; we took the lamp down to the Merchants' hotel—was it the Merchants' that used to be below Church street? A very old house; I don't think it is there now.

31 Q. You took them down to the hotel?

A. We took them down to the hotel, and charged them, and came up and tried them.

32 Q. What kind of gas was used in the lamp?

A. Illuminating gas; I know we were very much afraid that they were going to explode, and we wanted to get out of danger.

33 Q. How many of these lamps were burning, or tried to be brought to a light?

A. We tried both of them.

34 Q. About how long did the burning last?

A. Well, the globes became smoked so that we couldn't tell anything about it, and we opened them and looked at them.

35 Q. What kind of carbon did you use in these lamps?

A. I won't be positive whether it was this retort carbon or lead-pencil carbon.

36 Q. Do you remember about what the date of these experiments was?

A. Somewhere in February, 1878.

37 Q. Had your brother ever made any experiments with the electric lamp for incandescence before that time to your recollection?

A. No, sir; I am very sure his experiments all date from the 1st of February or latter part of January.

38 Q. Was Mr. Man present when those experiments were made?

A. Not this first one, no, sir. The first time Mr. Man was
291 present was on Washington's birthday, the 22d of February. I am very sure of that.

39 Q. And when Mr. Man was there was the experiment different from what it was before?

A. No, sir.

40 Q. After your brother moved to Centre street and while he was there, were you with him in his employ?

A. Yes, sir.

41 Q. How many flasks or lamp glasses did you buy for use at Center street, as you best remember?

A. I know that we had seventeen of them up there at one exhibition; they lasted no length of time at all; we were very glad to get the crowd out that was in there before everything would play out.

42 Q. What do you just mean by that; that you were glad to get them out?

A. Before everything would play out. It had a kind of partial success, and that was all, for probably half an hour.

43 Q. What would you do with the lamps after the people had left?

A. Take them down again. The carbons kept getting larger, and the globe darkened and the light dimmer.

44 Q. Do I understand you that you would put in new carbons after the people left?

A. Use the same carbon and recharge it.

45 Q. Recharge them?

A. Recharge them with gas.

46 Q. Was the glass plain transparent glass in these 17 or 18 globes?

A. Some of them were ground and others were transparent.

47 Q. What was your object in using ground glass?

A. To diffuse the light—show a difference.

48 Q. What kind of a machine for developing electricity did you have at Center street?

A. An Arnoux & Hochhausen machine, situated in the basement of the place when we got there; that is how we came to go there.

292 49 Q. How long did you use this machine that was situated in the basement?

A. I think only a few days; they took it away themselves.

50 Q. What did you use after that?

A. There was a Ball machine, I think, and a Weston in there, but there was nothing done with those; we used to take a lamp in there to the little shop corner of Howard and Mead—not Howard and Mead—a little corner up there that Arnoux & Hochhausen had, and they were running a machine then, trying to get one that would heat up a piece of metal so that we could use it.

51 Q. What kind of apparatus had you for conducting experiments at Centre street?

A. Only crude.

52 Q. How much; do you remember?

A. Charcoal furnace—these furnaces that they use for heating a tube—chemists use them; I don't know the name of them. They got it there to heat a tube filled with copper turnings; it didn't work. They use it for quicksilver.

53 Q. How often were you with your brother in Centre street, in the shop?

A. I was there continuously—all the time, except when out on errands, with the exception of one space of time, when I was away at Washington filing some patents for him.

54 Q. How long do you think that you were away?

A. Might have been a month, still, I don't think it was a month.

55 Q. How often would Mr. Man be at the shop in Centre street?

A. Sometimes for a short time in the morning, and again in the afternoon.

56 Q. Did he ever do any work in the shop that you saw?

A. Not much more than talking or consulting with my brother.

293 57 Q. About how many lamps do you think were made or used in Centre street during the time you were there?

A. I cannot recollect that.

58 Q. Give your best memory as to whether there was a great many or very few.

A. There were very few; we never had a great many.

59 Q. What would your idea be of a great many?

A. There may have been ten lamps put up there at Centre street.

60 Q. What difference was there between the lamps you used at Centre street and the lamp which you mentioned you had experimented with at the Coal and Iron Exchange?

A. A different way of sealing the bottom, so as to make it tight, and the conductor that went up inside, to keep it from loosening the sealing through the conduction of heat. It was a soapstone bar put in at that time; we only had the one workman working at the lamp there; that was my father.

61 Q. Were the lamps used with illuminating gas as they were at the exchange?

A. They were charged with different gas; some with illuminating gas, and then I think we had some with nitrogen; I don't know as we had any with other than illuminating gas.

62 Q. You have mentioned a stopper for the flasks or lamps; what kind of a stopper did you use at Centre street? What was it made of?

A. Glass.

63 Q. Who made the globes and covers, or caps?

A. Mr. Map got the globes from Brooklyn, I think, some place.

64 Q. And do I understand you that the globes and their fittings were not made at Centre street?

A. We had no apparatus for making glass there?

65 Q. How about the fittings; were those made there?

A. The fittings were made there.

66 Q. What kind of carbon was used in these lamps in Centre street?

A. Hard carbon, retort carbon, worked into shape.

294 67 Q. Was the resistance of these carbons high or low?

A. It was very low.

68 Q. How large were the carbons—were they large or small?

A. Well, might have been $\frac{3}{4}$ of an inch long, and filled out a sixteenth of an inch or more.

69 Q. Did you give an exhibition of these lamps in Centre street?

A. Yes, sir.

70 Q. Just state what you remember about that exhibition.

A. That was when we first went there from the Coal and Iron Exchange. I know that I was sent around to the newspaper office and telegraph—steamship companies—and invited all those different men—head men—there to this exhibition. There didn't near as many come as we expected. After they were there we started up; I think it was about three o'clock in the afternoon. We ran along until the lamps commenced to grow dimmer and dimmer, and I don't know how my brother excused them; he managed to have a reason, anyway, for shutting down and getting them out; he was very glad to get them out.

71 Q. Did you notice anything about the carbons after the exhibition was over?

A. Yes, sir; they had all increased in size.

72 Q. What remark did your brother make as regards this increase of size, if any?

A. I don't know as he made any remark—that is, to me personally.

73 Q. After the exhibition did you alter the style of fittings of your lamp at all?

A. No, sir; not the style of fittings; we were continually experimenting them at all times—made one lamp—no more than one lamp at a time.

74 Q. How did you close the lamp, as you have mentioned? What did you use to close the lamp?

A. It seems to me they had this flat stopper at this time, and fir balsam put in the joint, and the joint was clamped together; 295 there was a flange cast on the upper globe, and there was some kind of metal clamp to clamp the stopper and globe together.

75 Q. On all these lamps that you have mentioned up to the time you left Centre street do you remember any other carbon than hard carbon, or retort carbon, that you have mentioned being used?

A. No, sir.

76 Q. Did you ever see or hear of anything else being used in the lamps?

A. No, sir.

77 Q. What is the longest time that you remember any lamp burning at Centre street continuously—I mean at one time?

A. I do not believe we ever burned a lamp there over half or three-quarters of an hour at a time.

78 Q. What opportunities did you have of knowing?

A. I being there.

79 Q. Suppose visitors came there, what was your custom in showing them the lamps?

A. Turn it on; start a machine up, and turn it on. After they were in the place for half or three-quarters of an hour, then you can turn it out without them thinking much about it.

80 Q. What, if anything, would you do to the lamps after the visitors had gone?

A. If there was anything necessary we repaired it.

81 Q. What is the longest time that you remember a lamp being burned without having the carbon renewed or the globe recharged with gas?

A. I cannot recollect that, because there was none of them burned very long at a time; just what time it would figure up that they had been there I couldn't say.

82 Q. Did you ever see any carbon made at Centre street or see any substance carbonized?

A. No, sir.

83 Q. Did they have any means of carbonizing materials at Centre street?

A. No, sir.

84 Q. Was the charcoal furnace that you mentioned at all adapted for carbonizing?

A. No, sir; it was a plumber's furnace.

296 85 Q. Was there any fireplace in the room?

A. No, sir.

86 Q. How was the room heated?

A. Steam pipes.

87 Q. When you moved from Centre street to the corner of Howard and Centre what did you do there?

A. They were experimenting there on distribution. I think my brother got up a switch there and all gases for the lamps.

88 Q. Were the carbons used at the corner of Howard and Centre streets any different from the carbons used at Centre street?

A. I don't think so.

89 Q. Have you any recollection of any other carbon being used than the hard or retort carbon?

A. No, sir.

90 Q. You moved from Howard street to the corner of Walker and Elm streets, I believe, did you not?

A. Yes, sir.

91 Q. How much of the time that your brother was at Walker street were you with him?

A. I was there continually from early morning to late at night. In fact, as long as there was any one there.

92 Q. What was your employment there specially?

A. I took care of the engine there, and boiler, and ran errands.

93 Q. What machinery had they there? I mean mechanic's machinery.

A. They had a lathe.

94 Q. How many lathes?

A. One or two, and a grinding stone I think.

95 Q. Did they have any special apparatus for electrical experiments?

A. Well, they had a kind of chemical set there.

96 Q. At the shop at Walker and Elm street, how often was Mr. Man present, and what did he do?

A. He was present almost every day. Sometimes he remained for an hour, sometimes he would be there quite a while. Seeing to his own business—that occupied a great deal of his time.

297 97 Q. What class of carbon was used in the lamps at Walker street?

A. I think we got the French carbon then, but I will not be sure—I think we had a few sticks of the French carbon, but retort carbon was our principal one.

98 Q. What kind of gas, if any, was in the lamps?

A. We charged them with nitrogen gas and the vacuums.

99 Q. How much of a vacuum did you get in any of the lamps?

A. I think my brother used to claim that there was only one per cent. air left in the globes.

100 Q. What success did you have with the lamps when they had any vacuum instead of being filled with gas?

A. I don't know as we really used the vacuum; I think the method of charging our lamps was, we used to exhaust and allow the gas to flow in, and exhaust and allow the gas to flow in again and obtain the vacuum, as we called it, by dilution. Whether they used an absolute vacuum or not, we called it a vacuum because there was no air.

101 Q. Do I understand that you got rid of the air and filled the lamps with gas, so that only one one-hundredth part of air would be present in the gas?

A. Yes, sir.

102 Q. Did you see any lamps in which the air was taken out and nothing put in?

A. Yes, sir.

103 Q. How long were those tried?

A. Well, I can't state just the length of time. They were never tried very long, because they never run long. The carbon was always disintegrating.

104 Q. How did these succeed as compared with other lamps? I mean the ones with the air which you have mentioned?

A. I don't think as well as those charged with nitrogen gas. You couldn't seem to get enough vacuum.

105 Q. How did you try to get the vacuum that you did get?

A. We had a fall of water from the roof of the house—
298 I don't know what they call it—water carried up to a tank in the top of the house and through its fall by another pipe it sucks air.

106 Q. Do you remember your brother working upon what he called a feeder lamp, and if so, when do you remember his first beginning to work on these?

A. I think it was at Walker and Elm streets.

107 Q. What importance did your brother attach to the feeder lamp?

A. So that the lamp would not have to be taken apart every time in order to have the carbon replaced?

108 Q. What kind of carbon was used in the feeder lamp?

A. Retort carbon.

109 Q. Did you ever know any other kind of carbon used in the feeder lamps at Walker street?

A. No, sir.

110 Q. Was any carbonizing done at Walker street?

A. I think there was some willow twigs carbonized there, that Mr. Man brought.

111 Q. Do you remember anythin*k* else being carbonized there except willow twigs?

A. No, sir.

112 Q. What did they do with these willow twigs or sticks after they carbonized them?

A. Worked them down into the shape that they wished them, but it strikes me they never amounted to anything because they were of too high resistance for our machine, the machine would not accumulate upon them, they didn't seem to be dense enough.

113 Q. How did they work as compared with the hard carbons?

A. I can't recollect that, but not as well.

114 Q. What was the shape of these willow carbons when you used them?

A. They made them in different shapes.

115 Q. Just tell us the different shapes?

A. They were generally a straight round pencil about that length (witness indicates about three-quarters of an inch distance between his fingers).

299 116 Q. How many of these twigs do you remember being actually used in any of the lamps?

A. I can't remember how many.

117 Q. Were there many or few?

A. Few.

118 Q. Did they keep on using these willow twigs?

A. No, sir.

119 Q. What did they do after they ceased to use the willow twigs?

A. They experimented continually on different forms of carbon—different shapes—different forms of lamps.

120 Q. Was this use of willow carbon experimental, or did they make any considerable number of lamps or use any considerable amount of time with the willow carbon?

A. No, sir.

Objected by the counsel for complainant on the ground that the witness is not in the position to know.

121 Q. What means of knowledge had you of the extent of the use of the willow carbons at Walker street, as you have testified?

A. Why, from seeing them put into the lamps and the lamps run.

122 Q. Could the lamps have been run without your knowledge at Walker street?

A. No, sir; not more than, maybe, half an hour at a time; not more than that.

123 Q. With the exception of the French, or retort carbon, and the willow carbon, do you remember any other kind of carbon being used at Walker street in the lamps?

A. No, sir; I remember they tried to obtain other carbons, but they met with no success.

124 Q. Just state what you mean by their trying to obtain other carbons.

A. They tried to permeate blotting paper with the lead or plumbago of a lead pencil, and then heat them up with the machine and carbonize them, which cannot be done, as a plating machine would not accumulate on a thing of such high resistance. 300

125 Q. Did you ever see carbonized paper used in a lamp at Walker street, or at Centre street?

A. No, sir.

126 Q. I don't know whether I have asked you whether you ever saw a willow carbon, or any vegetable carbon, there at Walker, or Centre street, of an arched or horseshoe shape?

A. Yes, there were carbons worked into that shape there. One in particular, I know we had. Whether we had more than one that was set up at the time, I do not know; I think we did, but I know of this one. At the time of the Edison publication of the horseshoe lamp, it was taken down and placed in the hands of the New York "Tribune" people—I think it was the "Tribune," it was some newspaper or other—but that was of hard carbon worked into that shape.

The reason this was done was on account of diffusing the light, so that it would show a larger light—the incandescent part of the carbon will show a great deal larger. I only saw this at Walker street, I didn't see it at Centre street. I thought you were talking of Walker and Elm streets.

127 Q. Did you ever see any lamp with vegetable carbon or paper carbon having the arched or horseshoe shape?

A. No, sir.

128 Q. Were these carbons you have mentioned treated, or were they used untreated?

A. Generally treated.

129 Q. What do you mean by treated?

A. Immersed in some hydrocarbon oil, or in a hydrocarbon gas—illuminating gas.

130 Q. What was then done?

A. Immersed in that, and heated up to a state of incandescence.

131 Q. Do you know your brother's habits, as to applying for letters patent for inventions he made?

A. He was very prompt if he had the money. If he had an invention, he always was very sure to raise the money as soon as he could, to obtain the patent.

301 132 Q. Who drew up the most of his specifications?

A. Himself.

133 Q. What were his means during the time he was in Centre street and Walker street.

A. I guess they were rather limited, except what money he obtained from Mr. Man. I used to get a check once a week from Mr. Man to pay expenses.

134 Q. Did you ever know of his not applying for a patent, because he hadn't the money to apply for it?

A. No, sir.

135 Q. Did your brother at any time prior to the Edison publication in the "New York Herald" ever speak to you of paper carbon, or vegetable fibrous carbons of any kind as being important, or in any special degree useful?

A. No, sir.

136 Q. To your knowledge what carbon did he rely upon in the series of experiments you have mentioned?

A. Carbon of a very low resistance.

137 Q. What kind of material?

A. Well, carbon.

138 Q. Was it French retort, or the vegetable, or paper?

A. About all we knew anything about was the retort carbon.

139 Q. Coming down to the "Herald" publication of Sunday, December 21st, 1879, describing the invention of Edison electric lamp with the carbon horseshoe burner, did you read that article?

A. I did.

140 Q. When?

A. The same morning.

141 Q. Did your brother read it to your knowledge?

A. He did.

142 Q. What did he say in regard to that article?

A. He didn't believe it at all, it couldn't be done. There was nothing to it.

143 Q. Have you read a printed letter in the New York December 22d, 1879, which bears your brother's name, in r Mr. Edison's invention?

A. I have.

302 144 Q. Did you have any conversation with your as to what is stated in that letter?

A. No, sir; except what he had stated in it. I heard him e himself at different times about the challenge he made and th believed that he was perfectly right doing it, that he had a thing and nothing of the kind could be done.

145 Q. How many times did your brother talk in this way you about Mr. Edison's invention?

A. He never talked to me personally; generally there was my father in the office and also one of the other workmen, or Mr. Church. He would express himself to the party, not to me personally.

146 Q. Did you hear him talk this way more than once?

A. Oh, yes.

147 Q. Did your brother ever say anything to you as to whether he wrote that letter published in the "Sun," or not?

A. I know he wrote it.

148 Q. How do you know?

A. It was written by a person in Henry Darley's saloon, corner of Walker and Elm streets.

149 Q. Who dictated the letter?

A. My brother. My brother was on a little jamboree at that time, or nervous so that he couldn't write himself.

149 Q. Did you read a letter bearing the signature of your brother, published in the "New York Herald," December 24th, to which I call your attention?

(Counsel reads to witness letter referred to.) Do you remember that letter?

A. I remember that letter—yes, sir. That lamp was made at 94 Walker street.

150 Q. You mean the lamp mentioned in the letter, do you?

A. Yes, sir. That is, the carbon that was placed in the lamp, the globe may not have been made there, but the arched-shaped carbon was made at 94 Walker street.

303 151 Q. Do you know whether your brother wrote the letter published over his signature in the "Herald" of December 24th, to which I have just called your attention?

A. Yes, sir.

152 Q. Did he ever have any conversation with you or in your presence with regard to that letter, or the statements in it?

A. No, sir; but if I am not mistaken, I took that lamp and deposited it myself—put it in the hands of the "New York Tribune," not with Arnoux & Hochhausen.

153 Q. Is that the lamp that you have mentioned before as having an arch-shape carbon?

A. Yes, sir.

154 Q. Did your brother state to you his object in sending that

A. —o show that he had had the horseshoe shape, which he be-
part of
“A. I
—as the only thing that Edison was after—the shape of the

“31 . Did your brother say anything to you about any impor-
of the
e attached to the material of the burner?

“A. No, sir.

“3 Q. What was your brother doing at that time, if anything,
n the feeder lamp?

Th A. He was continually experimenting, writing at his desk, figur-
ing at his office.

157 Q. Did you read, at about the time of its publication, a letter over your brother's signature published in the "Herald" January 4th, 1884?

Counsel reads from page 455 of the printed record of complainant's exhibits in the suit of The Consolidated Electric Light Company against The Edison Electric Light Company (Exhibit B, taken from the "Herald" of January 5th, 1880).

—. Do you remember that letter?

A. I do, sir.

158 Q. Do you know whether your brother wrote
304 the letter as it was published in the "Herald" over his signature?

A. Yes, sir; I believe it was published the same as he wrote it; I have no means of knowing differently.

159 Q. Did your brother ever speak to you about writing the letter?

A. I think I was with him when he wrote the letter. I was with him mostly continuously. After he left the office, after his supper, I was at his house continually until bedtime, then I went home.

160 Q. What did your brother say as regards Mr. Edison's claims or statements as to his success with the carbon burner in his lamp?

A. Why, he never believed it.

161 Q. About this time did you see any of the Edison lamps, or see the illumination of any of the Edison lamps?

A. Yes, sir. I passed Menlo park—I think my brother sent me out there to ride by to see; how far I rode I don't remember, I think to Monmouth Junction. When I came home I told him they were burning at the park when I went and also when I came back. Then he said, they had made arrangements and started and stopped them at train time.

162 Q. I don't quite understand about starting and stopping them at train time; what did your brother say as to that?

A. He said that they started the lamps when a train would be due, and after it passed put them out; that is, they were not burned continuously.

163 Q. What did your brother say to you as to Mr. Edison's claim that he had carbonized a thin thread and that he had made a lamp in which such a thread was used as a burner?

A. He laughed at it.

164 Q. Why did he laugh at it?

A. Horse hair they called it at first.

165 Q. Do you remember a book entitled "Sawyer on E

Lighting" purporting to have been written by your brother

A. "Sawyer on Electric Lighting and Incandescence

305 166 Q. Yes, sir.

A. Yes, sir.

167 Q. Do you know whether your brother wrote that book?

A. He did.

168 Q. Going back to the exhibitions of the lamps at Centre street and again at Walker street, you testified substantially that when the visitors had gone the lamps would be turned out and the carbons, if necessary, changed?

A. Yes, sir.

169 Q. What representations, if any, did your brother make to the visitors as to the life of the lamps?

A. Well, that they would in a practical shape last forever.

170 Q. Was Mr. Man or Mr. Myers in a position to know how long the lamps actually burned?

A. Mr. Myers was not with us at Centre street.

171 Q. I mean, while he was with you at any time, was he or Mr. Man in a position to know how long a lamp actually burned?

A. Mr. Man was not; Mr. Myers was more so than Mr. Man. Mr. Myers lived out of town and was not there quite so long as the rest of us. Mr. Man was not in a position to know.

172 Q. What representations would your brother make to Mr. Man or Mr. Myers as to the lamps burning continuously?

A. Favorable.

173 Q. Did the statements that he made to Mr. Man represent the facts or not?

A. Sometimes they represented the facts, but very often they did not.

174 Q. What do you mean by "very often they did not"?

A. Well, that very often they did not represent the facts. He told about lamps running such a length of time when they hadn't.

175 Q. Did your brother ever state what his object was in making these statements to Mr. Man?

A. No, sir.

306 176 Q. You have stated that you have previously testified in the interference case, please state how you came to testify in that case.

A. That was at Mr. Broadnax's office, was it not?

177 Q. Yes, sir; I mean in the interference proceedings between Sawyer & Man and Thomas A. Edison on the paper carbons?

A. I was told I should come down there and remember this and that, that was all I would have to do; I should be questioned a little; that is all. I think I was not asked more than six or seven questions before I was out. I was cautioned what to say and what to say.

Q. Who gave you these cautions as to what to say and not to part of

"A. I think my brother.

"31 Q. Did Mr. Man speak to you as to the testimony you should of the

"A. Often.

"3 Q. What did he ask you with regard to your testimony?

A. Well, not with regard to the testimony I should give, but he Then tried to convince me that such and such was the case.

181 Q. Did your brother try to convince you also that such and such was the case?

A. No, sir.

182 Q. You stated that you were at present at the Mitchell house for medical treatment; please state how you came here and who is paying the expenses of your stay and medical attendance at this house?

A. Mr. Russell met me at Leighton, Penn., some months ago and found me in a very low condition. I told him I was not getting proper medical treatment, and that if I could go to New York and see a prominent doctor there and have a change of climate, it would be beneficial to me. He said he would see that it was done. I understand, in fact I know, that the Edison Electric Light Company is paying the expenses of my time here and medical attendance—not time, but medical attendance.

307 183 Q. You mean that they are paying all your expenses here in New York?

A. All my expenses here and my medical attendance.

As this testimony in direct has been taken in short-hand, by consent, and it being impossible for the typewriter to give counsel a copy for some time, the further examination of the witness is adjourned until to-morrow, February 21, 1889, at eleven o'clock a. m., at the same place.

MITCHELL HOUSE, 42D ST. AND B'WAY,
NEW YORK, *February* 21, 1889.

Met pursuant to adjournment.
Present, same counsel and parties as before.

Direct examination of GEORGE W. SAWYER continued by Mr. GRIFFIN:

184 Q. In your answer to the 99th question yesterday you stated that you thought your brother used to claim that there was only one-hundredth per cent. air left in the globes; what do you mean by that; how much air did you understand your brother to claim was left in the globes?

A. Well, now, I think it was that way, one-hundredth per cent., as he stated it.

185 Q. What do you mean by that?

A. One one-hundredth.

186 Q. Do you mean by that one one-hundredth part?

A. Of the entire contents of the globe was air. One o dredth—I wouldn't be sure which, now.

187 Q. When did your brother's experiments at Walker a streets end?

A. I think some time in 1879, just which date I can't now lect.

308 188 Q. What was the occasion or reason of the ex ments ending?

A. I think there was some trouble with the company, or that company hadn't the facilities for carrying out the work ther They took it to Ansonia.

189 Q. Did Mr. Man continue with your brother at Ansonia?

A. I don't recollect of Mr. Man ever being at Ansonia. I went up there before my brother two or three days, and took some lamps and other paraphernalia along.

190 Q. What class of work was your brother engaged on at Ansonia?

A. Mostly in winding and rewinding the Wallace-Farmer machine.

191 Q. Were there any experiments made on lamps, that you remember, at Ansonia by your brother?

A. Not while we were there; not while I was there.

192 Q. How long were you there with your brother, to your recollection?

A. It is a very hard thing for me to recollect now.

193 Q. Was it three months or six months, or a year?

A. No, sir; it was not—I don't think it was three months.

194 Q. Do you remember your brother making any further experiments on lamps after you gave up at the corner of Walker and Elm streets, up to the time of the publication of the Edison article in the "New York Herald"?

A. No, sir.

Cross-examination by Mr. BROADNAX, solicitor and of counsel for the complainant:

195 X Q. How did you come to be a witness on behalf of the Edison Electric Light Company in this case?

A. Through my own free will.

196 X Q. Who asked you to be a witness first?

A. I think Mr. Russell.

197 X Q. Who is Mr. Russell?

309 A. He is a gentleman that I have known for six or seven years.

198 X Q. Know him intimately?

A. Well, not very intimately; at the same time we are very friendly.

199 X Q. Was he a friend, also, of your brother, William E. Sawyer?

A. Not that I know of, sir.

200 X Q. Where was Mr. Russell when he asked you to become witness in this case, and where were you?

A. I met Mr. Russell first in New York.

X Q. When?

A. It must have been, anyway, six or seven years ago.

X Q. He didn't ask you then to be a witness in this case, of the ?

A. We were talking electric lights, and such and such goings on.

3 X Q. You said you met Mr. Russell at Lehighton?

. This last time, yes, sir.

204 X Q. How did you happen to meet Mr. Russell there?

A. I sent for Mr. Russell.

205 X Q. You sent for Mr. Russell?

A. Yes, sir.

206 X Q. By letter?

A. By letter.

207 X Q. Have you a copy of the letter you wrote to Mr. Russell?

A. No, sir, I have not.

208 X Q. Have you got the letter yourself?

A. No, sir.

209 X Q. Do you know where the letter is?

A. I don't know as I do now, because letters are something that I kept no record of whatever.

210 X Q. Why did you send for Mr. Russell?

A. On account of being in straitened circumstances, and wishing to see if I couldn't be benefited in some way or other, and knowing that he was a friend of mine, and probably could help me.

211 X Q. Did you say anything to him then about being a witness in this case?

A. No, sir.

212 X Q. Did he say anything to you about it?

A. No, sir.

213 X Q. When did he first speak to you about becoming a witness?

A. I cannot recollect.

214 X Q. What did he say to you?

A. I cannot recollect that—the words.

215 X Q. Can you give me any idea what Mr. Russell said to you when he asked you to be a witness here?

A. No, sir; but I think it was voluntary on my part.

216 X Q. In volunteering to be a witness, what did you say to him?

A. I cannot recollect the exact words, sir.

217 X Q. Give the substance of it?

A. I don't know as I could give the substance of it.

218 X Q. What arrangements did you make with Mr. Russell about testifying?

A. No arrangements whatever.

219 X Q. You came without making any arrangements?

A. Yes, sir.

220 X Q. Was Mr. Russell acting on behalf of the Edison Electric Light Company?

A. I couldn't say

221 X Q. He didn't say anything to you, then, about tes [illegible] on behalf of the Edison Electric Light Company?

A. No, sir.

222 X Q. You just came here of your own motion?

A. I came here to obtain better medical treatment than [illegible] receiving at the place where I was.

223 X Q. And you made no arrangements with him at [illegible] time, when you left Lehighton, about testifying in this case?

A. No, sir. None whatever.

224 X Q. When did you first make your arrangements with him about testifying in this case?

A. I cannot recollect, sir.

311 225 X Q. About how long was it?

A. I cannot recollect the exact time; it is impossible for me to remember.

226 X Q. I didn't ask you to state the exact time.

A. I cannot recollect any time to state a positive time when it was; I might say ten years ago, which it couldn't have been, and I might say it was five years, which it might have been.

227 X Q. Was it five years ago when you made the arrangements?

A. It might have been five years ago.

228 X Q. When you made your arrangements to testify in this case?

A. It might have been five years ago.

229 X Q. Was there any case pending then?

A. Not that I know of, sir.

230 X Q. Then it could scarcely have been five years ago?

A. I think it was all of five years ago, anyway.

231 X Q. Since you agreed to testify for the Edison Company?

A. Since I may have said anything that I could tell them that would help justice along, I was willing to do.

232 X Q. Did you tell them that?

A. I think I told Mr. Russell that.

233 X Q. Who did you tell that to—Mr. Russell?

A. I think so; yes, sir.

234 X Q. You have testified that the Edison Electric Light Company are paying your expenses here. How does that company happen to be paying your expenses?

A. I don't know; Mr. Russell said that he would try and make arrangements so that he would raise enough money to have me have the proper medical treatment here.

235 X Q. And he made the arrangements with the Edison Electric Company?

A. He made the arrangements, and since then I have ascertained myself that it was that company that were paying for my medical attendance and expenses.

312 236 X Q. And you don't know why they are paying your expenses?

No, sir, I do not.

X Q. Mr. Russell has never told you anything about that?

o, sir.

Q. And yet you are here testifying for them, and they are your expenses?

es. sir.

X Q. And you have no knowledge as to how you came to be to testify?

. Why, I think I clearly stated that I came here for proper medtreatment.

240 X Q. You came here for medical treatment, but you are here testifying for the Edison Electric Light Company and they are paying your expenses?

A. I can't see as that should signify anything.

241 X Q. That to your mind doesn't seem to signify anything, as I understand you?

—. ——.

242 X Q. Did you have any consultation with Mr. Edison's lawyers previous to your coming here?

A. No, sir.

243 X Q. Never saw any of them before?

A. No, sir.

244 X Q. All your consultations were with Mr. Russell?

A. Yes, sir.

245 X Q. Did you make an affidavit in this case before you came here?

A. No, sir.

246 X Q. Did you make one after you came here?

A. No, sir.

247 X Q. Did you make any affidavit in this case at all?

A. No, sir.

248 X Q. Did you make any statement in writing, or did you make any statement that was taken down in writing by any one about the case?

A. No, sir.

313 Counsel for the defendants states that he thinks the witness does not understand the question; that he probably refers to his coming the last time.

Counsel for the complainants states that he refers to his coming at any time.

The WITNESS: I was under the impression that you meant since I came here for this medical treatment; I supposed you were talking about the last time.

249 X Q. How did the gentlemen who examined you yesterday get a long typewritten statement from which he conducted your examination?

A. That, I think, was from a statement that I made some five years ago.

250 X Q. Where was that statement made?

A. In New York.

251 X Q. To whom?

A. To Mr. Tomlinson, I think.

252 X Q. Counsel for the Edison Company?

A. I don't know whether he was counsel for the Edison Co or not. I was not well acquainted with any of these parties

253 X Q. Whereabouts were you when you made these ments?

A. I think at their place in South Fifth avenue, or Fifth av wherever the company's place is. I cannot recollect now; n Fourteenth street.

254 X Q. Do you mean to be understood as saying that you mad your arrangements to testify in this case with Mr. Tomlinson, five years ago?

A. I merely made a statement of facts that I knew; made no arrangements to ever testify in it.

255 X Q. Did you have no understanding with Mr. Tomlinson that you would testify to the facts that you gave to him for his client?

A. When I told him that I knew those facts, I said I would make them known at any time that they wished me to; that is all the answer I should consider that required.

314 256 X Q. What did Mr. Tomlinson give you for the certificate you made to him at that time?

A. Nothing, sir.

257 X Q. Did he make any arrangements to give you anything?

A. I think my expenses were paid while I was here in New York; that, I believe, was all.

258 X Q. Who brought you here at that time to make that statement to Mr. Tomlinson; I mean at whose request did you come here?

A. On my own request, first, until I met Mr. Russell.

259 X Q. Did you go and see Mr. Tomlinson of your own motion?

A. No, sir; I was in straitened circumstances, myself.

260 X Q. And you went to see Mr. Tomlinson to get money?

A. No, sir; I didn't see Mr. Tomlinson at all; I saw Mr. Russell.

261 X Q. Did Mr. Russell help you out of your straitened circumstances?

A. Yes, sir.

261½ X Q Who furnished the money?

A. I couldn't state who furnished the money.

262 X Q. What is Mr. Russell's name in full?

A. James; that is all that I know of. He has a middle letter, but I don't remember now just what it is. James A., I think; I wouldn't be sure, though.

263 X Q. When did you say you made his acquaintance first?

A. When did I say I made his acquaintance first?

264 X Q. Yes.

A. It might have been five or six years ago; I think it was all of that.

265 X Q. Was that the time you had your first interview with Mr. Tomlinson?

A. No, sir; I had met Mr. Russell before, long before that.

Q. Was Mr. Russell in the employment of the Edison Electric Light Company?

A. That I couldn't say. I never knew whom he was employed by.

X Q. Did you make your arrangements with Mr. Russell, or the arrangements made for your interview with Mr. Tomlin- through Mr. Russell?

A. Through Mr. Russell?

268 X Q. Through Mr. Russell?

A. Yes, sir; through Mr. Russell.

269 X Q. How was that brought about?

A. I couldn't say.

270 X Q. Did Mr. Russell first see you about having an interview with Mr. Tomlinson?

A. No, sir; I first saw Mr. Russell, not about having an interview with Mr. Tomlinson personally, but with the Edison Company.

271 X Q. What was said between you and Mr. Russell at the time of that conversation?

A. It is so long ago that I cannot recollect now.

272 X Q. What was the substance of your interview?

A. I couldn't state.

273 X Q. Cannot you state what was said that brought you to testify, or to make your statement to Mr. Tomlinson?

A. No, sir.

274 X Q. Why did you go to see Mr. Russell, and where did you go to see him?

A. I think I have already stated that I went to see Mr. Tomlinson or Mr. Russell because I was in straightened circumstances and wanted to see whether I could raise a little money for myself—borrow it from him, or if he could borrow it from somewheres for me.

275 X Q. And did he borrow it from somebody for you?

A. I don't know whether he borrowed it or not. What I wanted I got—the small sum that I wanted.

276 X Q. How much was it?

A. I will not state.

277 X Q. Do you refuse to state how much?

A. That was a matter of private business of my own; I don't think it concerns this case in any way at all.

316 278 X Q. You are not the judge of that; we are the judges of that. You will please to answer my question—state how much?

A. It may have been $100; it may have been less or it may have been more.

279 X Q. How much was it, as matter of fact?

A. I cannot recollect the exact sum.

280 X Q. State as near as you can recollect.

A. I have.

281 X Q. You cannot state the amount?

A. No, sir; I cannot.

282 X Q. You cannot state it approximately?

A. I cannot.

283 X Q. Is your testimony which you have given now cordance with the statement you made to Mr. Tomlinson time?

A. I don't understand you, Mr. Broadnax.

284 X Q. Is the testimony which you gave yesterday and to- so far, in accordance with the statement you made to Mr. Toml son some four or five years ago?

A. I think so.

Before closing the examination of this witness, counsel for the complainant ask the question whether the book which was shown the witness and identified by him, but not submitted to counsel for the complainant, is to be offered in evidence, and an opportunity given to examine this witness in regard to the same, both as to the writing which he has identified, and as to his possession, and as to the nature of the contents.

Defendant's counsel says, that the book is marked for identification only, and refers the complainant's counsel to the record, whereby it will appear that no question as to the contents, and no proof as to the accuracy or truth of the contents was asked or required from the witness, but simply an identification of the contents, whatever they may be, as being in the handwriting of the witness' brother, William E. Sawyer.

317 Counsel for the complainants object to questions 3 to 7, as incompetent, unless the book is offered in evidence and the witness submitted to cross-examination, and they give notice to the counsel for the defendants, that in view of the refusal to produce the book and permit examination of the witness in regard to the writing which he has identified in reference to certain pages, as well as in reference to the contents of the book, and his possession of it, that at 10 o'clock on Saturday, February 23d, a motion will be made before the court, in Pittsburgh, to strike out so much of the testimony of this witness as relates to said book.

285 X Q. You have stated that you were examined as a witness in the interference between Thomas A. Edison, on the one side, and Sawyer and Man on the other; have you read your deposition in that case recently?

A. No, sir.

286 X Q. Has it been read to you?

A. No, sir.

287 X Q. Do you know what you testified to in that case?

A. I think I can recollect pretty well, but I won't be sure that I can; it is so long ago; I know it took place in your office and was very short.

288 X Q. I find your deposition in that case printed among the exhibits in the case between The Consolidated Electric Light Company, complainant, and The Edison Electric Light Company and Thomas A. Edison, defendants, pending in the United States circuit court for the southern district of New York, and numbered 3553,
-position being as follows:
part of
"A. I rge W. Sawyer, a witness called on behalf of Sawyer and
"31 ing duly sworn, and interrogated by Mr. Broadnax, testi-
of the follows:
"A.
"32 Q. What is your name, age, residence and occupation?
"A. My name is George W. Sawyer; am twenty-three
Th years of age; reside at Earle's hotel; my occupation is working for the Eastern Electric Manufacturing Company.

"2 Q. Please state where you were employed during the months of October, November and December, 1878.

"A. 94 Walker street, by the Electro-Dynamic Light Company.

"3 Q. State whether you are acquainted with Wm. E. Sawyer and Albon Man.

"A. I am, with both of them.

"4 Q. State what relation you are to either of them, if any.

"A. Brother of Wm. E. Sawyer.

"5 Q. State whether or not, during that time you were employed at 94 Walker street, you saw there in operation what is known as the Sawyer and Man electric lamp.

"A. I did.

"6 Q. State what your duties were at the works of the Electro-Dynamic Light Company at 94 Walker street.

"A. Employed to take care of the boiler and engine and operate them.

"7 Q. State whether or not, during the time you were employed there, you saw Mr. William E. Sawyer or Albon May carbonize any paper for the purpose of making carbon burners for their electric lamp.

"A. Yes.

"8 Q. Which of them?

"A. Mr. Man.

"9 Q. Who assisted Mr. Man?

"—. Edwin L. Meyers.

"10 Q. Where is Edwin L. Meyers?

"A. Dead, I believe.

"11 Q. How did Mr. Man corbonize the paper?

"A. By first cutting the paper to the proper shape; then put it in the retort made of fire-clay or graphite; one was made of fire-clay and one of graphite; put it in the boiler furnace and made it red hot; then took it out and let it cool gradually; then took the carbons out and used them in the lamp. 319

"12 Q. Did you see him put them in the lamps?

"A. Yes.

"13 Q. Which month was it you saw them do this?

"A. In the latter part of October, and in the months of November and December.

"14 Q. What shape was the retort?

"A. One, I believe, was three-cornered, and one was round; was about five or six inches long; they put the papers in the retort and then filled up with powdered carbon.

"15 Q. How many lamps did you see them put these carb

"A. A number of them. I could not say how many.

"16 Q. Did you see those paper carbons illuminated in the

"A. Yes.

"17 Q. How long were they illuminated?

"A. I can't say how long; I did not pay any especial atte to that.

"18 Q. State, as near as you can recollect, how long you had be at work at 94 Water street before you saw Mr. Man carbonizin paper as you have stated?

"A. Very shortly after we moved there; how long I cannot say.

"19 Q. Was it a week or two weeks?

"A. Think it was about a week; it is very shortly after we moved there.

"20 Q. Did you see Mr. Man or your brother, Wm. E. Sawyer, making, or causing to be made, any carbonized paper for burners for their electric lamps at any other place besides 94 Walker street, and if so, where?

"A. I think at 43 Centre street, in April or March.

"21 Q. Were you employed at 43 Centre street?

"A. Yes, sir.

"22 Q. In what capacity?

"A. As an errand boy.

"23 Q. Did you see them carbonize the paper?

"A. No, sir.

320 "24 Q. Did you see the paper after it was carbonized there?

"A. Yes.

"25 Q. How do you know that the paper was made of carbon?

"A. They laid it on the table, and I was told they were carbonized paper.

"26 Q. Who told you they were carbonized paper?

"A. My brother, Wm. E. Sawyer.

"28 Q. Did you see any of these carbon burners that your brother told you were made of carbonized paper used in the electric lamps at 43 Centre street?

"A. We had several lamps in use there, but I don't know whether the carbons used in the lamps were made of paper or not.

"28 Q. Was it at the time that your brother, W. E. Sawyer and Albon Man were experimenting with their lamps at 43 Centre street that your brother told you that the carbons were made of carbonized paper?

"A. Yes, sir.

"Cross-examination by Mr. DYER, of counsel for Mr. Edison:

"29 X Q. Then you do not know of your own knowledge that any carbonized-paper conductors were made at 43 Centre street?

"A. No, sir.

"30 X Q. Where was the boiler-room at 94 Walker street—what part of the building?

"A. In the northwest corner of the workshop.

"31 X Q. Was all the carbonizing done there done in the furnace of the boiler?

"A. Yes, all that was done in the shop.

"32 X Q. Were other things carbonized besides paper?

"A. Yes.

"33 X Q. What other things?

"A. Willor twigs.

"34 X Q. Anything else?

"A. Not that I remember.

321 "35 X Q. What was the proportion of the paper to the twigs?

"A. Could not say.

"36 X Q. How far away from where you were working were the materials prepared for carbonization?

"A. Perhaps twenty feet.

"37 X Q. Did you see any paper packed in retorts for carbonization at that shop?

"A. Yes.

"38 X Q. Who packed it?

"A. Mr. Man, and Mr. Edwin L. Meyers.

"Redirect examination by Mr. BROADNAX:

"39 Re-D. Q. State, if you recollect, what kind of paper was used for carbonization?

"A. Paper that looked like blotting paper.

"GEORGE W. S. SAWYER."

Q. Did you give that testimony?

A. I testified in the interference case at Mr. Broadnax's office, and what you have quoted is my testimony in that case.

Counsel for complainant request and demand that defendant's counsel furnish them with a copy of the statement made by the witness to Mr. Tomlinson, as stated by him in his deposition, four or five years ago, and upon which they examined the witness upon his examination-in-chief, in full sight of the counsel for the complainants.

It is consented between counsel that the examiner, Mr. Farnham, may sign the witness' name to the deposition.

GEORGE W. SAWYER.

Sworn to before me,

WILLIAM T. FARNHAM.

[L. S.] *Notary Public, County and State of New York.*

I hereby certify that the name of the witness, George W. Sawyer, was signed by me pursuant to the consent hereinbefore entered on the record.

WILLIAM T. FARNHAM,
Notary Public, County & State of New York.

322 I, William T. Farnham, a notary public in and
county of New York, in the State of New York, do
certify that the annexed deposition of George W. Sawyer wa
before me in the cause now pending undetermined in the
court of the United States for the western district of Pennsy
on the equity side of said court, wherein The Consolidated El
Light Company is complainant and McKeesport Light Compa
defendant, on the part of the defendant; that said deposition
taken under the notices hereto annexed at the time and place there
named and was continued from day to day as appears in said deposition, until concluded; that the parties to the cause named in the caption of said notices were present at the taking of said deposition, the said complainant by its counsel Amos Broadnax and Thomas B. Kerr and by Albon Man and the said defendant by its counsel Richard N. Dyer and Walter K. Griffin, as therein appears; that before deposing said Sawyer was by me first duly cautioned and sworn to tell the truth, the whole truth and nothing but the truth in said cause above named; that said deposition was reduced to writing by Mary F. Seymour and William C. Huson, who acted as amanuenses for me by consent of said counsel; that the signature of the witness to the deposition was waived by consent of counsel present for the respective parties and it was consented between said counsel at the close of said deposition that I subscribe the same with the name of the witness; that I did so subscribe the witness' name to the deposition; that the notice under which said deposition was taken was due and reasonable notice and was given by the party taking it to the solicitors for the complainant and stated the name of the witness, the time and place of taking the deposition and the reasons for taking it *de bene esse*; that said witness lived at the time of taking his deposition at the city of New York, a place distant more than one hundred miles from the place of trial of the cause above named; that said witness was very infirm at the time of taking his deposition and has since died, his death occurring Feb-
323 ruary 25th, 1889, about 2.30 o'clock a. m., as appears to me by a certificate thereof hereto annexed of the health department of the city of New York; that said witness was examined on the direct examination by Walter K. Griffin, Esq., on behalf of the defendants, and was cross-examined by Amos Broadnax, Esq., on behalf of the complainants.

I have retained the said deposition in my possession for the purpose of forwarding the same to the United States circuit court for the western district of Pennsylvania, the court for which the same was taken.

That I am not of counsel for either of the parties to the cause or interested directly or indirectly in the event of the cause.

In testimony whereof, I have hereunto set my hand and seal this 29th day of March, 1889.

WILLIAM T. FARNHAM,
[L. S.] *Notary Public, County and State of New York.*

nited States Circuit Court, Western District of Pennsylvania.

ONSOLIDATED ELECTRIC LIGHT COMPANY
against
ME McKEESPORT LIGHT COMPANY.
In Equity. No. 5. May Term, 1888. On Letters Patent 317,676.

Thomas B. Kerr, Esq., 32 Nassau street, New York city, N. Y.:

Take notice, that on Saturday, the 23d of February, 1889, at the office of Messrs. Dyer & Seely, No. 40 Wall street, in the city of New York, at 11 o'clock in the forenoon of that day, counsel for defendant will proceed to put in defendant's testimony and proofs under the order of the court herein, dated February 18th, 1889, and will continue from time to time by adjournment until they have fin d putting in such proofs and testimony as they may wish to adduce under said order. Complainant's counsel are invited to be present.

RICH'D N. DYER,
Of Counsel for the Defendant.

Dated New York, February 21st, 1889.

Receipt of copy acknowledged Thursday, February 21, 1889, 4.25 p. m.

T. B. KERR,
Compl't's Solicitor.

325 United States Circuit Court, Western District of Pennsylvania.

THE CONSOLIDATED ELECTRIC LIGHT COMPANY
against
THE McKEESPORT LIGHT COMPANY.
In Equity. No. 5. May Term, 1888.

Proofs taken in behalf of defendant before William T. Farnham, special examiner herein, under the orders of the court dated respectively February 18th and 21st, 1889.

NEW YORK, *February 23d*, 1889.

Met pursuant to notice.

Present: R. N. Dyer, Esq., and Walter K. Griffin, Esq., on behalf of defendant, and Amos Broadnax and L. E. Curtis, Esqs., on behalf of complainant.

JOHN M. D. KEATING, being duly called and sworn on behalf of defendants, testifies as follows:

1 Q. What is your name, age, residence and occupation and how long have you been in such occupation?

A. John M. D. Keating; age, about sixty-eight years; I r

Harlem, New York city. I am and for forty years or mo

been a machinist model-maker doing business all the while

city of New York.

326 2 Q. Did you do any work for Wm. E. Sawyer dur

time he was at 43 Centre street, New York, in the sp

1878, and if so please state the class of work you did for him.

A. Well, the class was general experimenting on a varie

things.

3 Q. How frequently to your best recollection were you in

shop or workroom in Centre street?

A. Occasionally, just when I was called for; sometimes he would have something for me to do and would send for me.

4 Q. Had you known Mr. Sawyer before he was at 43 Centre street?

A. I think I did because I knew him before I commenced to do anything for him.

5 Q. Were you in Mr. Sawyer's shop at any other times than when you went in after work or jobs?

A. Occasionally, yes.

6 Q. Did you ever call on him at the shop socially?

A. Yes, sir.

7 Q. How often?

A. I could not say; just when convenient.

8 Q. When Mr. Sawyer moved to 94 Walker street were you ever in his shop there?

A. At the corner of Elm? Yes.

9 Q. How often?

A. When I had occasion to go there on business and sometimes socially.

10 Q. Do you remember their moving there; if so, what fact caused you specially to remember it?

A. The fact that I was about locating myself elsewhere, and I thought that would be a good location—in the same building—I thought.

11 Q. Have you a mechanic's shop of your own, and did you have this at the time you knew Mr. Sawyer?

A. I have been in business for the last thirty-five or forty years, as I stated before. I had a shop stock of tools and everything for the business.

327 12 Q. How often would you be around to Sawyer's shop in Walker street; was it once a day or once a week, or how often?

A. Sometimes once a day; sometimes twice a day if I went in the morning; then again probably once or twice during the week. I was not there every day once or twice a day; you must understand me.

13 Q. How long would you stay in the shop on your visit?

A. Long enough to get my order for the work they wanted me to do.

14 Q. Did you ever stay there socially; if so, how long?

A. I would frequently drop in socially; would probably stay a
" 30 S r.
part of Did you ever see any of their lamps either at Centre street
"A. I alker street alight and burning; if so, how often?
" 31 ly one—once, a short time.
of the Did you ever ask to see the lamps burning?
"A. did.
" 32 Q. What answer did you get?
It was not convenient, or if I could call in some other time.
That is all I could get. That is the answer I got.

18 Q. What were your personal relations with the Sawyers outside of your work for them?

A. Nothing but that I was acquainted with the old gentleman—that's all—his father.

19 Q. Have you any knowledge in any way of what the Sawyers used inside of their lamps?

A. I did not.

20 Q. Had you any knowledge as to whether they used carbon of any kind?

A. , sir; I have my ideas that they must have used carbon, that they h to have carbon of some sort.

21 Q. I understand that you don't know anything about the kind of carbon?

A. No, sir.

22 Q. How many places of business have you had since the year 1879 up to the present?

328 A. Well, I don't think I have changed my place of business more than four or five times since I begun in business for myself.

23 Q. Where was your place of business at the time you were doing work for the Sawyers?

A. That is a question I can't answer without I refer back to my receipts to show where my location was.

24 Q. Was your name in the New York Directory?

A. John M. D. Keating. My name has always been in the directory since I have been in business up to the present time.

25 Q. Are you a man well known in the trade in the city of New York?

A. Very well in my line of business.

26 Q. Has there been any difficulty in finding you or your place of business?

A. Not if people are intelligent enough to read the directory.

27 Q. Were you well known amongst the machinists in the neighborhood of your shop from time to time?

A. Yes, sir.

Cross-examination by Mr. Broadnax:

28 X Q. What, if any, knowledge have you of the science of electricity?

A. Very little; only see the results; that is all.

29 X Q. What do you mean by your last answer?

A. Not being familiar with electricity.

30 X Q. What, if any, industrial application did you ev
of electricity?

A. Only to fill orders from customers for parts and parcels
class of work as experiments principally. I don't know an
of the principles of electricity, not being familiar with the p
ples.

31 X Q. Do you mean that you as a mechanic have merely m
different mechanical devices according to the directions of others
be used by them for different purposes in electrical apparatus?

A. Yes, that is correct.

329 32 X Q. What kind of jobs did you do for Mr. Sawyer?

A. A variety of little traps. I made a variety of little traps for him.

33 X Q. Do you know Albon Man?

A. Partially; I am not particularly acquainted with him. I think I have done a little work for him; I forget what it was.

34 X Q. Did you ever see Albon Man around the shop, at 43 Centre street or 94 Walker street?

A. I don't remember of ever seeing him there, only at his office, where he was agent for the Lorillard estate or some estate. I think so; I feel certain this was in Mercer street.

35 X Q. Did you go there to see Mr. Man at his office?

A. I did.

36 X Q. What took you there?

A. To deliver a little piece of work and get my money—that's all.

37 X Q. What was the piece of work?

A. That I could not state.

38 X Q. Was it a piece of work you had made for Mr. Man, or a piece of work you had made for Mr. Sawyer or by his direction?

A. I do not know about that. It may have been something for Mr. Man's private affairs, but I don't know what it was.

39 X Q. How intimately were you acquainted with Mr. Sawyer?

A. Only socially.

40 X Q. Did you visit his house?

A. No, sir.

41 X Q. Do you mean that you only met him occasionally in a social way?

A. When called upon to do some work for him. I never made it a business to run after him. I would call in and say, "Well, Mr. Sawyer, any work to do?" And Mr. Sawyer would say, "Perhaps I may have a little drawing for you to-morrow."

330 Redirect:

42 Re-D. Q. Did Mr. Sawyer inform you whether any of the work you did for him was for electrical purposes?

A Only to my own judgment and observation; seeing that he
“30 Xing on lamps, I was in no way inquisitive about his
part of
“A. I D. Q. What kind of an outfit did the Sawyers have, at
“31 Street I mean; was it a large or a small outfit of tools? What
of the remember seeing in the shop as to the tools and ma-
“A. ?
“32According to the general appearance of the place the facilities
quite limited to do any kind of extensive business. The tools
Th quite limited, perhaps one or two small foot lathes at that time
en I was there—when I called there.

44 Re-D. Q. What means of power, if any?

A. They had—all I saw there was a small upright engine and boiler about, as I should judge, from four to six horse power.

45 Re-D. Q. Do you remember about the size of the room at Walker street?

A. I should judge about fifteen feet wide, about eighteen feet wide, perhaps twenty-five or thirty feet deep—long. The boiler and engine stood in a small recess off from the room in one corner.

Recross:

46 Re-X Q. Did the shop consist of two rooms or one?

A. Well, now, that's a question—I don't know. They had a small partition in the main room—probably about six or eight feet high. Whether this makes two rooms of it is a question.

47 Re-X Q. Wasn't there a front room right on the corner of Walker and Elm streets and then, in addition, wasn't there a back room siding on Elm street, and wasn't there a door leading from one room into the other—from the front room into the back room?

331 A. I think there was, where they had the tools to work in there so as not to have it appear so in the front office.

48 Re-X Q. Was not most of the mechanical work done in the back room?

A. I presume so, as I did not go in there.

49 Re-X Q. Was not the boiler and engine set in a hallway partitioned off of the back room?

A. I couldn't say; it was off that room on the side—a sort of recess. It was not in the main room, anyway.

JOHN M. D. KEATING.

Sworn to before me.

[L. S.]

WILLIAM FARNHAM,
Special Examiner, Notary Public.

It is stipulated between counsel that a copy of the foregoing deposition, certified as correct by the examiner, may be filed and used

Cross-examination by Mr. BROADNAX:

28 X Q. What, if any, knowledge have you of the science of electricity?

A. Very little; only see the results; that is all.

29 X Q. What do you mean by your last answer?

A. Not being familiar with electricity.

30 X Q. What, if any, industrial application did you ev of electricity?

A. Only to fill orders from customers for parts and parcels class of work as experiments principally. I don't know an of the principles of electricity, not being familiar with the p ples.

31 X Q. Do you mean that you as a mechanic have merely m different mechanical devices according to the directions of others be used by them for different purposes in electrical apparatus?

A. Yes, that is correct.

329 32 X Q. What kind of jobs did you do for Mr. Sawyer?

A. A variety of little traps. I made a variety of little traps for him.

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A. Partially; I am not particularly acquainted with him. I think I have done a little work for him; I forget what it was.

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JOHN M. D. KEATING.

Sworn to before me.

[L. S.]

WILLIAM FARNHAM,
Special Examiner, Notary Public.

It is stipulated between counsel that a copy of the foregoing deposition, certified as correct by the examiner, may be filed and used by the defendants, The Edison Electric Light Co. and Thomas A. Edison, in the suit pending in the southern district of New York, between the complainant herein and said defendants, with the same force and effect as if said deposition had been taken in said suit before one of the standing examiners of the court.

Adjourned till Monday, the 25th inst., at 11 a. m.

MONDAY, *February 25th*, 1889—11

Met pursuant to adjournment.

Present, counsel as before, and the taking of testimony was adjourned till 2 p. m. of the same day.

332 MONDAY, *February 25th*, 1889—2 p.

Met pursuant to adjournment.

Present, counsel as before, and the taking of testimony herein wa adjourned till to-morrow (Tuesday), the 26th inst., at 2 o'clock p. m.

NEW YORK, *February* 26, 1889.

Met pursuant to adjournment.

Present: R. N. Dyer and E. H. Rogers, Esq., for defendant, and L. E. Curtis and T. B. Kerr, Esquires, for complainant, also present Albon Man, Esq.

WILLIAM HOCHHAUSEN, a witness, subpœnaed on behalf of defendant, and duly sworn, testifies as follows:

1 Q. What is your name, age, residence and occupation?

A. William Hochhausen, 48 years of age; I reside in Brooklyn; I am at present superintendent electrician of the Excelsior Electric Light Co.

2 Q. How long have you been connected with electrical enterprises as an electrician?

A. Since the year 1858, with an intermission of two years; there were three years; 1864, 1865, and 1866.

3 Q. What was your business connection in 1878?

A. I carried on the business of making electrical machines with Anthony Arnoux, who had become my partner in December, 1877.

4 Q. You were a member of the firm of Arnoux & Hochhausen?

A. I was.

5 Q. Were you actively engaged in the manufacturing business of that concern?

A. I was.

6 Q. How long was that business continued under your management?

A. Till December 31st, 1880.

7 Q. Where was the shop of that firm located during the years 1878, 1879, and 1880?

333 A. Till May, 1878, our shop was at the corner of Reade and Centre streets; in May, 1878, we moved to the corner of Howard and Centre; we stayed in this place till May, 1880, and then moved to Twentieth street, between Second and Third avenues; I don't recollect the number.

8 Q. Were you, in 1878, acquainted with William Edward Sawyer and Albon Man, the inventors named in the patent in suit?

A. Yes; I was.

9 Q. When did you first know them?

I became acquainted with Mr. Sawyer when he had some busi-
A. I the Coal and Iron Exchange, in connection with Mr. Schuy-
63 Q it was in 1877; Mr. Man, I became acquainted with in 1878;
A. I it was in May.
them . Where did you meet Mr. Man?
heard orner of Howard and Centre.

Q. That is, at the shop of Arnoux & Hochhausen?

339 Or perhaps in a room which Mr. Sawyer occupied in the same ilding.

12 Q. Were you acquainted with the fact that Mr. Sawyer was working on experiments relating to electric lamps at any time during 1878?

A. I was.

13 Q. Where were these experiments being conducted, if you recollect?

A. At 43 Centre street, the latter part of February or the beginning of March, and after May 1st, in the building corner of Howard and Centre.

14 Q. Did you know of the fact that after leaving Howard and Centre street the work was continued by Mr. Sawyer in a shop at the corner of Walker and Elm street?

A. I do know that. I have been there several times during the time they were experimenting there.

15 Q. Why do you fix the date that Sawyer was at 43 Centre street as in the latter part of February or the beginning of March. Might it not have been a somewhat later date?

334 Objected to as leading, and the constant reference to Sawyer alone in the questions of counsel is objected to as an attempt to betray the witness into separating unconsciously the experiments of Sawyer from those of Mr. Man, his joint inventor of the invention of the patent in suit.

Counsel for defendant suggests that the statement made by counsel for complainant in the presence of the witness is hardly proper. He disclaims any intention of misleading the witness and proposes to give the witness full opportunity to state what he knows of Mr. Man's connection with the experiments.

A. We had a machine at 43 Centre street for the purpose of adjusting electric lamps and electric lights in general. We placed it in the engine-room of this building the beginning of February and took it out about the middle of March. During this time Mr. Sawyer used the current of this machine repeatedly for his experiments.

16 Q. How have you ascertained the date when you removed that machine from 43 Centre street?

A. From memory.

17 Q. You have not consulted the books of Arnoux & Hochhausen in order to fix the date exactly?

A. I have not; nor would I need it.

18 Q. When Sawyer's shop was at the corner of Howard and Centre, in which building, I have understood you, your own sho was, how often did you go into Sawyer's shop?

A. Quite frequently.

19 Q. How near together were the two shops?

A. Sawyer's shop was right below our own office.

20 Q. Did Sawyer or any of the workmen make use of you at that time?

A. Yes, they did.

21 Q. To what extent, and how frequently?

A. They got permission from us, probably for a mone
335 consideration. As Mr. Arnoux managed the finances, I don
recollect what was paid. They used part of our shop as a workshop for several months, but not every day during the time.

22 Q. Do you mean that they had this permission while their shop was adjoining yours?

A. Yes; their own shop was too small to accommodate several men.

23 Q. What do you mean by the statement that they used your shop?

A. They used some of our tools and shop room.

24 Q. Did they have a separate part of your shop, or did they simply use your tools on your regular benches?

A. They used a certain corner of our shop, but it was not partitioned off.

25 Q. Who went in there, to work in your shop?

A. Chiefly Mr. Sawyer's father.

26 Q. Do you recollect any other workman?

A. Yes.

27 Q. Who was it?

A. I don't know his name. He wasn't there long.

28 Q. Any other that you recollect?

A. Sawyer's brother was in repeatedly. He was not actually working there.

29 Q. Do you recollect the brother's name?

A. Not this minute. I can't think of his name just this minute. Of course, I know it very well.

30 Q. Was it not George Sawyer?

A. Yes, that's so; George.

37 Q. What was the character of work that was done by Sawyer's father and the other workmen, whose names you do not call to mind, in your shop?

A. They made parts of incandescent lamps.

32 Q. Do you recollect what these parts were?

A. Carbons, clamps for the same, and the conductors leading to these clamps, also lamp bottoms.

33 Q. What was the kind of work done on carbons that you recollect, in your shop?

A. Chiefly forming their cylindrical sticks, also some flat curved plates V-shaped.

34 Q. How were these sticks and plates formed?

336 A. Chiefly of gas-retort carbon.

35 Q. What was done with the gas-retort carbon in form-
A. I sticks and plates?
63 Qieces were cut off with a saw from a lump of gas carbon
A. I were got to the proper shape by filing and sandpapering.
them a. This cutting and sandpapering of the carbons was the
heard ter of work, as I understand it, that you saw done in your
on carbons?
339 jected to as improper and leading.
Question withdrawn.)

37 Q. What other kind of work, if any, did you see them do in your shop on carbons?

A. I saw them making clamping blocks.

38 Q. How were these made?

A. They were also filed into shape.

39 Q. What kind of carbon were these blocks made from?

A. Gas-retort carbon.

40 Q. Did you see them cutting and filing any other kinds of carbon in your shop, either for burners or clamps?

A. No.

41 Q. Did you see any other work done on carbons in your shop, except the filing and cutting of burners and clamps from gas-retort carbon?

A. No.

42 Q. When Sawyer's shop was at 43 Centre street, how often did you visit the shop?

A. Probably six times.

43 Q. During that time did Sawyer or anybody connected with him visit your shop?

A. Yes.

44 Q. Who were the people, and how often did they come?

A. I can recollect but Mr. Sawyer and a certain Mr. Hays. Mr. Hays paid a bill; that is how I recollect his name.

45 Q. Was he an old man or a young man?

A. An old man, I think.

337 46 Q. How often did Sawyer come to your shop during the time he was at 43 Centre street?

A. Repeatedly.

47 Q. Did he do any work or make any experiments at your shop during that time?

A. Once he did something which might be called an experiment. He lighted an incandescent lamp using the current from a dynamo which I had wound specially for a nickel-plater in Wooster street.

48 Q. What did he do at other visits to your shop?

A. During one visit he ordered a machine. At another time he requested us to alter the speed of the dynamo which was running at 43 Centre street. Besides that we talked about electric lighting in general during his visits.

49 Q. When you visited his shop, did you also discuss electric lighting matters with him?

A. Yes.

50 Q. Did these discussions between you and Mr. Sawy
tinue after Sawyer's shop was moved to Howard and Centre s

A. Yes.

51 Q. And also after Sawyer's shop was moved to Walk
Elm.

A. I have seen Mr. Sawyer very seldom after he moved to W
and Elm.

52 Q. Did he not call upon you occasionally after that time?

A. He did, but not often.

53 Q. Did Sawyer have any work done at your shop while h
was at Walker and Elm upon electric lamps?

A. No.

54 Q. On the occasions that you met Sawyer while his shop was at Walker and Elm, did you not continue with him your discussions as to electric lighting?

A. Yes.

55 Q. Have you made any inventions relating to electric lighting yourself, if so, how long have you been at work on that general subject?

A. I have taken out a number of patents for electric light-
338 ing devices. I made my first dynamo for electric lighting in 1875.

56 Q. Did you see any of Sawyer's electric lamps and carbons during the time that he occupied any of the three shops that have been referred to?

A. I have seen some.

57 Q. How often did you see them?

A. A few dozen times, probably.

58 Q. Did you see any carbon or carbon burners in his shops during this time?

A. Yes.

59 Q. What kind of carbons did you see there?

A. Mostly straight pencils, also some V-shaped carbons.

60 Q. Did you see any of the rough material from which these carbon burners were made?

A. Yes; I have seen a lamp of gas-retort carbon, to which I have referred in a former answer as having seen it in the building corner of Howard and Centre. I have also seen a lot of French carbons, each one being one meter long and one millimeter in cross-section.

61 Q. What was the character of these French carbons, if you know, and whose make were they?

A. They were either Gaudouin's or Carre's. I thought they were Gaudouin's. As far as I know these carbons were made up by mixing powdered carbon of good quality with some adhesive substance, squeezing that substance through a die and drying and baking.

These formed sticks afterwards. Gaudouin kept his way of manufacturing carbons a secret.

62 Q. With the exception of these French carbon pencils and the block of gas-retort carbon, what other kind of rough material for making carbon burners did you see at Sawyer's shop at any time?

A. I have seen charcoal pencils.

63 Q. Where did you see the charcoal pencils?

A. I have certainly seen them in Walker street. I think I saw them also at 43 Centre street. If I have not seen them there I have heard Mr. Sawyer talk about charcoal pencils which he proposed to treat in olive oil, to deposit bone carbon on them.

339 64 Q. What was it Mr. Sawyer told you about charcoal pencils?

A. Either that he had made them or was going to make them.

65 Q. How make them?

A. File a piece of charcoal down thin, put the two ends in the clamps, to which wires were fastened, immerse them then in olive oil and heat them to incandescence while in the oil by the passage of an electric current.

66 Q. Was this all he said to you about the charcoal pencils?

A. That is all I recollect at present.

67 Q. Do you recollect seeing yourself any charcoal pencils made into burners for Sawyer's lamps?

A. I am not sure of that. I have seen lamps burning which were said to contain such carbons, but I can't say for certain whether they did or not.

68 Q. When were you told that any such lamps had the charcoal pencils?

A. I think I heard of it at first during the latter part of Sawyer's stay at 43 Centre street.

69 Q. Did you ever see any carbonized-paper burners at any of the shops occupied by Sawyer?

A. Not that I am aware of.

70 Q. Did you ever hear of such burners during the time that Sawyer was carrying on his experiments?

A. He may have mentioned it, but I do not recollect it; I had a conversation with him once about incandescent light conductors, and mentioned to him that the superintendent of a gas company had come to me in 1877 with a lamp containing a strip of asbestos cloth impregnated with carbon which he requested me to bring to incandescence by electric currents; did not have at that time a machine developing sufficient electro-motive force to bring the strip to incandescence, as the resistance was very high, and as the party could not spare the money to have a proper machine built, his scheme was dropped, as I suppose. We also spoke of another incandescent lamp, the incandescent body being composed of 340 kaolin impregnated with carbon. Kaolin is a kind of clay. At that time he may have spoken of paper carbons.

71 Q. Do you recollect that he did speak of paper carbons?

A. I heard him speak later on of paper carbons, I mean in later years. So that I should be afraid to state that I heard it at the time mentioned, as my recollection might be influenced by what I heard afterwards.

72 Q. What do you mean by "later years," as to time?

A. The year 1879, for instance.

73 Q. Do you mean after or before it was known that Mr. Edison was using paper carbon in his lamps?

A. It was probably after Edison published something about lamps.

74 Q. Did you understand generally what was used in the made by Mr. Sawyer at the time you saw them at his shops?

Objected to as incompetent.

A. As far as I understand, the majority of lamps contained artificial carbon, a carbon made of the residue of gas retorts.

75 Q. How many of Sawyer's lamps did you see at any of his shops containing burners of gas-retort carbon?

Objected to by Mr. Kerr as incompetent. I don't understand that the witness has testified of his own knowledge what kind of carbon was inside of the lamps.

A. I have no positive knowledge about the nature of the burners in the lamps which I saw lighted.

76 Q. How about the lamps that were not lighted which you saw?

A. I have seen very few indeed, in the shop besides those which were on exhibition, and of those I am not positive what kind of carbon they contained.

341 77 Q. What is your best recollection as to the character of carbon contained in the lamps which you did see and examine?

A. It is that most of them either contained carbons made of the residue of gas retorts or the French carbon pencils spoken of in a former answer.

78 Q. Do you recollect seeing at the time of its publication the article in the "New York Herald" of December 21, 1879, of which I show you a copy? (Counsel shows witness the copy already in evidence.)

A. I do.

79 Q. Do you recollect any published replies to this article purporting to come from Mr. Sawyer?

A. I do.

80 Q. Do you recollect an article in the "New York Herald" of December 24, 1879 (counsel reads to witness Exhibit A, page 453 of complainant's exhibits, in the suit of the complainant *vs.* The Edison Electric Light Co. *et al.*, pending in the southern district of New York, case No. 3553)?

A. I do.

81 Q. Is the statement contained in the publication as to a lamp being put in the hands of Messrs. Arnoux and Hochhausen true?

A. It is true. The lamp was placed in the hands of my partner, Mr. Arnoux, by Mr. W. E. Sawyer himself.

82 Q. What became of the lamp?

A. A day or two after it was placed in Mr. Arnoux's hands, either Mr. W. E. Sawyer himself, or his brother, called on Mr. Arnoux, and both went out with the lamp to take it to some newspaper office, to the "Tribune," I think.

Q. Did Mr. Sawyer say anything to you as to whether he had
A. I the letter in the "Herald" of December 24, 1879, which I
63 Q lready read to you?
A. I Iis signature was under the letter so I understood it was
them a by him. So far as I know he has not denied having
heard n the letter.

339 oss-examination by Mr. KERR:

84 X Q. How soon after the publication of the "Herald" 42 article of December 21, 1879, did Sawyer bring you the lamp?

A. At an early hour the next morning.

85 X Q. What did he say to you?

A. He did not speak to me directly. He spoke to my partner, Mr. Arnoux. Mr. Arnoux was in the office close to the entrance. I was in the next room. The door was open, so I heard what was said. He was quite excited; said he wanted to deposit the lamp which anticipated Edison into the hands of an unbiased party—a disinterested party so that he would be able to prove that the lamp was made before this article was published. That was the drift of his conversation.

86 X Q. Please state particularly any words he used?

A. I don't think it possible for anybody to remember the words which were made use of in any conversation which took place even only a few years ago. One does not listen to the words but to the sense.

87 X Q. Did he say what kind of a carbon was in that lamp?

A. As he claimed the lamp to be an anticipation of the lamp which Edison describes in his article I infer that it must be a lamp just as the one described in that article.

88 X Q. Didn't he in fact say that that lamp had a paper carbon in it?

A. He may have said so, but I do not know; I do not recollect that.

89 X Q. Did you examime the lamp?

A. Yes; not very closely. It had a V-shaped carbon, flat and very thin.

90 X Q. Did it look like a paper carbon?

A. I did not have any experience at that time in such matters, so I could not tell. If I could see it now I would be able to tell.

91 X Q. Didn't Sawyer say something about Edison's having stolen the invention?

A. I don't recollect any such statement.

92 X Q. Did he say when that lamp was made?

A. A long time prior to the day he brought it to us.

343 93 X Q. Did he say anything about paper carbons at that interview?

A. I should think he did, as he spoke about this "Herald" article.

94 X Q. Did he say anything about his having used paper carbons?

A. I am not sure that he did.

95 X Q. Did he say anything about his having used ve
carbons or fibrous carbons?

A. I knew long ago that he professed to have made veg
fibrous carbons.

96 X Q. I now show you the drawing of the patent in su
ask you if the lamp he brought to Mr. Arnoux was like that

A. It was, in general appearance, except that the carb
sketched far too thick there. The width is all right. I refe
figure 4 of the drawing shown me.

97 X Q. To what occasion in 1879 did you refer in answer
question 72, as being the time when Sawyer spoke to you abou
paper carbons?

A. To the time he brought this lamp to Mr. Arnoux.

98 X Q. Was there no other occasion in 1879?

A. I cannot point out any just now.

99 X Q. When was it that Sawyer professed to have made vegetable fibrous carbons and where?

A. As I stated before, he spoke about treating willow charcoal in oil—charcoal pencils are made of willow—I have always understood it so; I may be incorrect about that, as I stated before; it was in 1878, during his stay at 43 Centre street.

100 X Q. Did he speak of treating willow charcoal?

Counsel asks that the word willow be underscored.

A. Yes; he spoke of that.

101 X Q. Did he say that was what he meant by vegetable fibrous carbon?

344 Objected to because the witness has not stated that Mr. Sawyer used the words vegetable or fibrous carbon, but that he talked of treating willow carbons, which the witness in his previous answers stated to be vegetable fibrous carbon.

Counsel for complainant suggests that the statement of counsel for defendant would be more correct if he would bear in mind the witness' answer 95.

A. He relied on the fibre as probably giving him a carbon of more durability than those made of gas-retort carbon.

102 X Q. You do not catch my question. It is, did he say that willow charcoal was what he meant by vegetable fibrous carbon?

A. He may have meant something else, for all I know.

103 X Q. Did he tell you how he carbonized the willow?

A. Yes.

104 X Q. What did he say?

A. Carbonized it in olive oil.

105 X Q. Did he mention any other method of carbonizing vegetable fibrous material?

A. I think he mentioned hydrocarbon oils—other hydrocarbon oils; I think he got the best results at that time with olive oil.

106 X Q. Did he speak to you about making the charcoal in a retort with powdered carbon around the material to be carbon-

A. I hink he did.

63 Q Q. Did he never speak to you about carbonizing paper in
A. I.?

them a may have done so, but I am not sure of it.

heard Q. Did you ever see any carbonized paper in any of the
hops you have mentioned?

339 None has been pointed out to me; I may, for aught I know.
have I was not aware of it.

)9 X Q. You are not prepared to say that there was none there.
A. No.

45 110 X Q. Are you prepared to say that none of the lamps you saw at Centre street contained paper carbons?

A. No, I could not say that they did not.

111 X Q. Are you prepared to say that none of the lamps you saw in use at Centre and Howard street- contained paper carbons?

A. No; I could not pretend to know all about their experiments and methods of making carbons.

112 X Q. Are you prepared to say that none of the lamps you saw in use at Walker and Elm streets contained paper carbons?

A. I am not prepared to say that.

113 X Q. I understand that you saw lamps in use at all three places. Is that correct?

A. That is correct.

114 X Q. How did these lamps work—well or poorly?

A. They worked very well while I saw them.

115 X Q. Did you see arch-shaped carbons at all three places in use in lamps?

A. I do not think that I saw any arch-shaped carbons in 43 Centre street, but I have seen them in the building corner of Howard and Centre and also corner of Walker and Elm.

116 X Q. How did those arch-shaped lamps work?

A. While I saw them burning they were very good lamps. I have not been there longer than perhaps from a quarter to half an hour.

117 X Q. How many lamps did you see in operation at any one time?

A. About six lamps—the largest number I have ever seen burning at any one time, both at the corner of Howard and Centre and Walker and Elm. At 43 Centre I have never seen more than four burning at the same time.

118 X Q. About how many times were you there when the lamps were burning; I mean at all three places?

A. At least twenty times.

119 X Q. Weren't you told that some of these lamps contained vegetable fibrous carbon burners?

A. Yes.

346 120 X Q. Who by?

A. E. W. Sawyer, William E. Sawyer.

121 X Q. Did he point out any particular lamp or lamps as containing any such carbon?

A. I think he did, but as the carbons were in an incandescent state I could not tell whether such statement was true or not.

122 X Q. Had you any reason to doubt it then?

A. Not particularly.

123 X Q. Can you state whether the lamps which he pointed out as containing vegetable fibrous carbons had arch-shaped burners?

A. No; I am not sure whether the carbons he pointed out were straight or arch-shaped.

124 X Q. Isn't it a fact that some were straight and some were arch-shaped?

A. Yes; some were straight and some were arch-shaped.

Adjourned till Wednesday the 27th inst., at 11 a. m.

WEDNESDAY, *Feb. 27th*, 1889.

Met pursuant to adjournment.

Present: R. N. Dyer, Esq., for defendant and Thomas B. Kerr, Esq., and L. E. Curtis, Esq., on behalf of complainant, also present Albon Man, and the examination of Mr. HOCHHAUSEN was continued as follows:

125 X Q. Under what circumstances did you become acquainted with Mr. Man?

A. He was introduced to me by Mr. Sawyer as being interested in his enterprise.

126 X Q. Where?

A. In the building corner of Howard and Centre. I had probably seen him before that time but had no knowledge that he was interested with Mr. Sawyer.

127 X Q. Did Sawyer & Man rent their shop corner Howard and Centre from Arnoux & Hochhausen?

A. They did not rent their own shop from us which was
347 below ours, but I think they rented from us shop room in
our shop.

128 X Q. When did they rent shop room from you?

A. In the early summer, the latter part of June or July.

129 X Q. Did Sawyer & Man purchase any dynamo machinery from your firm?

Objected to as not proper cross-examination, the question not being based on anything brought out by the direct.

A. They did.

130 X Q. Please state what and when?

Same objection.

A. The first dynamo bought was a machine capable of developing a current of about fifty amperes and an electro-motive force of about fifteen or twenty volts. At this time I did not know that Mr.

Man was connected with the concern. A second dynamo was purchased of a larger capacity, perhaps two and a half times the capacity of the first. The first was bought while Sawyer occupied the premises in 43 Centre street, and the second after he had moved to Walker and Elm.

131 X Q. What was the capacity of that second machine?

Same objection.

A. From fifty to sixty volts, and about the same current strength as the other.

132 X Q. Who paid for the first machine?

Same objection.

A. Mr. Hays.

133 X Q. What was his Christian name?

Same objection.

A. I don't recollect his Christian name.

348 134 X Q. Did you ever see that machine running at 43 Centre street?

Same objection.

A. I did.

135 X Q. About the second machine; who purchased that?

Same objection.

A. Mr. Man.

136 X Q. When was that machine ordered; when they were at 43 Centre street or after they had moved to Howard and Centre?

Same objection.

A. After they had moved to Howard and Centre.

137 X Q. Are you positive about that?

Same objection.

A. I am positive that we did not do any work on the second machine before we were in the building corner Howard and Centre. That makes me believe that it was not ordered before.

138 X Q. Did you ever lend them any dynamo machines?

Same objection.

A. Yes; we lent them several at different times?

139 X Q. Please state what machines you lent them, where they were located at the time, and where the machines so lent were used by them?

Same objection.

A. The first one of our machines of which they utilized the current when we did not need it ourselves was located in Centre street, 43, during the latter part of February and March.
349 After moving to the building, corner of Howard and Centre, they obtained a current from various dynamos

we had on the floor. The first machine so lent was capable of developing a current of fifty ampéres and electro-motive force of a hundred volts and over. The machines made use of by them in the building, corner of Howard and Centre, had a capacity of about eighty ampéres and fifty volts electro-motive force, our ordinary machines for the production of large single arc lights.

140 X Q. Didn't you lend them one or more machines for use in the shop, corner of Walker and Elm streets, while you were building their second dynamo?

Same objection.

A. We did.

141 X Q. How many and of what capacity?

Same objection.

A. I can think of but one. It was one of our large single arc-light machines of eighty ampéres and fifty volts.

142 X Q. Did you ever rewind any machines for them; and, so, when and why?

Same objection.

A. Yes; we rewound machines. The armature had burned out because excessive current had been developed. The first machine they bought from us was rewound, I believe, while the premises at 43 Centre street were still occupied by Mr. Sawyer. I think we rewound the same machine afterwards again when we were in the building, corner of Howard and Centre.

143 X Q. Didn't you rewind the second machine purchased by them?

Same objection.

A. I don't recollect that we did.

144 X Q. Please explain what is meant by "excessive
350 currents had been developed" in your 142d answer?

Same objection.

A. Owing to low resistance of the external circuit the development of current was abnormally large and the wires heated to such an extent that the insulation of them was charred.

145 X Q. I wish you would explain how the low resistance of the external circuit, which resulted in the burning of the machine, was obtained?

Same objection.

A. It was obtained by placing a number of incandescent lamps in parallel or derived circuit.

146 X Q. Is that the same as multiple-arc arrangement ot lamps?

Same objection.

A. Yes, sir.

147 X Q. What factor of the current was changed when the excess was developed?

Same objection.

A. The volume of the current strength.

148 X Q. Did the voltage of the current remain the same?

Same objection.

A. The voltage was very slightly altered.

149 X Q. How?

Same objection.

A. Slightly increased.

150 X Q. Did you not lend Sawyer & Man several machines for use at 43 Centre street, at different times?

Same objection.

351 A. I do not recollect having lent them other machines besides the large arc-light machine we had on the premises, 43 Centre street.

151 X Q. Do you recollect having lent them a machine which you had built for a man on Wooster street?

Same objection.

A. They had made use of this machine in our own shop, corner of Reade and Centre. I do not recollect that they ever had it at 43 Centre.

152 X Q. How large was Sawyer & Man's shop at Howard and Centre streets?

A. Probably twenty by fifteen feet.

153 X Q. Was all the work which was done in your shop by Sawyer & Man, or the workmen, work requiring mechanical tools?

A. Mostly, if screw-drivers, files, and such things answer to the term used in the question.

154 X Q. What do you mean by "mostly"? Did they do any work in your shop which did not require mechanical tools?

A. While assembling lamps certain operations are performed by the hand unaided by tools.

155 X Q. Did they assemble lamps in your shop?

A. They did.

156 X Q. What were these operations which were done by hand in assembling lamps in your shop?

A. Placing carbons between clamps for instance; placing the bottom of the globe or the glass receptacle, and similar operations.

157 X Q. Was it their custom to assemble all their lamps in your shop at Howard and Centre streets?

A. No; they had work done outside too.

158 X Q. Do you know what work they had done outside?

A. The glass-work, also most of the brass-work was done outside. Filling the lamps with gas was done in their own room in the same building.

159 X Q. Do you know whether they had a circuit run from your shop to their own room?

A. They had.

352 160 X Q. Did they get the current from your shop?

A. They did.

161 X Q. Do you know what use they put it to in their shop?

A. They lighted lamps.

162 X Q. Do you know of any other use?

A. No; I do not.

163 X Q. Isn't it your recollection that they used the current for treating carbons and other purposes?

A. They may have done so, but I do not recollect having seen it.

164 & 165 X Q. Do you recollect of having heard of their doing so?

A. I had heard of their treating carbons before that time.

166 X Q. Do you recollect that a man by the name of Miller had a room upstairs?

A. There was a firm in the building, Mueller & Neuman.

167 X Q. Do you recollect that a circuit was run from your shop up into Mueller & Neuman's room?

A. The same circuit which ran into the room occupied by Sawyer & Man was run through portions of the premises of Mueller & Neuman, as it was the handiest way to run the circuit, they occupying all of the floor below us except the room belonging to Sawyer & Man.

168 X Q. Did you ever hear of Sawyer & Man doing any work in Mueller & Neuman's room?

A. I have a faint recollection that they did.

169 X Q. What kind of work?

A. I think they used a forge there.

170 X Q. Don't you know of their having carbonized vegetable fibrous materials there?

A. I think that is what they did.

171 X Q. Do you recollect for what purpose?

Objected to on the ground that the question assumes that the witness knew of such carbonizing being done of his own knowledge, which fact does not yet appear.

353 A. To use them as the incandescing body in lamps, I suppose.

172 X Q. Did you ever see Sawyer & Man's carbonizing apparatus?

A. I do not remember that I did.

173 X Q. Was it ever described to you?

A. One process was described to me, as I have testified before.

174 X Q. I mean the apparatus for carbonizing vegetable fibre in a furnace.

A. Do you refer to the apparatus used by Sawyer?

175 X Q. Yes; by Sawyer, or Sawyer & Man.

A. I do not recollect having heard any description of such an apparatus from them. I knew how to carbonize animal or vegetable substances for quite a long time, having had occasion to use such carbons for other purposes.

176 X Q. What other purposes?

A. Making coal charcoal from leather for the purposes of case-hardening iron.

177 X Q. And do you regard that as the same thing as carbonizing the burners for incandescent lamps?

A. Just the same thing.

178 X Q. What was the shape of the leather you used, and what was its form when it came out of the carbonizing apparatus?

A. Leather such as old boots, and other refuse of leather was cut up in small pieces, placed in an iron box, which consisted sometimes of a piece of gas pipe, large pipe. If a pipe was used, both ends were closed up by discs of iron, luted with clay to keep the air out, and the whole was subjected to a strong heat for a number of hours. The carbonizing shriveled the pieces up.

179 X Q. Were the pieces packed in powdered charcoal when they were put into the box?

A. No; as there was no occasion to preserve shape, this would have been superfluous. When I answered before as to the operations resulting in the same, I meant this to cover the nature of the carbon produced, irrespective of shape.

180 X Q. Did you ever see Sawyer & Man, or either of
354 them, or any of their workmen, carbonize incandescent lamp burners?

A. While passing through Mueller & Neuman's shop for the purpose of inspecting some work which they did for us, I have seen some person or persons interested or employed by Sawyer & Man, or the Sawyer & Man electric light enterprise, working in a forge fire carbonizing something, as I now think.

181 X Q. Can you give me any description of the apparatus he was using?

A. They seemed to have a rectangular iron box in the fire.

182 X Q. Was he blowing up the fire?

A. I don't know whether he was blowing at the time, but the fire was burning.

183 X Q. Did you stop and ask him what he was doing, or have any conversation with him about it?

A. I am not certain about that.

184 X Q. Did you ever see Sawyer and Man or either of them or any of their workmen treating carbons?

A. I can't say that I did.

185 X Q. When did you first hear of them treating carbons?

A. I have answered that before. It was while Mr. Sawyer occupied the premises at 43 Centre street.

187 X Q. In answer to question 42, you say that you were in Sawyer's shop at 43 Centre St., probably six times. What were you there for?

A. Several times I went there to see him about the working of the machine he bought. A few times before this to caution him not to start circuit over electric light machine, so it should not be in danger of being burned up. Several times I took people round to the shop that inquired for him.

188 X Q. At the time you had your conversation with Sawyer when you told him about the superintendent of the gas company, isn't it your impression that Sawyer spoke to you about carbonizing paper, and was not that what led you to tell him about the superintendent of the gas company's asbestos lamp?

355 A. Such might be the case, but I could not say it was an absolute fact.

189 X Q. Well, isn't it your impression that he mentioned carbonizing paper at that time?

Objected to as leading, also as immaterial.

A. I think it is likely that he did.

190 X Q. Is Mr. Arnoux alive?

A. He is not.

191 X Q. When did he die?

A. In July, 1884.

192 X Q. Please describe the Sawyer & Man rooms at Walker and Elm streets?

A. I have seen three of their rooms. I do not know how many more they may *may* have had. They were quite large.

193 X Q. When in answer to question 116 you say, I have not been there longer than perhaps from a quarter to half an hour, do you mean altogether or at any one time?

A. I mean at any one time.

194 X Q. Did you have any conversations with Mr. Man about incandescent lamps during 1878?

A. Yes, repeatedly.

195 X Q. Did he ever say anything to you about using paper carbons in the lamps at any of those conversations?

A. I am not certain whether he did or not.

196 X Q. Did he ever say anything to you about the use of vegetable fibrous materials in the lamps during any of those conversations?

A. I had heard that they used such material. I may have heard it from either or both of them.

197 X Q. Do you remember of Mr. Man being present on one occasion when Mr. Sawyer was pointing out the lamps to you?

A. Mr. Man was generally present when I visited their rooms and very likely was present when the lamp spoken of was pointed out to me.

Adjourned till 2¾ p. m.

356 Resumed at 3¾ p. m.

198 X Q. Do you remember any occasion when you were in Sawyer & Man's shop, and Mr. Man was present and in conversation with you and Sawyer, that Sawyer pointed out one or more lamps as being lamps containing paper carbons?

A. I do not.

199 X Q. What was the business of Arnoux & Hochhausen during the years 1878 and 1879?

A. Making dynamo-electric machines, for electric lighting and electroplating purposes; also for the production of electric lights, and arc lamps for the same purposes.

Redirect examination by Mr. Dyer:

200 Re-D. Q. Did Mr. Sawyer ever speak to you about vegetable fibrous carbon in terms or did he simply mention charcoal?

A. He spoke of vegetable carbon as being a fibrous substance. He seemed to expect more strength from the fibrous nature of vegetable carbon.

201 Re-D. Q. As I understand your testimony, you have stated that Mr. Sawyer spoke of filing and cutting charcoal down to the form of a pencil and then treating charcoal pencil in olive oil. Did you understand that this was the character of the carbon in the lamp or lamps which Mr. Sawyer, you think, subsequently pointed out to you as containing the vegetable fibrous carbons?

Objected to as leading and suggestive to the witness and therefore incompetent.

A. I understood this to be the character of some of the lamps which he so pointed out to me.

202 Re-D. Q. Is it not a fact that charcoal carbons of the kind described in my last question are the only vegetable fibrous carbons of which you have any definite and certain recollection of having heard about from Sawyer & Man prior to the date of the
357 "Herald" article of December 21st, 1879, which has before been referred to?

Objected to as grossly leading and this form of examination by defendant's counsel of his own witness is protested against by the complainant's counsel.

Question withdrawn.

203 Re-D. Q. What other kind of vegetable fibrous carbon besides that described in my question 198, if any, have you any definite and certain recollection of having heard about as being used or proposed to be used by Sawyer & Man before the date of the "Herald" article of December 21, 1879, before referred to?

A. I have no definite or certain recollection of any other fibrous or vegetable carbon than the one alluded to above.

204 Re-D. Q. Are you prepared to say whether it was or was not the intention of Sawyer or Sawyer & Man to make these treated charcoal carbons in the manner described in the following statement:

"The most perfect of all these carbons were prepared by taking sticks of fine willow charcoal and first saturating the same with syrup and subjecting to heat as in the Carré process in order to increase their conductivity. The sticks were then divided into pieces one-half an inch in length and three sixty-fourths of an inch in diameter and placed between carbon-holders for treatment. Heated to extreme incandescence and surrounded by an atmosphere of hydrocarbon, the deposit described immediately formed. The pencil with shining rounded ends was then filed on one side until the original willow was exposed, but leaving the ends of the pencil untouched. The willow being next removed a pencil of boat shape and remarkable durability was obtained."

358 Objected to as incompetent and also as improper, being a cross-examination by defendant's counsel of his own witness and also as introducing new matter into the deposition on a so-called redirect examination.

A. I do not recollect having such a process described to me by either Mr. Sawyer or Mr. Man, in all its features.

205 Re-D. Q. What features of the process stated were not described to you, if any?

A. I don't remember that I ever heard anything about filing away one side of a so formed carbon until the original willow was exposed, leaving the ends of the pencil untouched, next removing the willow, leaving a pencil of boat shape of remarkable durability.

206 Re-D. Q. Did Mr. Sawyer say anything to you which would exclude the idea that he intended to use the feature of the process referred to in your last answer in forming these carbons from charcoal?

Objected to as incompetent.

A. He did not.

207 Re-D. Q. Are you prepared to say whether or not the lamp or lamps which were pointed out to you by Mr. Sawyer as having carbons made from vegetable fibrous material had such carbons formed in accordance with the process described in Re-D. Q. 201?

A. I am not prepared to say that they had or that they had not.

208 Re-D. Q. I read to you your answers to cross-questions 119 to 124, inclusive (questions and answers read to witness). Did you mean by your answer to cross-question 124 that some of the lamps that he pointed out as having vegetable fibrous carbons had such carbons in the form of an arch, or only that some of all the lamps had arch-shaped carbons?

A. That some of all the lamps had arch-shaped carbons.

209 Re-D. Q. I read to you cross-questions and answers 170 and 171 (counsel reads questions and answers). What is the process referred to by you in answer 171?

A. The treatment in olive oil.

359 210 Re-D. Q. Are Mueller & Neumann still in business; if so, where are they located?

A. They have dissolved partnership a good many years ago; I think in 1881.

211 Re-D. Q. Do you know where either of them lives or does business now?

A. Mueller went to work in machine shops afterwards. Neumann may have business of his own yet. I don't know anything about his whereabouts. No; I do not know where Mueller lives or works at present.

212 Re-D. Q. Do you recollect the Christian names of these men?

A. No; I do not think I ever heard them.

213 Re-D. Q. Is it not a fact, Mr. Hochhausen, that I called at your place of business in Brooklyn on last Saturday and asked you to state to me the facts within your recollection relating to the experiments of Sawyer & Man on electric lamps?

Objected to as not proper redirect examination.

A. Not quite that. You made some statements to me about facts brought out by witnesses who testified in this case before. You also put a few questions to me which I thought I was at liberty to answer. Having received a retainer about a year ago from the Sawyer-Man Company I thought it would not be proper for me to say very much at the time.

214 Re-D. Q. Did I call upon you afterwards, if so, state the circumstances?

A. Yes; Monday morning Mr. Dyer brought some papers and read to me portions of the contents of them and told me that he would subpœna me to appear in this case.

215 Re-D. Q. Were you then brought here by subpœna?

A. I was.

216 Re-D. Q. What do you mean by having received a retainer from the Sawyer-Man Co.?

360 A. They sent me a check which I at first returned to them as I did not have any desire to appear as witness in any case, but they sent it back to me and I accepted it.

217 Re-D. Q. How many interviews, if any, have you had with the officers or counsel of the complainant, The Consolidated Electric Light Co. or The Sawyer-Man Co., with reference to your recollection of the experiments of Sawyer & Man?

A. One interview only, which was on last Washington's birthday, Friday. This interview took place at Mr. Curtis' office at his request. I had an interview prior to the day I received that check with Mr. Broadnax. He came to me and asked me whether I would appear as witness but he did not go into details as to my recollections.

218 Re-D. Q. Who were present on Washington's birthday at the interview in Mr. Curtis' office?

A. Mr. Kerr was present during a small fraction of the time during which the interview lasted.

Recross-examination:

219 Re-X Q. Were you ever approached or interviewed in behalf of the Edison Electric Light Co. prior to Mr. Dyer's visit to you last Saturday in reference to this case or to Sawyer & Man's operations?

A. No; but I received a letter several years ago from the Edison Company, asking what electro-motive force the machine which I had at 43 Centre street in 1878 was capable of developing. I did not know at that time why they should ask such a question. I should think now that this question would seem to have some connection with this case, providing this case was commenced at that time.

Re-redirect:

220 Re-re-D. Q. Did you answer the letter of the Edison Electric Light Co.?

A. I did.

221 Re-re-D. Q. What did you say?

361 A. I told him it was capable of giving a hundred and over volts of electro-motive force.

WILLIAM HOCHHAUSEN.

Sworn to before me,
[L. S.] WILLIAM T. FARNHAM,
Notary Public and Special Examiner.

Complainant's counsel asks examiner to note the fact that Grosvenor P. Lowrey, Esq., was present during part of the afternoon session, on the part of the defendant, and the examiner so notes.

Counsel for defendant hereby requests the complainant through its counsel to produce at the next session the books and papers, and especially the minute books of the Electro-Dynamic Light Company, the assignor of the complainant.

Adjourned till Thursday, the 28th, at 11 a. m.

NEW YORK, *February* 28, 1889.

Met pursuant to adjournment.

Present—R. N. Dyer, Esq., and W. K. Griffin, Esq., for defendant, and L. E. Curtis, Esq., for complainant, and Mr. Albon Man.

Counsel for defendant asks counsel for complainant if he has present in his possession the books and papers of the Electro-Dynamic Light Company called for at the last session; if not, he is requested to state whether such books and papers are in the custody of the complainant or any of its officers or counsel, or, if not, whether any of the officers of the complainant or any of its counsel know where such books and papers are.

362 Counsel for complainant states that he has not present or in his possession, or under his control, any of the books and papers referred to, and he does not know where they are or whether any of the officers of the complainant or any of its other counsel know where such books and papers are, and that he was not present during the latter part of the proceedings herein on February 27th; that Mr. Kerr, who was present and has immediate charge of this case, is too ill to-day to attend to any business, and that he has had no opportunity to consult with him in regard to the matter.

WILLIAM SHARP, a witness called on behalf of defendants, and duly sworn, testifies as follows:

1 Q. What is your name, age, residence, and occupation?

A. William Sharp; about fifty-three years of age; was born July

31st, 1835. I live at 14 Pleasant place, Brooklyn; I am a chandelier-maker.

2 Q. Were you in the employment of Messrs. Sawyer & Man when they had their workshop at No. 2 Howard street, New York city?

A. Yes, sir.

3 Q. Prior to that time had you done any work for Mr. Man on any electrical apparatus?

A. Yes, sir.

4 Q. Where did you do it and what was it?

A. At my residence in Brooklyn; I believe that it was two lamps.

5 Q. Describe them?

A. Well, one was an enclosed glass with two holes at the bottom to put the working parts of the lamp through. They was put together at the holes with a kind of a clamp or washer, I should call it. Then it was screwed together. I can't exactly think how it was screwed together. There were two nuts on the bottom. I think I have given it all about as near as I can think of it.

6 Q. Did you make any burners for these lamps; and if so, state what they were?

363 A. I can't remember just what the burner was in that lamp.

7 Q. What was it made of?

A. Well, I can't just remember what it was. I can't just tell how it was put together.

8 Q. I do not refer to the metal parts, but to the burner or part to be lighted by electricity. What was it made of?

A. I believe that that was a cross-piece holding a pencil of carbon.

9 Q. What kind of carbon?

A. Retort; gas retort.

10 Q. What did you do to this gas-retort carbon, if anything?

A. I don't remember of putting that carbon in that lamp.

11 Q. Did you make the carbon?

A. No; I don't think I had anything to do with the carbon in that lamp.

12 Q. Did you do any work at Brooklyn on carbons for Mr. Man; if so, what was it?

A. I turned a small disk of retort carbon.

13 Q. State exactly everything you did to the carbon, from the beginning to the end?

A. I got a small piece of carbon and filed it down flat; then I turned the carbon to somewhere about a thirty-second part of an inch thick. It was turned to about a half an inch in diameter, I believe, with a hole in it about a quarter of an inch in diameter.

14 Q. Did you work on any other piece of carbon for a lamp, in Brooklyn for Mr. Man?

A. I don't believe I did.

15 Q. Was Mr. Man at any time present while you were at work on these lamps?

A. Yes, sir; he was there very frequently.

16 Q. Did he superintend your work?

A. Yes, sir.

17 Q. Where did you deliver these lamps?

A. I delivered those lamps to Mr. Man at my residence.

364 18 Q. About how long in all were you working on these lamps?

A. That I couldn't say very plainly.

19 Q. Is that all your answer?

A. Yes, sir.

20 Q. Would it be a week, or a month, or three months, or what?

A. I couldn't say. It might perhaps be a month or six weeks.

21 Q. How long after you finished your work on these lamps was it that you were first employed at Sawyer & Man's workshop at Howard street?

A. I couldn't say that for certain. It might perhaps be about a month.

22 Q. How large a room did Mr. Sawyer have at Howard street?

A. Well, at Howard street I couldn't say. We were working in a shop with other men, in the shop of Arnoux & Hochhausen.

23 Q. Did Mr. Sawyer have a room of his own?

A. He had a kind of an office there about ten foot square.

24 Q. What kind of furniture was in the office?

A. There was a desk or a table something similar to this (witness pointing to the table on which the master is writing). There was a chair.

25 Q. Was there any work-bench or tools for a workshop in the office?

A. Not that I know of, any further than a kind of gasometer they had there.

26 Q. Did you ever do any work in the office?

A. No, sir; I never done any work any further than to go down and see Mr. Sawyer one time. He wanted some one in the room in case anything might happen to the gasometer, or something similar to it, while he was working it.

27 Q. Who besides yourself did work for Sawyer & Man while you were there at Howard street?

A. Mr. William Sawyer.

28 Q. Where did he work?

A. I believe he worked on the same bench that I did. We were close together.

365 29 Q. Was this in Arnoux & Hochhausen's shop?

A. Yes, sir.

30 Q. Who supplied the tools for you to work with?

A. We used to use Arnoux & Hochhausen's tools, and the small tools was principally our own.

31 Q. Were you employed by Sawyer & Man while they were at the corner of Walker and Elm street-?

A. Yes, sir.

32 Q. How soon after they moved there were you working there?

A. I suppose about a couple of weeks after they had left Arnoux & Hochhausen's.

33 Q. During these two weeks where were you working?

A. I was working at Arnoux & Hochhausen's.

34 Q. For whom?

A. Arnoux & Hochhausen.

35 Q. After you went to Walker street, how long did you remain there at work?

A. I couldn't say how long I remained there. I remained there till they broke up the business.

36 Q. Were you employed by Mr. Sawyer after he left Walker street?

A. Well, I worked for Mr. Sawyer after Sawyer and Man dissolved, so far as I know of it.

37 Q. Where did you continue to work for Mr. Sawyer?

A. In the same room.

38 Q. And after that?

A. After that I went up to Ansonia with him. Mr. Sawyer made arrangements with the firm of Wallace & Sons, at Ansonia, Conn.

39 Q. While you were at Howard street and at Walker street, were you at work continuously from day to day or only occasionally?

A. I was working continuously from day to day.

40 Q. What were the working hours?

A. Ten hours a day.

41 Q. What rooms did Sawyer & Man have at Walker and Elm streets?

A. They had one large room partitioned off pretty near
366 the middle; one part was their office, the other part was the
workshop. There was a recess in the side where the water-closet, the boiler, and engine was.

42 Q. How many windows were there in the workshop?

A. Two.

43 Q. Were there any work-benches; if so, where were they placed?

A. There was one bench in front of the two windows and the chemist bench in the end of the room.

44 Q. Was this chemist bench at the partition end or the other end of the room?

A. The other end of the room.

45 Q. How did the chemist bench run—in what direction?

A. It run east and west.

46 Q. And the work-bench?

A. North and south.

47 Q. Who worked on the work-bench?

A. Mr. William Sawyer and myself.

48 Q. What part of the bench did you work at?

A. I worked on the north end of it.

49 Q. Was this the end near the chemical bench, or the other end?

A. Near the chemical bench.

50 Q. What machinery did Sawyer & Man have at Walker street?

A. They had a small dynamo, a lathe, a grindstone, a boiler and engine. I might say there were two vises in there.

51 Q. Who provided most of the tools?

A. Outside of the lathe and vises, we furnished our own tools pretty much.

52 Q. Was there any machinery in the office?

A. No, sir; not that I know of.

53 Q. What was in the office?

A. I don't remember anything further being there than a desk and a couple of chairs and a chandelier

54 Q. Did you ever see any work done in the office?

A. Nothing further than filing down some carbons.

55 Q. Where did you see this done?

A. On the end of the table.

367 56 Q. Who was doing it?

A. Edward Sawyer.

57 Q. What was your work at Walker street—what were you employed at?

A. Principally making parts of lamps.

58 Q. Who finished or mounted the lamps?

A. I believe I done a good part of it—towards the last part of it—put them together with Mr. Myer's assistance.

59 Q. Did you work on the burners?

A. Principally all burners, for anything I know. I can't designate any parts.

60 Q. What do you mean by "burners" in your answer?

A. I consider the whole concern a burner.

61 Q. What did you call the part which gave the light when heated up?

A. That is the carbon.

62 Q. Did you work on the carbons?

A. Sometimes I used to file them down, get them of proper length and size.

63 Q. What did you make the carbons from when you filed them?

A. The carbons that I filed on was filed from long strips of carbon in the shape of wire, ranging from about a sixteenth to somewhere about three-sixteenths in diameter.

64 Q. What was the name of these long strips?

A. I did not know that they had any name, further than that I understood that they were imported from France.

65 Q. What sort of carbon were they?

A. They were hard carbons, similar to what they burn in these arc lamps.

66 Q. How hard were they?

A. They were not quite as hard as glass, but they would break quite as easy.

67 Q. What was the shape of these long strips?

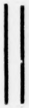
A. Round.

68 Q. Were they straight or crooked?

A. Straight.

368 69 Q. Take the pen and make a sketch of the size to which you filed down these carbons?

(Witness does so.)



A. I have done so, as above.

70 Q. How near does your sketch come to the size of the carbon?

A. I should think it would come in between the inside of one line and the outside of the other line.

71 Q. How about the length of the carbon?

A. I think the sketch is about the length as near as I can think of it.

Adjourned till 2 o'clock p. m.

Resumed at 2 o'clock p. m.

72 Q. When these carbons were put in the lamps on what did they rest?

A. They rested on a larger carbon point.

73 Q. What were these larger carbon points made of?

A. They were made of the crude carbon.

74 Q. What kind of crude carbon?

A. Gas-retort carbon, I believe it is.

75 Q. Did you see any other kind of carbon than the gas-retort carbon and the French carbon?

A. No, sir.

76 Q. Were any of the carbons made out of the gas-retort carbon?

A. Which carbons do you mean?

77 Q. I mean the pencils burnt in the lamps?

A. I can't remember whether there was any of them made out of the crude carbon or not.

78 Q. What do you remember seeing any pencils made out of?

A. I don't remember seeing them made of anything excepting that imported carbon.

369 79 Q. Did they use gas-retort carbon for any purposes; if so, what?

A. They used it for making the holders for these pencils.

80 Q. Who used to make the holders?

A. I think I used to make them principally.

81 Q. Who else?

A. I don't remember whether Wm. Sawyer had anything to do with making them or not.

82 Q. You have stated that you made a circular carbon for Mr. Man in Brooklyn. Did you make any circular carbons while working for Sawyer & Man, either at Howard or Walker street?

A. I made two or three while we was in Walker street.

83 Q. What tools or machinery did you use to make them?

A. Make them with a lathe, with a face plate and files and small turning tools.

84 Q. What was the size of these circular carbons?

A. I don't remember very distinctly, somewhere from a half inch to three-quarters.

85 Q. Was that in diameter?

A. Yes, sir.

86 Q. How thick were they?

A. About a thirty-second of an inch thick.

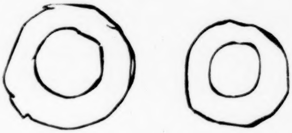
87 Q. What was the inside diameter?

A. That is something I don't distinctly remember.

88 Q. How large a tool did you use to make the hole in the centre?

A. Small hand turning tools.

89 Q. Sketch the size and shape of these carbons as finished by you as near as you can remember?



A. That is about as near as I can get at it.

90 Q. What kind of carbon were these circles made of?

370 A. They were made of retort carbon.

91 Q. What was done with these circles?

A. I don't remember what was really done with it, one was put in a lamp and the other two,—or rather there was one-half a one put in a lamp. The other two I don't know what became of them.

92 Q. What do you mean by one-half of the circle being put in a lamp?

A. They were cut in two so as to form a half circle between the two holders.

93 Q. What kind of a lamp did you see this half circle put into?

A. It was into a long tube-shape- lamp, the same as the majority of the lamps made there.

94 Q. What kind of holders were used for the half circle?

A. I think it was clamped carbon-holders.

95 Q. What were the clamps made of?

A. Retort carbon.

96 Q. How were they held in place?

A. By means of two platinum screws and nuts.

97 Q. Who made these platinum screws and nuts?

A. I did.

98 Q. Who made the lamp or lamps in which these half circles were used?

A. I think likely I must have made them.

99 Q. Were the holders for the half circle arranged differently

or the same as the holders for the straight pencils you have mentioned?

Objected to as bad in form, instructive to the witness and leading.

A. The holders to the half circles was flat clamped together with two platinum screws and nuts.

100 Q. How did this arrangement compare with the arrangement for holding the straight carbon pencils?

A. Well, in the circle carbon we had two upright clamps for the straight carbons; there was one upright round carbon and one horizontal.

371 101 Q. Could you use the half circles with the holders for the straight pencils?

A. Not very well.

102 Q. How many lamps, if any, did you see with the holders arranged for half circles?

A. Not more than one distinctly.

103 Q. Which one was that?

A. I cannot say, with the exception of that one we have just been speaking of.

104 Q. Which one do you mean?

A. The one with the upright clamps, the flat clamps.

105 Q. Did you ever see any other circles or half circles of carbon or curved or circular pieces of carbon besides the circles you have just said you made yourself?

A. No, sir; I can't remember that I have seen any.

106 Q. Did you ever see any one working on circles or half circles of any material besides yourself?

A. No, sir.

107 Q. Nor any curve or circular carbon of any kind?

A. No, sir.

108 Q. Did you ever see any of the lamps with the holders arranged for straight pencils altered over or changed in any way for circular or bent carbons?

A. No, sir; I don't know that I have.

109 Q. How near you did Mr. Sawyer, Senior, work?

A. About four or five feet—let me see—it is more than that. It was near the length of the bench.

110 Q. Was there any partition between you?

A. No, sir.

111 Q. Was his work hidden in any way?

A. No, sir.

112 Q. How far did you work from where Mr. Myers worked?

A. About three or four feet.

113 Q. Who worked on the lathe when it was used?

A. Me, principally.

114 Q. Who else?

A. I don't know that any one did. I don't remember of any one.

372 115 Q. Was Mr. Myers' work in any way hidden from you?

A. I couldn't say that it was.

116 Q. Did you ever work on the same jobs with him?

A. Well, when we was ready to seal the lamps, I used to clamp most of them together.

117 Q. What would Mr. Myers do?

A. He used to expel all the air he could get out of the glass before charging them with gas—nitrogen gas, I believe it was.

118 Q. Was there any partition of any kind in the workshop preventing one workman from seeing the work of the others?

A. No, sir.

119 Q. Did you see any attempt made to hide the work of one man from the others?

A. No, sir.

120 Q. Did you see Mr. Man at any time in the workshops?

A. Yes, sir, frequently.

121 Q. What did he do?

A. He used to come round to see whether the work was going on all right.

122 Q. How often was he there that you know of?

A. Generally every day.

123 Q. Did you ever see him doing any work?

A. Well, no work in particular. He might give some suggestions and help us to work it out.

124 Q. What do you mean by suggestions?

A. Suggest some way of making the parts for the lamps.

125 Q. Do you mean suggestions as to doing your work on the lamps?

A. I mean some suggestions as to how he wanted the work made.

126 Q. What kind of work do you remember Mr. Man giving you suggestions as to?

A. In different forms of the patterns on the parts of the lamps.

373 127 Q. Did you ever see any carbon or charcoal of any kind other than the retort carbon, and the French carbon you have mentioned at either of the workshops?

A. I have seen them file down a piece of willow charcoal—willow carbon.

128 Q. Do you know where this willow charcoal came from?

A. I bought some myself on Fulton street.

129 Q. Do you remember the shop?

A. I believe it was Reynolds'; I won't be certain, though.

130 Q. What kind of willow charcoal was it?

A. It was in the form of crayons.

131 Q. How large were the crayons?

A. About five-sixteenths of an inch in diameter about six inches long.

132 Q. What kind of store is Reynolds'?

A. Paint and artists' supplies.

133 Q. What did you see done with these charcoal crayons?

A. They were filed down to about the same dimension of the carbon pencils.

134 Q. Do you mean the carbon pencils you made a sketch of?

A. Yes, sir.

135 Q. What was done with them then?

A. There was a deposit of carbon formed over them.

136 Q. Who did this work?

A. Mr. Edward Myers was the one I saw do it.

137 Q. Did you ever see anybody else do it?

A. I don't remember seeing any one else do it.

138 Q. How did they get the deposit on the charcoal?

A. By putting it into a closed glass vessel with the gas into the vessel and electricity.

139 Q. Do you mean that they put the charcoal into the glass vessel?

A. Yes, sir; put the charcoal in between two metal points.

140 Q. How large were the charcoal crayons after the deposit had been formed upon them?

A. I should judge about an eighth of an inch thick.

374 141 Q. What did they do with these pencils next?

A. They worked the charcoal core out of the carbon.

142 Q. How was this done?

A. It was done with a piece of wire or head of a file or something. I don't remember exactly how it was done.

143 Q. How much of the charcoal was left in the pencil?

A. Mr. Myers tried to get it all out.

144 Q. Do you know whether he tried to get it all out?

A. That is the way I understood he was doing—trying to get it all out.

145 Q. Did you ever see any willow charcoal or crayons or any form of charcoal or wood carbon used in any way except in forming these pencils as you have just described?

A. No, sir; I don't remember seeing them used in any other way.

146 Q. Did you ever see any wood carbons or wood charcoal of any kind except these willow crayons which you purchased?

A. No, sir.

147 Q. Did you ever see any one at either of the workshops carbonize any material of any sort?

A. No more than willow charcoal.

148 Q. Did you ever see them try to carbonize willow so as to make into charcoal or carbon?

A. Not that I know of. I don't know what they might be trying in that line.

149 Q. Did you ever see them trying yourself?

A. Trying to make charcoal into carbon?

150 Q. I mean trying to make willow wood into willow charcoal or willow carbon?

A. No: I don't know. They might be trying that; that I wouldn't know anything about.

151 Q. Did you ever see or hear about or work on any carbon made from paper of any kind in either of the workshops?

A. No, sir; I did not.

375 152 Q. While you were at the workshops did you ever see

or work on or see anybody working on or using any carbon of any kind, made from paper of any kind?

A. No, sir.

153 Q. Did you ever hear any one saying that such carbon had been used in any way or tried to be used in any way at either of the workshops?

A. No, sir.

154 Q. When did you first see a piece of paper carbon of any kind?

A. I don't know whether I have seen any particular yet, but I saw them trying it in Ansonia, trying to form carbon out of paper. I guess somewhere about 1880.

155 Q. Whom did you see trying?

A. Mr. William Wallace and Mr. Howell, who was Mr. Wallace's electrician.

156 Q. Was this after or before Mr. Sawyer left Ansonia?

A. Afterwards.

157 Q. State the circumstances under which Mr. Wallace and Mr. Howell came to make or show you the paper carbon so far as known to you?

A. Mr. Wallace came up into the shop and said that he had read an account in the paper of Mr. Edison inventing a carbon of paper by accident, and they were trying an experiment between themselves in the shop.

Answer objected to as immaterial and incompetent.

158 Q. Did you, while you were at either of the shops of Sawyer & Man, see any one making or altering any curved or semicircular or circular carbons of any kind, except the circles of hard carbon you have testified you yourself made?

A. No, sir.

159 Q. Did you ever, during the same time, hear any talk of any kind as to using curved or circular carbons of any kind, other than the circles of hard carbon you have testified to making?

A. No, sir.

376 160 Q. About how many lamps of all kinds did Sawyer or Man have at Walker street, so far as you know?

A. Well, I don't know; they seemed to me to be pretty much all one thing; they were generallly pencil carbons—straight pencils.

161 Q. How many lamps did they have, so far as you know?

A. I don't know that I have ever seen more than about a dozen at a time.

162 Q. Do you know any time when they had more than a dozen?

A. No, sir; I do not.

163 Q. What did they do to these dozen or so lamps?

A. That I don't know. They used to have exhibitions once in awhile.

164 Q. Did you ever know of their selling any?

A. No, sir.

165 Q. Did you ever see the lamps burning?

A. Yes, sir.

166 Q. Where were they kept burning?

A. Usually in the office.

167 Q. Where else?

A. We had one one time in the shop, trying to work by it.

168 Q. Did you succeed in working by it?

A. No; it was rather too far away from us to see to work good.

169 Q. How long did that lamp burn?

A. Well, I couldn't say how long that lamp burned. It was burned several times, that lamp; it didn't burn any length of time each time.

170 Q. What is the longest you knew it to burn at one time?

A. Not more than twenty minutes to half an hour.

171 Q. What was done to it then?

A. That I couldn't say.

172 Q. What was the longest you remember to have seen any lamp burn at one time?

A. I don't think I ever saw one burn over half an hour.

377 173 Q. What, so far as you remember, was the general life of a lamp carbon burning in a lamp?

A. As far as my knowledge leads me I don't think they last more than half an hour.

174 Q. What, if anything, was done to the lamps then?

A. They would be taken apart, cleaned and set up again with new carbons.

175 Q. Did you ever work at doing this?

A. Yes, sir.

176 Q. How frequently?

A. Well, I don't know; pretty nearly every time they burnt out.

177 Q. Did you ever see any willow twigs of any description in either workshop?

A. Yes, sir; I saw them in Walker street.

178 Q. What kind of twigs were they?

A. Green willow twigs, three or four feet long.

179 Q. Where did you see them?

A. I saw them in the workshop.

180 Q. Whereabouts?

A. I think they lay in the corner near where I worked.

181 Q. What became of these twigs, so far as you know?

A. I don't know what did become of them.

182 Q. How long did you see them lying round as you have mentioned?

A. I suppose about a month or two.

183 Q. Did you see more than one lot of these twigs?

A. No, sir.

184 Q. Did you ever do any work or see any one do any work on these twigs of any description?

A. Not that I remember.

185 Q. Did you ever see any one at Walker street put anything into the boiler furnace except the coal?

A. Yes, sir; I have seen them with small crucibles with graphite or something in.

186 Q. Do you know what was in these crucibles?

A. No, sir; I do not, further than graphite.

378 187 Q. How often did you see any crucibles put in the furnace?

A. Not more than three or four times, to my knowledge.

188 Q. Did you ever see any crucibles except those you saw put under the boiler furnace at Walker street around the shop or rooms?

A. No, sir.

189 Q. Did you ever know of any of the contents of any of these crucibles being used in any of the lamps?

A. No, sir; I did not.

190 Q. Did you ever do any work on any material which you knew or were told came out of these crucibles?

A. No, sir.

191 Q. Did you ever see any one work on any of the material which came out or which you were told came out of these crucibles?

A. No, sir.

192 Q. Did you ever see anything besides this which, to your best recollection, is in any way possibly connected with manufacturing carbons of any kind at Sawyer & Man's?

A. No, sir.

Counsel for complainant requests examiner to note that Mr. Lowrey was again present at a portion of the afternoon session.

Adjourned to Friday, March 1st, at 11 a. m.

FRIDAY, *March 1st*, 1889.

Met pursuant to adjournment.

Present: R. N. Dyer, Esq., and Walter K. Griffin, Esq., for defendants, and Thomas B. Kerr, Esq., and Amos Broadnax, Esq., for complainant, and Mr. Albon Man, and the examination of Mr. SHARP was continued as follows:

379 R. N. Dyer and Walter K. Griffin, Esqs., as counsel for the defendants in the suit in the southern district of New York, between the complainant herein and the Edison Electric Light Co. and Thomas A. Edison, request of record that the testimony taken for defendant in this present suit may be used by defendants in the New York suit upon the filing of copies certified by the special examiner herein and as heretofore stipulated in regard to the deposition of J. M. D. Keating, for the purpose of saving the retaking of such testimony, and further request the counsel for complainant present for an answer of record to such request.

193 Q. Do you know for what purpose the crucibles were used?

A. No, sir; I don't know really what they was used for.

194 Q. Was Mr. Myers at work with Sawyer & Man when you first went to Walker street?

A. That I can't say for certain whether he was there when I went there or not.

195 Q. How many men were employed in Sawyer & Man's at Walker street? Name them.

A. Mr. Wm. Sawyer, George Sawyer, myself and Mr. Myers.

196 Q. How many men were employed at Howard street? Name them.

A. Two—William Sawyer and myself.

197 Q. Did you see George Sawyer at Howard street?

A. I don't remember distinctly whether I saw him there or not.

198 Q. Did William E. Sawyer work at Walker street? If so, what did you see him do?

A. Saw him treating carbons, making drawings and writing.

199 Q. Did he work at the bench?

A. I don't remember seeing him.

200 Q. Do you remember seeing him do any work at Howard street?

A. No, sir.

380 201 Q. When you were at Ansonia with William E. Sawyer what class of work was done there?

A. The class of work done in Ansonia was feeder lamps.

202 Q. What kind of a lamp was the feeder lamp?

A. The feeder lamp was a lamp with a long pencil made by reversing the current to feed the lamp into contact in case it burnt out or got broke away in any way.

203 Q. How long would a feeder lamp burn?

A. I don't remember seeing it ever burn more than half an hour.

204 Q. What kind of carbon was used in the feeder lamp?

A. A long, thin, hard carbon.

205 Q. Was it the same or different from the carbon used in the lamps at Sawyer & Man's?

A. As far as I knew it was the same kind.

206 Q. Outside of the carbon, please describe generally the lamps used by Sawyer & Man.

A. The lamps generally were a disc of metal with two upright posts. I don't know how to explain that. There was one with a kind of a bend, an L. The carbons were clamped between these two posts. The whole thing was supported by a zigzag strip of metal. This was all encased in a glass tube.

207 Q. Were the zigzag strips of metal all of the same shape in the different lamps?

A. They were, as a general thing.

208 Q. I show you a copy of the specifications of letters patent 205,144 to W. E. Sawyer and A. Man, dated June 18th, 1878, and ask you to look at the figure 1 in the drawings and state how that compares with the general style of lamp used by Sawyer & Man.

A. I remember that lamp, but I think that is the lamp that was made before the one I speak of, yet I could not say for certain whether it was one made before or after the ones I speak of. I remember having tubes in the latter ones to charge them with.

381 209 Q. I ask you to look at figure 49, on page 83 of a book marked for identification "Sawyer's Book on Electric Lighting," March 1st, 1889, and to state whether you saw any lamp at Sawyer & Man's resembling such figure.

A. Yes, sir.

210 Q. When?

A. I think, when I come to think of it, that that was the lamp that was made before the feeder lamp.

211 Q. Was this early or late in the time you were at Walker street?

A. It was late.

212 Q. Please look at figure 50, on page 85 of the same book, and state whether you recognize that figure.

A. Yes, sir; that is the general lamp that I spoke of.

213 Q. Please look at figure 51, on the same page of the same book, and state whether you recognize that figure.

A. Yes, sir; that is the latest one; the other one I am mistaken in.

214 Q. Which one were you mistaken in?

A. I am mistaken in the one 49—the figure 49.

215 Q. What mistake did you make about that figure 49?

A. I haven't any distinct recollection of that lamp. I think it is one that was made before my time.

216 Q. Look at figure 52, on page 87 of the same book, and state whether you recognize that figure.

A. Yes; I recognize that.

217 Q. Where did you see anything resembling that and what was it you saw?

A. That is the lamp I have described as having two upright posts with flat carbon clamps screwed together with platinum screws and nuts.

218 Q. Do you recognize the carbon in that figure?

A. I don't recognize the carbon as being as large as that.

219 Q. Do you mean as large as shown in the figure?

A. As large as shown in the semicircle—the semicircle in the figure.

220 Q. Were the posts or uprights for the carbon as far apart in the actual lamp you saw as in the figure?

382 A. I believe not.

221 Q. How many lamps did you ever see at Sawyer & Man's with the upright posts as shown in or as resembling figure 52?

A. One.

222 Q. Did you ever see any of the lamps resembling figures 49 or 50 or 51 altered over so that the posts in any way resembled figure 52?

A. Well, I can't say whether that one was altered over or whether it was made new.

223 Q. What kind of carbon did you see in the lamp resembling figure 52?

A. I saw retort carbon.

224 Q. How did it compare with the circles or half circles of retort you yourself made?

A. It appears to be about twice the diameter in the figure.

225 Q. What I mean is, was there any difference between the half circles that you made and the circular carbon you actually saw in the one lamp at Sawyer & Man's resembling figure 52?

A. The only difference I see is that the carbons that I turned was an equal thickness all around, an equal breadth.

226 Q. You saw a lamp at Sawyer & Man's with circular carbons you say; were the circular carbons in that lamp the same or different from the half circles of carbon you yourself made?

A. The one I saw there was the one I made.

227 Q. Look at figure 55 on page 89 of the Sawyer book and state whether you recognize that figure?

A. Yes, sir; I do.

228 Q. How do you recognize it, and what does it resemble?

A. By its general appearance.

229 Q. What does figure 55 look like?

A. That is the feeder lamp. I made that all myself—all the parts.

230 Q. Where did you make it?

A. I think I made about two of them in Walker street—Walker and Elm.

383 231 Q. Did you make any more?

A. I don't know that I made any more there.

232 Q. Did you make any more elsewhere?

A. No, sir; but the parts of one hundred.

233 Q. Where did you make these parts of one hundred feeder lamps?

A. At Wallace & Sons, Ansonia, Conn.

234 Q. Was this while Mr. Sawyer was there?

A. Yes; they were started while he was there.

235 Q. You stated that you made two of these lamps at Walker street but only made the parts of the one hundred lamps at Ansonia. What is the difference in your mind between making a lamp and making the parts.

A. I made the lamp and put it together, all but the carbons, I believe, and in Ansonia the metal parts were made by different men.

236 Q. Do you recognize figure 54 in the Sawyer book?

A. That appears to me about the same thing, there is a little difference there. I can't; I don't know whether there is any difference or not. It looks to me as if this feeder tube in the figure was a little different, otherwise I don't see but what it is the same one.

237 Q. The same one as what?

A. 55.

238 Q. Do you recognize figure 53 in the Sawyer book?

A. No, sir; I can't say that I do.

239 Q. You have given the names of the workmen at Sawyer & Man's. Besides these men and besides what Mr. W. E. Sawyer or Mr. Man may have done, did you know of any one making carbons

or doing work on carbons for Sawyer & Man, either at Howard street, or at Walker and Elm?

A. Only Mr. Myers.

Adjourned one hour for luncheon, to resume at 1¾ p. m.

384 Resumed at 1¾ p. m.

240 Q. You have spoken of refilling the lamps at Sawyer & Man's when the carbon burned out: what would you have to do to the lamps before they were ready for relighting?

A. Take them all apart, clean the parts, put new carbons in and sodium we used to put in a little in a piece of rag or cloth.

241 Q. Were the lamps recharged with gas?

A. Yes, sir.

242 Q. How long would this all take for one lamp?

A. About two or two and a half hours.

243 Q. Where was this work done in the office or the workshop, or where?

A. It was done in the workshop.

244 Q. Were there any tools or apparatus in the office for this kind of work?

A. No, sir.

245 Q. Where were all the lamps refilled with gas that you saw refilled?

A. All in the workshop.

246 Q. What part of the shop?

A. On Mr. Myers' bench.

247 Q. Where were the carbons treated?

A. They were treated on the same bench.

248 Q. What different substances have you seen them treat the carbons in?

A. I can't remember now what substances they did treat them in. It was generally oil.

249 Q. Look at figure 41 on page 71 of the Sawyer book and state how that figure compares with what you remember as to the apparatus used for treating the carbons.

A. I don't remember seeing the apparatus at all.

250 Q. How did they fix the carbons for treating?

A. They used to have two metal rods in the bottom of an old lamp, and place a carbon in one end, the upper end of it, and place the electric wires on the other and immerse the carbon end in the oil. That is about all, I believe. They used electricity.

385 251 Q. How often would the lamps be taken apart and refilled?

A. I couldn't say how often—just as soon as they would be burned out or used up.

252 Q. Did you see this refilling done frequently or seldom?

A. I used to see it about every time.

253 Q. Who used to take the lamps apart and refill and refit them?

A. Mr. Sawyer and myself used to take them apart and refit them.

Mr. Edward Myers used to do the filling. Sometimes it was done outside at Mr. Stillman's down in Broadway.

254 Q. Do you mean the refilling or the refitting?

A. Refilling.

255 Q. When a lamp was completed was it kept in the same shape or altered?

A. Well, sometimes altered, sometimes kept in the same shape.

256 Q. What alterations were they making?

A. I don't know. They might make some little difference in the shape of the carbon-holders, or some little thing of that kind.

257 Q. How often would such little alterations be made in the lamps?

A. They would be making them pretty much all the time.

258 Q. How many years have you been a mechanic, and what trade did you learn?

A. I have been working as journeyman mechanic about thirty to thirty-five years. I learned the trade of general brass-finisher.

259 Q. Did you ever know of a lamp at Sawyer & Man's which you were told by any one or which, in your judgment, was a satisfactory lamp as an electric lamp?

Objected to as incompetent.

A. Well, I can't tell exactly whether any one has told me that they had such a lamp, but I never considered that there was one.

386 260 Q. What did you consider the lamps?

Same objection.

A. I didn't consider the lamps anything more than an experiment.

261 Q. You mentioned making the parts of a hundred lamps at Wallace's. How many of these were put together, so far as you knew?

A. Well, not more than ten or twenty, at the very outside.

262 Q. What became of the lamps, so far as you know?

A. The last I saw of the lamps they were cleaning out the room and fired the lamps all out in the yard.

263 Q. Who fired them out?

A. William Wallace, Junior, I believe.

264 Q. Have you ever testified as a witness before?

A. I testified a little for a man in Brooklyn about building a house.

265 Q. Is that your only experience as a witness?

A. No, sir; that's all.

Cross-examination by Mr. Kerr:

266 X Q. How long have you been acquainted with Mr. Albon Man?

A. I should think about fifteen or sixteen years.

267 X Q. Have you known him intimately?

A. Only through business.

268 X Q. Do you believe him to be a man of truth and veracity?

Objected to as irrelevant and immaterial.

A. I do, so far as I have known him and heard of him.

269 X Q. Do you think that Mr. Man would, when testifying under oath, testify to a falsehood?

Same objection.

387 A. I should not think he would.

270 X Q. If Mr. Man should make a statement to you in regard to something which he said he did or had seen, would you believe him?

Same objection.

A. Of course I suppose I should have to if I did not know any different.

271 X Q. On March 14th, 1881, Albon Man testified in an interference case in the U. S. Patent Office, between Sawyer & Man and Thomas A. Edison, as follows:

"Early in the month of October, 1878, we prepared paper carbons in the manner I have described, by carbonization, in the furnace at the corner of Elm and Walker streets, in this city, and perfected them substantially as I have described, and used them during the month of October and the following month until the latter part of March, 1879, in electric lamps at that place, successfully, and exhibited them to great numbers of people."

Do you believe that Mr. Man was swearing to a falsehood when he gave that testimony?

Objected to as incompetent, immaterial and irrelevant and improper, especially because Mr. Man has not testified in this present suit, and because complainant's counsel, General Duncan, in open court, at Pittsburgh, made the statement to the effect that one of the objects of the form of the bill of complaint herein was to avoid the necessity of putting Albon Man on the stand on direct, and as an improper attempt to introduce alleged testimony in this suit.

A. Well, I can't say anything about that, but I can say that I have never seen or heard anything of paper carbons until a year or two after April—May—a year or two after May, 1879.

272 X Q. That is no answer to my question. Please answer my question?

388 A. That is a question I would not like to answer. I have not had sufficient dealings with Mr. Man to know for certain what he would do.

273 X Q. The question has nothing to do with your knowledge. I want you to say whether or not you believe that Mr. Man, when he gave that testimony, was swearing to a falsehood?

Same objection.

A. I tell you I don't know. I couldn't say for certain. The thing is I haven't seen it. I haven't seen it in use nor heard of it.

274 X Q. My question has nothing to do with your seeing or hearing of it. I want you to tell me whether you believe that Alben Man was swearing to a falsehood when he gave that testimony?

Same objection and as especially incompetent in view of the witness' answer.

A. That is something I don't care to answer.
275 X Q. I insist on an answer.

Same objection, and further because complainant has no right to cross-examine the witness except as to facts and circumstances connected with the examination on direct. Defendant's counsel instructs the witness not to answer the question.

A. Under advice of counsel I so refuse.
276 X Q. When you came here to give your testimony, did you know about the testimony of Mr. Man as to the manufacture and use of lamps with paper carbons at Walker and Elm streets?

Objected to as immaterial and irrelevant and because there is no testimony of Mr. Man in this case, and for the further reasons stated to cross-questions 271 to 275, inclusive.

A. No, sir.
389 277 X Q. Were you told that he had testified to any such facts?

Same objections.

A. No, sir.
278 X Q. How did you happen to come here to testify?
A. I was hunted up and brought here or invited here.
279 X Q. Well, which?
A. Invited.
280 X Q. Who by?
A. By Mr. Russell.
281 X Q. Who is he?
A. Mr. Russell is a gentleman I see around here. I don't know any more than that. He must be a kind of an agent.
282 X Q. Around where?
A. Around this office.
283 X Q. When did Mr. Russell first see you about testifying?
A. About two years and a half ago.
284 X Q. Can you fix that date exactly?
A. No, sir.
285 X Q. Why not?
A. Because I don't know it.
286 X Q. Where did you see Mr. Russell first?
A. In the office of the Ansonia Brass and Copper Company, Ansonia, Conn.
287 X Q. Were you working there?
A. No, sir.
288 X Q. How did he happen to find you there?

A. By inquiry, I suppose. I don't know how he found me there.

289 X Q. Did he tell you who gave him your address?

A. I can't say for certain, but I believe he said that George Sawyer told him I was working at Wallace's.

290 X Q. Well, what did he say to you when he saw you?

A. That I can't tell you now, it is too long ago. He told
390 me that Mr. Tomlinson would like to see me, something on
my old—well, I can't tell now what he did say, really. He
wished me to come down and see Mr. Tomlinson.

291 X Q. Didn't he ask you anything about what you would testify to?

A. He asked me if I would testify about the lamps and what I was working on—that is after I got down to the office here.

292 X Q. Did you come down with Russell from Ansonia to New York?

A. No, sir; I did not.

293 X Q. When did you come down?

A. I came down the next morning.

294 X Q. According to your agreement with Russell?

A. Yes, sir.

295 X Q. Did Russell give you any money?

A. He gave me enough to pay my expenses down.

296 X Q. How long were you in New York at that time?

A. I don't know whether I went back the same night or the morning following. It might have been the next night.

297 X Q. Where were you working at Ansonia?

A. At the Electrical Supply Co.

298 X Q. Is that company still in operation?

A. For anything that I know, it is.

299 X Q. Did it have a time book showing the time of the men?

A. I don't know whether it had a time book or not. It had a time list.

300 X Q. Would your absence that day be shown by that time time list?

A. I think very likely it would. It would on Saturday, I know—or Thursday, rather—pay day.

301 X Q. Were you absent often from work?

A. No, sir; very seldom.

302 X Q. Fix the month and year, if you can, when you came to New York at that time.

A. I can't do it very well. It might be somewhere in June, about 1878, I think so; 1887 I meant to say.

303 X Q. Do you think it was that time?

391 A. I think it was somewhere about that time.

304 X Q. That would be less than two years ago?

A. Then that can't be the time; it was about two years and a half ago.

305 X Q. Why do you think it was two years and a half ago?

A. Because it was about a year and a half before I left Ansonia, and I have been in New York a little over a year.

306 X Q. When you came to New York on that trip whom did you see?

A. I saw Mr. Russell. He introduced me to Mr. Tomlinson.

307 X Q. Where did you see Russell?

A. Right out here on the landing. In this hallway here.

308 X Q. Did you at any time make any statement or affidavit?

A. I made a statement.

309 X Q. Was it taken down in writing, and if so, by whom?

A. It was taken in shorthand writing by some stenographer.

Defendant's counsel offers said statement for the inspection and use of complainant as they may deem proper.

Same placed on the table in front of counsel for complainant by counsel for defendant.

310 X Q. To whom did you make the statement?

A. Mr. Tomlinson.

311 X Q. Was it read to you after you had made it?

A. Yes, sir.

312 X Q. How long did you wait for it to be written out?

A. I couldn't say how long it was, perhaps half an hour or an hour.

313 X Q. Did you read it yourself?

A. No, sir.

314 X Q. When was it read to you?

392 A. It was read to me as soon as it was written, as near as I can remember.

315 X Q. When did you next hear of that statement?

A. About two or three hours afterwards, after it was put in printed form.

316 X Q. How did you hear about it then?

A. The stenographer brought it back here and read it over again.

317 X Q. Did you sign it?

A. That I can't say now—whether I did or not. I think likely I did.

318 X Q. Was it dated?

A. I suppose so.

319 X Q. Did you receive a copy of it?

A. No, sir; no further than to see it brought back in the office and read over.

320 X Q. When did you next hear of that statement?

A. I didn't hear anything more of it since then.

321 X Q. Did you swear to that statement when you made it?

A. I don't remember now whether I did or not.

322 X Q. Did you swear to the copy of it after it was typewritten?

A. That is a rather funny thing for me to swear to.

323 X Q. What was funny about it, wasn't it true?

A. Well, if it was read over to me I might possibly swear to it, but to look at it I couldn't tell anything about it.

324 X Q. Have you within the last few days had a paper read to you and been told that that paper was a statement made by you when you were here the first time?

A. No, sir.

325 X Q. Has such a paper been shown to you?

A. That is about the first time I have seen it, I believe.

Witness points to paper on the table.

326 X Q. Do you mean to say that you have not seen that paper during the last week?

A. Yes, sir.

393 327 X Q. Has any reference been made to a statement which you formerly made?

A. I don't remember of any.

328 X Q. When were you requested to come here and testify?

A. This time or the time before?

329 X Q. At this hearing.

A. Tuesday of this week, I believe.

330 X Q. Who requested you to come?

A. Mr. Russell.

331 X Q. When did you come?

A. Wednesday morning.

332 X Q. Did Russell talk to you on Tuesday about your testimony?

A. Not as far as telling me anything about what was in it.

333 X Q. In what?

A. In my testimony.

334 X Q. What testimony do you refer to, the statement made two years and a half ago?

A. Yes, sir.

335 X Q. Did Russell have a copy of that statement you made two years and a half ago along with him?

A. I don't know what he had with him. I didn't see any. I don't know that it was mentioned in any way.

336 X Q. Was it mentioned on Wednesday?

A. I don't remember of its being mentioned.

337 X Q. Did you see it on Wednesday?

A. I don't believe I did.

338 X Q. Was any statement made to you on Wednesday as to what it contained?

A. No, sir.

339 X Q. Did you see it on Thursday?

A. No, sir.

340 X Q. Were you told what was in it on Thursday?

A. No, sir.

341 X Q. Did you see a copy of it on Thursday?

A. No, sir.

394 342 X Q. Do you mean to be understood that never since the time that you made the statement to Mr. Tomlinson two and a half years ago until the present, you have not seen or heard of that statement or had any information as to its contents to the present time?

A. I mean to say that I haven't seen or heard anything about it.

343 X Q. Then you can't say that the paper which was placed on

this table by counsel is the statement you made two years and a half ago, can you?

A. I can't. I haven't seen the inside of it yet. I can't tell anything about it.

At this point counsel for complainant take the paper and retire from the examination-room.

Counsel return.

344 X Q. Please read the paper which counsel placed on the table, and state whether that is the statement made by you to Mr. Tomlinson, about which you have been testifying, and whether it was signed and sworn to by you, and if so, upon what date.

Paper handed to witness.

A. I am pretty satisfied that that is the statement. It was signed on the day I came down here. I can't make out what the figures are. It looks like the 12th day of June, 1886. Well, I can't say really as to swearing, except as it is here.

Defendant's counsel (Mr. Kerr and Mr. Broadnax being present) read and repeat the request already of record as to the books and papers of the Electro-Dynamic Light Co.

Complainant's counsel suggests that no foundation has been laid for any such request or any reasons stated, nor the materiality of said books and papers shown in any way, nor does the request seem to have reason about it that commends it to plaintiff's counsel. Complainant's counsel further suggest that this is not a drag-net investigation, and that there is a proper and legal way which
395 defendant can adopt to obtain anything that it is entitled to obtain. Furthermore, complainant's counsel state that they have not got such books and papers in their possession and don't know where they are.

Complainant's counsel also asks examiner to note that G. P. Lowrey, Esq., was present, for a part of the time during the morning session.

Adjourned till Saturday, the 2d inst., at 10½ a. m.

NEW YORK, *March* 2, 1889.

Met pursuant to adjournment.

Present: Mr. Dyer for defendant and Mr. Broadnax for complainant, and the examination proceeded. (Also present, Mr. Man.)

Cross-questions by Mr. BROADNAX:

345 X Q. Please to make a pen-and-ink sketch of the first lamp you made for Sawyer & Man, or for either of them.

A. I don't know that I can just get on to the first one I had to do with.

346 X Q. Make it as nearly as you can recollect.

Witness makes a sketch and produces the same.

A. That is as near as I can remember it.

347 X Q. Referring now to the sketch made and produced by you, what does the part marked A represent?

A. The glass globe.

348 X Q. What does the part B represent?

A. That represents an upright to hold the top piece E.

349 X Q. You mean one end of the top piece E?

A. I am not sure whether that piece rested on one end or the centre.

396 350 X Q. I do not understand your last answer. Please to state what you mean?

A. What I mean is that I don't know whether this top piece E was pivoted at the center of the top piece or the left end of the top piece.

351 X Q. What does the part D represent?

A. D represents a wire drawing E. to bind carbon F on upwright post C.

352 X Q. What does the part C represent?

A. I should call that the upright C, holder for the carbon.

353 X Q. What does the part I represent?

A. The part I represents the bottom part of the globe.

354 X Q. What do the parts H H represent?

A. The parts H H represent coming through two holes in the bottom of the glass to hold up the upright.

355 X Q. Do you mean that the parts H H represent the bottom ends of the upright B and C where they passed through the bottom of the lamp and where they are sealed therein?

A. Yes, sir.

356 X Q. Was the bottom of the lamp made of glass?

A. A and I are all one continuous piece of glass.

357 X Q. Then the bottom of the lamp was not made of a separate disc of glass as I understand you?

A. No, sir; it was all one piece.

358 X Q. Now were the uprights B and C tubular, I mean were they made of small tubes?

A. I can't say really what they were made—whether of tubes, strips of metal or what. They were metal.

359 X Q. Was the upper end of the part B made wedge-shaped as you have shown?

A. I think it was.

360 X Q. What does the part F represent?

A. The part F represents the pencil of carbon.

361 X Q. And the part E what does that represent?

A. The part E represents a piece of metal bearing on one end of the carbon and pressing the carbon on the upright C.

397 362 X Q. And the other end of the part E as I understand you bears upon the top of the part B?

A. Yes, sir.

363 X Q. The part E is held down on the parts F and B by the part D?

A. Yes, sir.

364 X Q. Now did the lower end of the part D pass through the bottom of the lamp, about midway between B and C?

A. That I can't remember about. The wire came through somewhere, but where I don't recollect; somewhere on the bottom.

365 X Q. By the wire you mean the part D?

A. Yes, sir.

366 X Q. Now, wasn't the part D secured to the loop at its lower end, which was fastened to the inside of the bottom of the lamp?

A. I couldn't say. I don't remember it.

367 X Q. Did the whole or any part of the part D consist of a small spiral spring?

A. I couldn't remember, but it seems to me there was a small spiral spring attached to it.

368 X Q. There must have been some way of drawing or holding the part E down upon the upper ends of E and B. Can't you call to mind how that was done?

A. No, sir; I cannot.

369 X Q. Were the lower ends of the parts B and C sealed in the bottom of the lamp?

A. They were.

370 X Q. How were they sealed?

A. Those bottom pieces H H were turned with a flange partly conical shape under the flange, the lower part straight with a thread. They are cut in two halves, slipped inside of the glass, with a paper washer, I believe. The two halves were drawn through the paper as a washer, then through the glass, another paper washer on the outside of the glass, and screwed down with a nut.

398 371 X Q. Please make a sketch of the arrangement you have described in your last answer?

Witness makes and produces a sketch.

A. I have done so.

372 X Q. Is this sketch marked figure 2 which you have just produced the best you can recollect of the method of fixing and sealing the lower ends of the parts B and C in the bottom of the lamp?

A. Yes, sir.

373 X Q. And in this sketch, figure 2, as I understand it, there is a vertical section of a conical tubular end shown, into which or to which the parts B and C are connected; the nut M shown in figure 2 being screwed on the lower end of the part K, the part K being made in two parts joining in the centre vertically. Is that the way it was?

A. That is as near as I can think of it.

374 X Q. Now, can you recollect how the lower ends of the parts B and C were connected to the parts K K?

A. No; I can't remember just how it was done.

375 X Q. Did the parts K K, when they were put together, form a tube or hole through the centre?

A. I don't know whether it formed a hole or not, but I know that it clamped the two uprights.

376 X Q. Now, how was the carbon F fixed in the upper end of the part C?

A. I don't remember whether there was a countersink in the top of upright C or what there was.

377 X Q. In short, you don't recollect how part F and part C were united, as I understand you?

A. All I remember is that there were put in between these two points and held down by the wire or spring D.

378 X Q. What were the uprights B and C made of?

A. That I can't tell; there was a piece of metal, but what the form of the metal was is more than I can tell.

379 X Q. What was the part F made of: was that made of metal also?

A. The part F is supposed to be made of carbon.

399 380 X Q. Do you distinctly recollect that that part was made of carbon?

A. No, sir; I do not.

381 X Q. Did you understand this lamp to be an incandescent electric lamp?

A. No, sir; I didn't know anything at all about it, what it was.

382 X Q. Who told you to make it?

A. Mr. Man and myself made it together, or rather I worked according to Mr. Man's dictation.

383 X Q. Did you make this lamp at your house?

A. Yes, sir.

384 X Q. What did you understand it to be for when you made it?

A. I didn't know anything at all about it. Mr. Man got me to make such parts as he wanted, and I made them as directed.

385 X Q. Did you see it after it was finished?

A. Mr. Man and I put the parts through into the lamp; made the connections in the bottom; whether we put a carbon in or not, I can't say for certain. Then Mr. Man took it away with him, and that was the last I heard of it.

386 X Q. Did not Mr. Man tell you what it was for?

A. He did not.

387 X Q. Then, as I understand you, you made this lamp without having any idea what it was for?

A. Yes, sir.

388 X Q. Did you subsequently ascertain what it was for?

A. I don't believe—I don't know that I ever saw or heard anything of it afterwards.

389 X Q. Who made the holes in the bottom of the lamp into which the uprights are set or secured?

A. Those was made in the glass when I got it?

390 X Q. Did you not drill these holes yourself with a steel drill?

A. If I am not very much mistaken they were punched out in the glass-house wherever the glass was made.

391 X Q. Do you mean to answer my question in the negative?

400 A. I don't remember of doing so.

392 X Q. As I understand, you cannot swear that you did

nor can you swear that you did not drill these holes in the bottom of this lamp. Is that correct?

A. I cannot swear either way.

393 X Q. In placing these uprights in the bottom of the lamp, did you use cement or any other material for the purpose of making an air-tight joint between the uprights and the glass bottom?

A. I don't remember making anything more than paper washers. If I remember right, my thought was to keep from breaking the glass.

394 X Q. Did Mr. Man tell you that he wanted those uprights made with an air tight joint between them and the glass?

A. Not that I can remember.

395 X Q. Do you remember of drilling holes in a lot of glass discs which were to form the bottom of incandescent electric lamps at your house?

A. I remember drilling holes in such things. Whether I drilled any of them at my house or not I don't remember. I believe I drilled some corner of Walker and Elm streets.

396 X Q. How did you drill those holes?

A. As near as I can remember, I drilled them with a hand drill and turpentine.

397 X Q. What was the drill made of?

A. Steel, with a very hard point.

398 X Q. Now this, as I understand you, is the first lamp that you made at your house for Mr. Man?

A. According to my recollection I believe that was the first one.

399 X Q. Did Mr. Sawyer see you at all in connection with this lamp, in connection with the making of this lamp I mean?

A. No, sir; he did not.

400 X Q. Did you make two lamps at your house for Mr. Man?

A. I believe I made one more after that.

401 X Q. Please to make a pen-and-ink sketch of the second lamp made by you for Mr. New at your house.

401 A. I can form very little idea of the second lamp I made, any further than it was in tubular form.

402 X Q. Please to illustrate it in a sketch as far as you recollect it.

Witness makes and produces a sketch as requested.

403 X Q. Referring to the sketch you have just made what is represented by the part A of that sketch?

A. The part A is a glass tube with a flange at B.

404 X Q. The part C, what does that represent?

A. That represents the bottom of the tube A.

405 X Q. In this case as I understand you the enclosing globe of the lamp is represented by A, and that this globe has an open bottom which was closed by a separate disc of glass C. Is that the way it was?

A. I can't remember whether the disc C was made of glass, metal or soapstone.

406 X Q. And yet you say you made the lamp?

A. Yes, sir.

407 X Q. Were there holes in the disc of the lamp that formed the bottom?

A. I believe there were.

408 X Q. Please to put them in your sketch.

A. I do so and letter them D D.

409 X Q. What were these holes for that you have illustrated and marked D D?

A. They were to—I don't know hardly how to explain that—they must be for the holders for the carbon.

410 X Q. Well, they were as a matter of fact holders for the carbon, were they not?

A. So far as I know about lamps now, they must be—they were.

411 X Q. Please to illustrate them on the drawing as nearly as you can—I mean the carbon holders to which you have referred.

A. I can't illustrate them because I can't form any idea what they are.

Adjourned for lunch.

402 Resumed after lunch.

412 X Q. Do you mean that you have so far forgotten the construction of the lamp as to be unable to illustrate its principal parts?

A. I do.

413 X Q. And that you have illustrated it as far as you are able to?

A. Yes, sir.

414 X Q. Now did you see either of the lamps of which you have made sketches in part, illuminated?

A. I did, sir.

415 X Q. I am referring of course to the identical lamps that you made. Did you understand me in that way?

A. Yes, sir.

416 X Q. Which one of the lamps did you see illuminated?

A. Figure No. 3.

417 X Q. Did you put the carbon in that lamp?

A. No, sir; I did not.

418 X Q. Do you know who did?

A. No, sir.

419 X Q. For whom did you make that lamp?

A. For Mr. Man.

420 X Q. Did Mr. Sawyer give you any direction in the construction of that lamp?

A. No, sir.

421 X Q. You made it, as I understand you, wholly under the direction of Mr. Man and delivered it to him?

A. I did, sir.

422 X Q. Where did you see it illuminated?

A. Mr. Sawyer turned it on for me, soon after I went to work at the corner of Centre and Howard streets.

423 X Q. What did Sawyer "turn on"?

A. Turned on the current of electricity.

424 X Q. How long was that after you delivered the lamp to Mr. Man?

A. It might be a month, it might be two months after.

403 425 X Q. How do you know that it was a month or two months?

A. Well, I don't know for a certainty. I am only giving it to you as near as I can think of it.

426 X Q. Can you give the time when you went into the employ of Messrs. Sawyer & Man at their shop or laboratory?

A. No, sir; I cannot. I have no recollection of the dates.

427 X Q. Can you tell about how long it was after you went into the employ of Messrs. Sawyer & Man at their shop before Mr. Sawyer turned the current into the lamp for you?

A. No, sir; I cannot. I can't give it any nearer than I gave it before.

428 X Q. Then, I understand you to say that your best recollection is that it was within one or two months after you delivered the lamp to Mr. Man that you saw that same lamp illuminated?

A. Yes, sir.

429 X Q. Can you recollect when it was that you delivered the lamp to Mr. Man?

A. All that I can say on that is that when the lamp was finished Mr. Man took it away with him. I can't give any date; I can't remember any.

430 X Q. State what year it was, and as near as you can what time in the year.

A. I don't know. I should think it must be somewhere in July of 1878.

431 X Q. You are referring now to the lamp you saw illuminated, as I understand you?

A. I am referring, I believe, to the time I went to work for Sawyer & Man, if I understand it right.

432 X Q. You misunderstand me; I am referring to the time when you delivered the last lamp you made to Mr. Man; give the year and the month in the year when that occurred?

A. I think it must have been somewhere about May or June of 1878.

433 X Q. Is that as near as you can give the date?

A. It is.

404 434 X Q. How do you know that the lamp Mr. Sawyer turned the current on for you as you have testified was the identical lamp you made for Mr. Man?

A. Mr. Sawyer told me that that was the lamp and the best lamp of any they had had. That is the first lamp that I know of being a lamp. I did not know that it was a lamp till I went to get my pay for it from Mr. Man. Then he called my attention to it and said it was a very good lamp and he thought that I might like to know what I had been working on.

435 X Q. Was that before or after you had seen it illuminated?

A. It was before I saw it illuminated and within a few days after I delivered it to Mr. Man.

436 X Q. When you say "lamp" in your previous answer you mean an incandescent electric lamp, do you?

A. I do, sir.

437 X Q. When you saw this lamp illuminated by Mr. Sawyer, were you able to identify it as the lamp you had made, irrespective of anything Mr. Sawyer told you?

A. Well, I can't remember now; I believe I made a surprise at the time and told Mr. Sawyer I wouldn't have known it.

438 X Q. How long did you see the lamp illuminated?

A. A few seconds.

439 X Q. When you say you saw it illuminated "a few seconds" do you mean that Mr. Sawyer then turned the current off from the lamp, or do you mean that the lamp went out on account of the disruption of some of its parts?

A. Mr. Sawyer turned the current off.

440 X Q. At that time did you understand the principle or mode ot operation of these lamps?

A. I did not.

441 X Q. Do you understand the principle or mode of operation of the lamps now?

A. I don't understand very much about it any further than one pole has got to be insulated from the other.

407 442 X Q. Is that all you know about it?

A. Perhaps I have stated that wrong; I ought to have said I believe that one pole should be insulated from any metallic parts of the works of the lamp, so that the two poles may work through.

443 X Q. After you made the first lamp shown by your pen-and-ink sketch, figures 1 and 2, how long was it before you made the other one shown by figure 3?

A. I don't know; I suppose it would be, perhaps, a couple of weeks.

444 X Q. Is that all the lamps you made for Mr. Man at your house?

A. That is all.

The two pen-and-ink sketches made and produced by the witness, marked as figures 1, 2, and 3, are offered in evidence as Complainants' Exhibits Sharp's Drawings, said exhibits being offered as part of the cross-examination of the witness Sharp, and the same are marked Complainants' Exhibits Sharp's Drawings, figures 1, 2, and 3, March 2d, 1889.

(Here follow diagrams marked pp. 405 & 406.)

445 X Q. After you had delivered the lamps, about which you have been testifying, to Mr. Man, what is the next work you did for them or either of them?

A. I can't remember the class of work I did there.

446 X Q. Did where?

A. At Centre and Howard streets.

No. 286.
C.E. Light Co.
v.
McK-Light Co.
} p. 405

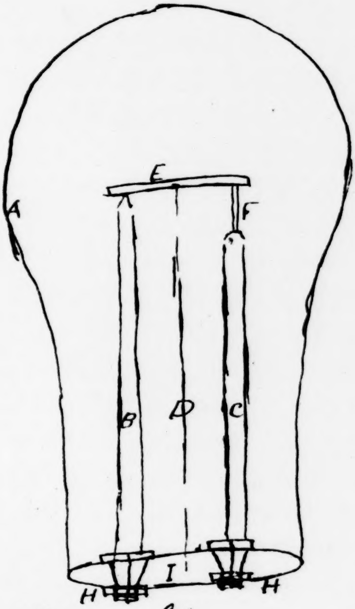


FIGURE I

William Sharp

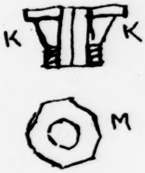


FIGURE 2.

Complainant's Exhibit.
Sharp Drawings.
Figs I and 2.
March 2d 1889.
W.J.F.
S.E.

No. 286.
C.E. Light Co
v.
M.C.K. Light Co. } p. 406

Complainants Exhibit
Sharp Drawing
Fig. 3.
March 2d 1889
W J F
J.E.

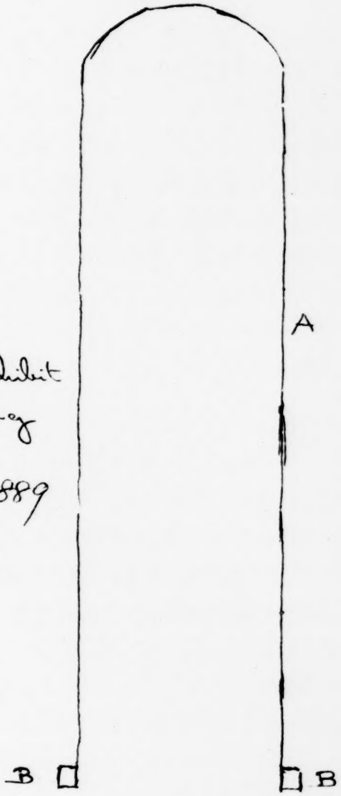


FIGURE
3.

William Sharp

447 X Q. Was Centre and Howard streets the place where you did the first work for them or either of them after making and delivering the two lamps to Mr. Man about which you have been testifying?

A. It was.

448 X Q. And, as I understand you, you do not recollect what the work was that you first did when you went in their employ at Centre and Howard streets?

A. That is right.

449 X Q. What kind of work were you employed upon for them at Centre and Howard streets?

408 A. As near as I can tell, it was parts of electric lamps. When I first went there I didn't know anything about electricity. I was working with Mr. Sawyer, helping him out at whatever he was doing.

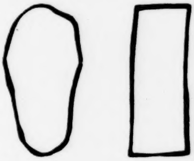
450 X Q. Do you mean Mr. Wm. E. Sawyer?

A. No, I mean Mr. Wm. Sawyer.

451 X Q. What was he doing that you helped him on?

A. The only thing I can distinctly remember is pieces of brass like the sketch which I now make on this sheet.

Witness makes the accompanying sketch.



452 X Q. What are these sketches intended to represent? I mean, what were these pieces of brass for?

A. As far as my knowledge goes, they were parts of some of the lamps they were then making.

453 X Q. Was it not explained to you what parts of the lamp these pieces of brass were intended for?

A. I don't know that it was, I supposed at the time that I was on lamp work.

454 X Q. But really you didn't know whether you were or not?

A. I did not.

455 X Q. How many of these pieces of brass did you make and how long were you to work upon them?

A. I have no recollection.

456 X Q. What else did you work on besides these pieces of brass?

A. That was all I can recollect.

457 X Q. Was this work done in the shop of Arnoux & Hochhausen?

A. It was.

458 X Q. Under the direction of Mr. Wm. Sawyer as I understand you?

A. Yes, sir.

409 459 X Q. How much of your time at Howard and Centre streets was spent at work in the shop of Arnoux & Hochhausen, and how much of your time was spent down-stairs in the room of Mr. Sawyer?

A. My time was all spent in the workshop of Arnoux & Hochhausen with the exception of a few minutes, perhaps two or three times.

460 X Q. Now, when the shop or laboratory of Sawyer & Man was moved from Howard and Centre streets to the corner of Walker and Elm, did you go with them and continue right on in their employ?

A. I did not, not at first.

461 X Q. How long after the removal to the corner of Walker and Elm before you went there to work for Sawyer & Man?

A. When Sawyer & Man moved I went to work for Arnoux & Hochhausen. Then they used to borrow me from Arnoux & Hochhausen about every day or every other day to do some job for them for perhaps two or three weeks. Then they took me to work for them altogether until Sawyer & Man disagreed and broke up the business.

462 X Q. And that was when?

A. I can't give you any dates. I don't remember them.

463 X Q. Now, during the time that Sawyer & Man were borrowing you of Arnoux & Hochhausen how much of your time was spent in the laboratory of Sawyer & Man after their removal to Walker and Elm streets?

A. I don't know. I might, perhaps, have been there one, two or three days in the week.

464 X Q. What work was you engaged upon for them during that time?

A. That I don't remember.

465 X Q. After you left Arnoux & Hochhausen's employ and went into the employment of Sawyer & Man what work were you engaged upon for them. I mean when you first went in their employ there?

410 A. It was work similar to what I have been working on all the way through, experimental work, such as making parts for experimental lamps.

466 X Q. What were the first experiments or parts for experimental lamps that you worked on after going to work in that shop?

A. I couldn't tell you no more than if I had never made them.

Adjourned till Monday, the 4th inst., at 10½ a. m.

MONDAY, *March 4th*, 1889.

Met pursuant to adjournment.

Present: Mr. Griffin for defendants, Mr. Kerr for complainant, and Mr. Albon Man and the cross-examination of Mr. SHARP was continued.

Questions by Mr. KERR:

467 X Q. Did you ever assemble any lamps for Sawyer & Man?

A. Do you mean by "assembling" putting them together?

468 X Q. Yes.

A. Yes, sir.

469 X Q. Those lamps all had a base plate, did they not?

A. Are you referring to No. 3 now?

470 X Q. No, I am not referring to No. 3.

A. All but the first one I made.

471 X Q. And the working parts were all mounted on that base plate, weren't they?

A. Yes, sir.

472 X Q. Then when the lamp was put together the working parts were inserted into the glass globe, and the base plate was clamped to the lower open end of the glass globe?

A. Yes, sir.

473 X Q. How was it clamped?

411 A. They were clamped by two rings, one above the flange of the glass globe, one under the base and clamped together with about six screws, as near as I can think.

474 X Q. When you wanted to take out the working parts what did you do?

A. We had to take the screws out, and take the rings off and take the works all out with the base.

475 X Q. Merely pull them out?

A. Yes, sir.

476 X Q. How long did it take you to undo the six screws?

A. It might take about two or three minutes.

477 X Q. Then how long did it take to pull off the rings and pull the base plate off the lamp?

A. About one minute, I guess.

478 X Q. Wasn't that a long while for that operation?

A. Sometimes it was not.

479 X Q. Why not?

A. Sometimes we would have to warm the bottoms of the lamps to get them apart—soften the cement.

480 X Q. Did you ever have to pry the base plate off?

A. Not very hard.

481 X Q. How long did it take you to wipe out the globe?

A. I don't remember whether I wiped out globes or not. I might have done it sometimes.

482 X Q. Did you ever put in a new carbon in the clamps?

A. That is something I can't distinctly remember.

483 X Q. Did you ever see it done?

A. Yes, I believe I have seen it done.

484 X Q. Where there were screws to clamp the carbons, how long did it take to take out an old one and put in a new one and screw up the clamping screws?

A. That is something I can't give just exactly; I should think on an average it might take a couple of hours.

485 X Q. A couple of hours to unscrew two screws, take out

412 a little piece of carbon less than an inch long from the loose clamps and then put in another piece into the open clamps and screw up two clamping screws again. Do you mean that?

A. In taking down a lamp there was always more or less cleaning to be done and instead of two clamping screws there were six.

486 X Q. Six clamping screws to hold the carbon in the carbon clamps? Do you mean that?

A. No, sir; I mean putting the lamp together, all through.

487 X Q. I didn't say anything about cleaning or putting the lamp together all through. Now please go back to question 485 and answer it.

A. No, sir; that wasn't my general work, putting in the carbons.

488 X Q. That don't answer my question. How long would it take to unscrew the two clamping screws which held the carbon?

A. I don't know whether two clamping screws come in on the carbon.

489 X Q. How was the carbon held?

A. As near as I can think of it, it was done with a small wire and a spiral spring, with a short piece of threaded wire and one nut to regulate it.

490 X Q. How long would it take to take a broken carbon out of that kind of a fastening?

A. They would generally fall out themselves, break and fall out.

491 X Q. Then how long would it take you to put a new carbon back into those fastening devices?

A. Without cleaning it would take about a couple of minutes.

492 X Q. Then after you had the carbon in the clamp and the globe cleaned you put the lamp together by inserting the works inside of the globe, putting on the two clamping rings at the bottom and screwing up the six screws in the clamping rings, did you not?

A. I did.

493 X Q. How long did that take you?

A. Before doing that we had to cement the two glasses
413 with Canada balsam. I had to be very careful not to get the
balsam smeared on the inside and for that reason and being careful not to break the glass by tightening one screw tighter than another it would take fifteen or twenty minutes.

494 X Q. Did you put the balsam on the base plate or on the end of the globe?

A. I suppose I put it on the end of the globe. That would be the most proper place.

495 X Q. You simply touched the end of the globe with a brush dipped in the balsam, did you not?

A. I don't know whether it would be wood or whether it was wire. I had no brush.

496 X Q. How much of the fifteen or twenty minutes did it take you to put the balsam on the end of the globe?

A. It might take two or three minutes to put it on the globe and work it evenly through, leaving no air space.

497 X Q. Then it took you from twelve to seventeen minutes to put in the six screws?

A. That is the figures as near as I can give them to you. I never timed myself on any of the work.

498 X Q. Don't you think that you have given four or five times too much time to that operation of putting in six screws?

A. I don't think I have given any too much time for taking it altogether.

499 X Q. I am not taking it altogether. I am taking the six screws by themselves.

A. I don't think I have given much over the time that it would take.

500 X Q. Isn't it a fact that this work was done by Mr. Myers and not by yourself, as a usual thing?

A. As a usual thing it was done by myself.

501 X Q. How often did you do it altogether?

A. I can't say. I don't remember.

502 X Q. Ten times?

A. Yes.

503 X Q. More than that?

A. Yes, sir.

504 X Q. Twenty times?

414 A. Yes, over fifty times.

505 X Q. How much over fifty times?

A. I don't know. I wouldn't want to go any further than that.

506 X Q. Are you willing to swear that you did it more than fifty times?

A. I have no recollection of the number of times I have taken. I can't swear to a thing that I don't remember perfectly.

507 X Q. What is your impression?

A. I haven't got any.

508 X Q. Then you are not willing to swear that you did it more than fifty times?

A. No, sir.

509 X Q. Did Myers ever change any carbons?

A. I think Myers was the man that generally done it—Mr. Edward Myers.

510 X Q. The only other thing necessary in changing the carbons was to exhaust and fill the lamps, is that so?

A. Yes, sir—well, I don't know—there was sealing after that.

511 X Q. Who did that work of exhausting, filling and sealing?

A. I have seen Edward Sawyer do it, Edward Myers and Thomas Stillman.

512 X Q. Where did they do it?

A. They did it on Mr. Myers' bench.

513 X Q. What kind of apparatus did they have for exhausting the lamp?

A. The first thing I saw was a couple of rubber bags—gas bags. The apparatus they had after that I don't distinctly remember. They put two or three in a line, attached them together with rubber tubes, made the gas in a glass retort and forced it through the lamps.

514 X Q. Where was this apparatus placed?

A. On Mr. Myers' bench in the shop.

515 X Q. Did you see any mercury tube connected with it?

A. There was a glass tube with a bottle of mercury on the 415 bottom of the tube. I don't remember seeing it attached to the lamps.

516 X Q. Was there more than one mercury tube?

A. I don't remember whether there was one or two.

517 X Q. Did you see any other chemical apparatus connected with that exhausting and filling apparatus?

A. I have seen them use melted sodium. I believe that there was bottles of chemicals that the gas run through besides the sodium.

518 X Q. Was this exhaustive and filling apparatus mounted permanently in any place?

A. I can't remember for certain whether it was built permanently in Walker street or not. I know the retort used to be removed every time they got through with it.

519 X Q. What retort?

A. The retort they made the gas in.

520 X Q. When you say that the exhausting and filling apparatus was on Myers' bench do you mean that it was permanently fixed to Myers' bench?

A. I say I don't remember whether it was permanently fixed or not.

521 X Q. How often was it used?

A. That I couldn't say, there was no regular time for using it.

522 X Q. Was it put up every time it was used and then taken down?

A. I have stated that I don't know whether it was permanently or not. I don't remember what kind of an apparatus it was. It was something in form of a rack or shelf. That is all I can tell about it.

523 X Q. Do you remember anything of a screen being used to show the form of the carbon in the lamp?

A. I think I remember seeing a screen one night when they had an exhibition in the office. They had some magnifying glasses. That is about all I remember of it.

524 X Q. Was that the only time you ever saw the screen?

A. That is the only time.

416 525 X Q. How often were you in the front office?

A I don't know. I might perhaps be two or three times a day in it. The screen I saw was after the exhibition was over.

526 X Q. Do you know about any person ever coming to see the lamps. I don't refer to exhibitions they made?

A. I have seen gentlemen around the place looking at them trying how far they could see to read from them.

527 X Q. How often?

A. I don't remember whether I have seen it more than once or not.

528 X Q. Do you wish to be understood as saying that Sawyer & Man never made but one arch-shaped carbon lamp?

A. I don't remember of any other.

529 X Q. Are you willing to swear that they never made any other?

A. I don't remember of any other. I wouldn't swear to it.

530 X Q. Are you willing to swear that they never used a paper carbon lamp?

A. I am willing to swear that I never saw or heard of such a thing till some time after I got through with Sawyer & Man'-work.

531 X Q. Then you are not willing to swear that they never used a paper carbon lamp?

A. I never saw them use one.

532 X Q. That don't answer the question. Please answer it.

A. Or heard of them using such a thing.

533 X Q. That don't answer the question. Please answer it.

A. I am not willing to swear to something I don't know anything about.

534 X Q. Were they in the habit of telling you all they were doing there?

A. They were not in the habit of telling me all that they were doing, but I think if there was anything like that, I would be apt to know something about it.

417 535 X Q. What do you mean by "like that"?

A. The like of paper carbon, or anything of that description.

536 X Q. And yet you didn't know what they were doing in the crucibles you saw?

A. I don't remember—I don't know what they would be doing with the crucibles.

537 X Q. Didn't you ask any questions about operations that were going on there?

A. I have asked lots of questions.

538 X Q. Did Sawyer or Man, or old Mr. Sawyer, answer all your questions?

A. No, sir; I can't say they would answer all.

539 X Q. Didn't they rather snub you?

A. No, sir, they did not.

540 X Q. Don't you know that there was a number of things going on there that you knew nothing about?

A. There was things going on there, when it did not concern me, that was going on anyway secretly—that I wouldn't ask questions.

541 X Q. Wasn't your work principally brass work?

A. Yes, sir. Brass and copper. It was principally copper.

542 X Q. Were all the carbons they used treated in oil, or hydro-carbon gas?

A. Hydro-carbon gas is something I don't know anything about. I don't know what it is, without it is explained to me. The carbons was all, I believe, treated in oils of some kind. I think I have seen it done in naphtha; I am not sure.

543 X Q. After a carbon was treated, could you tell what the original carbon was?

A. I couldn't see that there was much difference after treating, than they were before treating, except they might be a little thicker and a little brighter.

544 X Q. Did you ever have treated carbons to put in lamps, the original carbons of which, before treatment, you never saw?

A. The placing of the carbons in the lamps was not a part of my business.

418 545 X Q. Did you ever see treated carbons, the original carbons of which before treatment you did not see?

A. I couldn't say anything about that.

546 X Q. Do you think it is an easy matter to tell what kind of carbon a treated carbon originally was?

A. I never took that much notice of them.

547 X Q. Please make a plan of the rooms at Walker and Elm streets showing the position of your bench, Mr. Myers', the machinery, office, boiler, boiler-room, water-closet and the whole thing, and any other rooms there were in connection with Sawyer and Man's business?

Adjourned for one hour.

Resumed after luncheon.

A. I have made and produce a sketch, A is Mr. Edward Sawyer's desk, B the lathe, C William Sawyer's vise, D first dynamo, E is my vise, F is Mr. Myers' bench, G second dynamo, H boiler, I the engine and J water-closet.

(Here follows diagram marked p. 419.)

548 X Q. What is the place marked K?

A. The place marked K is an opening, I believe, between the first floor and the roof.

549 X Q. What occupied that space, if anything?

A. On the second floor it was not occupied by anything. It was fenced round, if I can remember.

550 X Q. Wasn't the water-closet J between that space K and the engine?

A. I think not.

551 X Q. Do you remember anything about a pump for exhausting the lamps?

A. I don't know of any particular pump with the exception of the glass tube and the bottle of mercury that I have mentioned before; I don't know of that being as a pump any further than Mr. Man spoke to me about it recently.

552 X Q. How closely were you at your bench E?

A. I was working from the bench to the lathe B principally.

553 X Q. At which were you the greater part of the time?

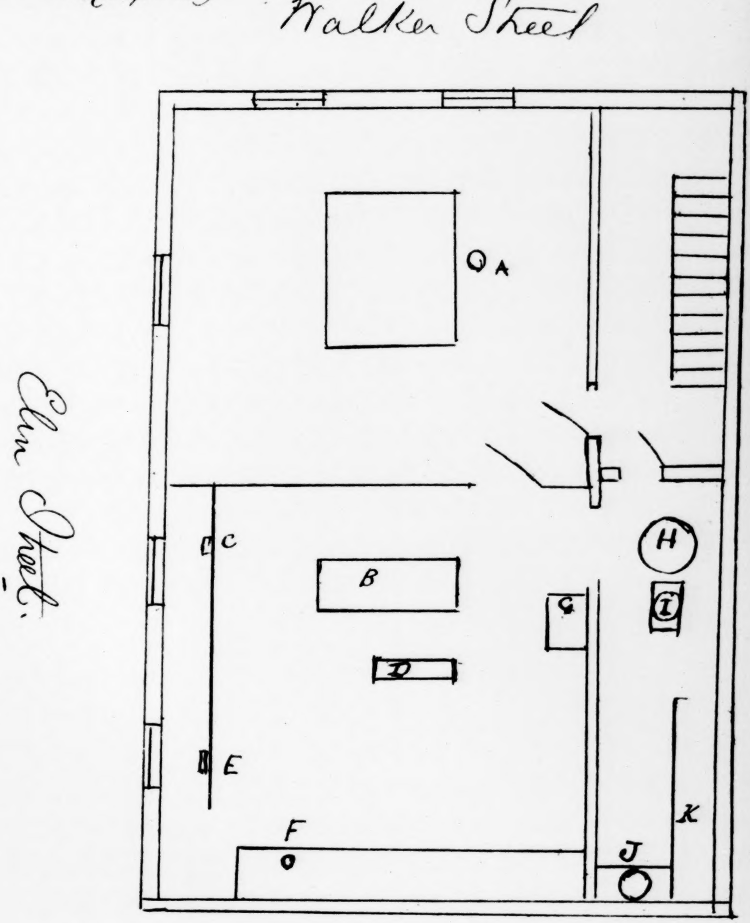
420 A. I think at the vise.

554 X Q. When working there your back was to the balance of the room, was it not?

A. Back of the bench, this way, I faced the window.

555 X Q. Is the room in which Mr. Sewyer's desk appears what you have referred to as the office?

No. 286.
C. E. Light Co
v.
McK. Light Co. } p. 419


Walker Street
Elm Street.
A
B
C
D
E
F
G
H
I
J
K

Wm Sharp's
Deposition
X-Q. 547.

Consolidated E. L. Co
v.
McKeesport Co }
Complainants exhibit
Sharps diagram of
Walker Street Shop
April 4 1887
W. J. S. E.
N. P.

A. Yes, sir.

556 X Q. Did you know all that usually went on in the office?

A. No, sir.

557 X Q. Do you know how much they burned the lamps in the office?

A. No, sir; I don't know how much.

558 X Q. Do you know that Mr. Wm. E. Sawyer was setting up lamps, putting in carbons, testing carbons and making measurements in the office?

A. No, sir; I don't know as I knew that. I know that there has been lamps put up, some on the wall and some on the chandelier. I have seen him filing carbons. I don't know about setting up and testing them. I may have seen him do such things, but I being working at my vise E, or at the lathe B, could not see much in the office.

559 X Q. How many lamps were on the chandelier?

A. I couldn't say whether there was three or four.

560 X Q. How many lamps were put up around the room, not on the chandelier?

A. I have no distinct recollection of that. I don't know of more than three or four. I know there was one on the office side of the partition, between the office and the workshop. I believe there was one on the front of the building between the windows. There was one I know; whether there was more than one, one or more, on the Elm street side. I don't remember seeing anything on the stairway partition.

561 X Q. Do you remember anything about a hand lamp on Sawyer's table?

A. I have no recollection of a hand lamp on Sawyer's table, but I have seen a picture of it in the "Scientific American."

421 562 X Q. About these chandelier lamps; did they stand upright or were they pointing downward, pendent.

A. To the best of my knowledge they were always standing.

563 X Q. Do you remember any other tables or desks in the office room?

A. No, sir; I don't know that I do.

564 X Q. Did you ever see any testing instruments in the office?

A. I don't know hardly how to answer that question. I believe there has been such a thing in there, or some mention of getting one.

565 X Q. Were there any cupboards in the workshop?

A. No, sir, I believe not I believe there was something—something with a piece of black cloth around Mr. Myers' bench for a time. I know the cloth took fire and burned up. I believe it was a small closet with some kind of chemicals in.

567 X Q. Were there any galvanic batteries in the office room?

A. I never saw any batteries further than the two dynamos.

568 X Q. But they weren't in the front room, were they?

A. No, sir.

569 X Q. Please tell me what money, if any, you have received from Mr. Russell or from anybody in anyway connected with the

Edison Electric Light Company in connection with the matter of the testimony you have supplied or promised to supply them in reference to Sawyer & Man?

A. I received ten dollars last Friday; I was out of pocket money; I asked Mr. Griffin if he could let me have a little change, as I was getting short, and he gave me the ten dollars. I have made no agreement whatever. Mr. Russell gave me ten dollars to come down to New York from Ansonia. I made no arrangements for what testimony I should give. I didn't know when I came down really what I was coming for. I made no arrangements for my testimony or money.

422 570 X Q. How much did you receive when you came to New York the first time?

A. When I got through with the testimony Mr. Tomlinson gave me sixty-five dollars.

571 X Q. What wages were you receiving in Ansonia?

A. Three dollars a day.

572 X Q. Did Mr. Russell tell you that it would be made all right with you if you came to New York and made your statement or anything to that effect?

A. I don't remember that he did.

573 X Q. Did you have any such expectation when you came?

A. I had no such expectations as that. I expected to be paid pretty liberally for my loss of time and trouble.

574 X Q. Had you known Mr. Russell before that time?

A. I don't know that I ever saw him before.

575 X Q. Do you mean that you came to New York at the request of an entire stranger, risking your time and trouble?

A. I mean to say that there was about a half a dozen men came chasing me around at Ansonia, wanting to find out something, I don't know what. Mr. Russell spoke pretty frank to me. He gave me some idea what was wanted. I came down and thought I would give my evidence, as I did not suppose it would amount to anything and as that might put an end to people running after me.

576 X Q. Am I to understand, then, that you came to New York with Mr. Russell, an utter stranger, without any understanding with him?

A. I didn't come down with Mr. Russell, and there was no understanding as to money.

577 X Q. Money is not the only valuable consideration. Was there any understanding as to anything else in the shape of a consideration?

A. No, sir; there was not. My understanding as to coming down with an utter stranger was that I was coming to my old home and to see my own people. If it had been in any other place I wouldn't have come.

423 578 X Q. After you had made your statement did you have any understanding in regard to being called as a witness?

A. No, sir; the only understanding I had, as I told Mr. Tomlinson, was, as I was going out of the office, that I hoped—I can't give it in just the same words—that he would not bother me any more. He told me that he would if it was needed.

579 X Q. After that when did you next see Mr. Russell?

A. I believe it was last Tuesday morning.

580 X Q. What did he say to you?

A. I can't just remember what he said to me then. He spoke to me and asked me if I didn't know him. I told him "Yes." He told me that these people wanted to see me again, that they had made a change and that Mr. Tomlinson was out of Mr. Edison's employ and that there was a man by the name of Dyer in his place. That is about all I remember. He told me that Mr. Dyer wanted to see me,

581 X Q. Did he say to you that it would be all right if you came over?

A. I don't know that he did.

582 X Q. You don't know that he didn't, though?

A. I don't know really particularly what he did say. Of course I expect to have my time and expenses paid.

583 X Q. What else do you expect?

A. I have got no expectation.

584 X Q. You have bought a house lately, haven't you?

A. I have, sir.

585 X Q. Now, referring to the time you were at the Walker and Elm street shop, what other work, if any, was done besides making lamps there?

A. I saw Mr. Sawyer tinkering with a meter or trying to get up a meter to measure an electric current, and there was something done concerning some switch. I believe I made some patterns and they got castings. That is about as much as I remember of them. I done some work at it, but I don't remember what; I don't remember finishing them.

424 Redirect by Mr. GRIFFIN:

586 Re-D. Q. Did you ever see Mr. Broadnax before you met him at this examination?

A. I did, sir.

587 Re-D. Q. How did you come to see him?

A. The first I remember of seeing Mr. Broadnax, he was one of the men, as near as I can judge, that came to see me in Ansonia.

588 Re-D. Q. About what did he talk to you?

A. I can't remember just exactly just what it was he said. He spoke about Sawyer-Man—the Sawyer-Man lamp. I can't remember what it was he asked me. I suspected there was some trouble about it, and I didn't want to have anything to say about it.

589 Re-D. Q. Did he come to see you again?

A. No, sir.

590 Re-D. Q. Did you see him again?

A. Mr. Man took me over to his office, spoke a few words concerning what I knew about the lamps, then, I believe it was last

Tuesday night—Monday, I guess it was—I am not sure whether it was last week or not—I think it must be the week before last—I know it was before Mr. Russell came to see me—I think it must have been Tuesday night of week before last, I had a note given to me to go and see Mr. Broadnax.

591 Re-D. Q. Did you go?

A. Yes, sir.

592 Re-D. Q. What did he talk to you about?

A. He wanted to know what I had done on lamps and different things when I worked for Messrs. Sawyer & Man.

593 Re-D. Q. Did he ask you about paper carbons?

A. Yes, sir; wanted to know if I hadn't seen them. I told him that I hadn't seen any or heard of any, only what I had seen and heard of in Ansonia.

594 Re-D. Q. You say Mr. Man took you once to Mr. Broadnax; how did Mr. Man come to see you?

A. Mr. Man was settling the business for the house I have been lately buying, and from there he took me over to New York
425 here somewhere. He took me to his office; from there I went with Mr. Man to Mr. Broadnax's office.

595 Re-D. Q. From the time you first saw Mr. Russell in Ansonia until he called on you here in New York, to ask you to come to see Mr. Dyer, did anybody whom you know, or believe as in any way connected with the Edison Company, or Mr. Russell, or Mr. Tomlinson, Mr. Dyer or myself come after you in any way?

A. No, sir.

596 Re-D. Q. Besides Mr. Broadnax and Mr. Russell do you know any of the others who came to you at Ansonia?

Objected to as incompetent, the witness not having identified Mr. Broadnax sufficiently as a man who came to see him at Ansonia.

A. No, sir; I do not.

597 Re-D. Q. Was the Mr. Broadnax who was examining you Saturday the Mr. Broadnax you referred to in redirect answer 587?

A. Yes, sir.

598 Re-D. Q. Do you remember Mr. Broadnax coming to see you at Ansonia or not?

A. I remember a man who looks very much like him. When I got in conversation with him here in New York I asked him if he hadn't been to Ansonia to see me, and he said he had.

Adjourned till Tuesday, March 5th, at 11 o'clock.

Defendant's counsel here stated of record that the reason of his adjourning at 10 minutes to 4 is because he has a compulsory reference in the N. Y. supreme court in which an adjournment has been refused.

Adjourned till Tuesday, the 5th inst., at 11 a. m.

426 TUESDAY, *March 5th*, 1889.

Met pursuant to adjournment.

Present: Mr. Griffin, for defendant; Mr. Kerr, for complainant, and Mr. Albon Man; and the examination of Mr. SHARP continued as follows:

599 Re-D. Q. You were asked in cross-question 584 whether you had bought a house lately, and you answered that you had. Did you ever mention this purchase to me or any of the Edison people?

A. No, sir.

600 Re-D. Q. Has the matter anything to do with your testimony in this suit?

A. It does not.

601 Re-D. Q. Going back to your work for Mr. Man in Brooklyn, did you do any work for him there except as you have already testified?

A. I got a recess from the shop; I don't remember how it was; and the switches we were talking about yesterday—the castings—I remember that I formed some slides of sheet brass. That is about as much as I remember on that arrangement. I know that Mr. Man paid me for them when I brought them into the shop.

602 Re-D. Q. Were you ever at Sawyer's shop, 41 or 43 Centre street?

A. No, sir, I was not.

603 Re-D. Q. At your home or shop in Brooklyn did you ever bore several dozen glass base-plates for Mr. Man or Mr. Sawyer?

A. I have a slight recollection of drilling one or two holes, but no such quantity as one or two dozen.

604 Re-D. Q. Where do you remember drilling these holes—in Brooklyn or at Sawyer & Man's?

A. I think I did the first ones at my own home, if any, and I think likely that I done some in Walker street.

605 Re-D. Q. You have testified as to a lamp with a circular carbon. Did you ever see or hear of as many as fifty of those lamps being used at Sawyer & Man's?

A. No, sir.

606 Re-D. Q. How many did you see or hear of?

427 A. I don't remember of more than one, and that is only by making the clamps for holding the carbon.

607 Re-D. Q. Did you ever see as many as two hundred lamps of any kind at Sawyer & Man's?

A. I have not.

608 Re-D. Q. What is your best recollection of the entire number of lamps from the beginning to the end of the time you were at Sawyer & Man's at Howard and at Walker street?

A. I don't remember distinctly of seeing more than one.

609 Re-D. Q. I am not referring to lamps with circular carbons, but lamps of every kind? (The master re-reads the Re-D. Q. 608.)

A. I have no recollection of seeing more than one.

610 Re-D. Q. How many lamps, to your best recollection, were

made at Sawyer & Man's all the time you were there; I mean of all kinds?

A. At that one particular place?

611 Re-D. Q. I mean the lump total of lamps at all the places of Sawyer & Man where you worked.

A. I don't believe I have seen more than fifty.

612 Re-D. Q. What is the greatest number they had at any one time?

A. I don't know that I have ever seen more than a dozen at one time.

613 Re-D. Q. Were these fifty lamps, new lamps, or were some made up of the parts of the preceding lamps?

A. Well, the lamps was mostly all changed one way or other.

614 Re-D. Q. What would they do to the lamps in changing them?

A. Make some difference in the conductors or new works, new holders, or something of that kind. I can't think of all the changes that was made in them.

615 Re-D. Q. Does your total of fifty lamps cover all these changed lamps as well as the original lamps?

A. Yes, sir.

616 Re-D. Q. How often were these lamps changed?

428 A. That is something I can't answer direct. There was no stated time for changing them. I suppose when the lamps didn't work they would make some different change in them. I can't tell how often they were changed. That is as near as I can give it.

617 Re-D. Q. You spoke, on cross-examination, of putting Canada balsam on the glass globe or base of the lamps. Did you put it on hot glass or cold?

A. The glass was, towards the last, all made hot to expel all the air.

618 Re-D. Q. What do you mean by "towards the last"?

A. Towards the last of my working in Walker street.

619 Re-D. Q. When you took the lamps apart did you have to warm the glass?

A. Sometimes I had to.

620 Re-D. Q. Generally, did you have to?

A. No, sir; once in awhile they would stick a little tighter than others.

621 Re-D. Q. You talked about cleaning the works of the lamp and taking them apart; what do you mean by that?

A. In taking an old lamp apart it would get kind of smoky or they would be smoking, and I would have to clean all that off—get everything perfectly clean before putting them together again.

622 Re-D. Q. What parts would you clean?

A. All the parts in the lamp—the metal parts and the carbons and the carbon-holders.

623 Re-D. Q. How did the lamps become smoky?

Objected to as incompetent.

A. By the carbons or pencils burning out.

624 Re-D. Q. If a lamp was brought to you with a burnt-out carbon how long did it take you to take the lamp apart, clean it and do such things as were ordinarily necessary and put the lamp together again?

A. As near as I can think of it it would take about two hours, on an average.

625 Re-D. Q. Would this two hours include the time taken up in charging the lamp with gas?

A. No, sir.

429 626 Re-D. Q. After the lamp was charged with gas what had to be done to it, if anything?

A. They used to be sealed with sealing wax.

627 Re-D. Q. Who, besides yourself, did you ever see cleaning the inside works of the lamps?

A. William Sawyer—the old gentleman.

628 Re-D. Q. Any one else?

A. I don't know whether Mr. Myers would take a hand in it once in a while to help out; I can't remember.

629 Re-D. Q. Besides the one lamp you mentioned with a circular carbon did you see any other lamps with metal clamps for the carbon?

A. They all had a kind of a metal socket with a carbon or pencil holder with the carbon-holders pressed into them.

630 Re-D. Q. I refer only to the carbon which was made incandescent and not to the carbon-holders. Besides the one lamp with the circular carbon, did you see any other lamps in which the carbon pencil itself was held by metal clamps?

A. I never saw a lamp held by metal clamps.

631 Re-D. Q. In the lamp figure 52, page 87, of the Sawyer book, as to which you testified, how was the circular carbon clamped or held (witness shown the book)?

A. It was held by two flat carbons--held in a socket as I have mentioned and two other flat pieces held together by platinum screws and nuts.

632 Re-D. Q. I understood from you yesterday that you wished to correct part of your statement about seeing Mr. Wallace fire out the Sawyer feeder lamps at Ansonia. What correction do you wish to make?

A. I don't know whether I said that I saw or heard of it. When I come to think of it I remember that I was told of it. I was in the same building but did not see anything of it personally—did not see it personally.

633 Re-D. Q. Did you personally see the parts of the feeder lamps lying around as you testified?

A. Lying around the yard?

430 634 Re-D. Q. Either the yard or the rooms at Ansonia?

A. I have seen them laying around the rooms a long time before they was thrown out.

Recross-examination by Mr. KERR :

635 Re-X Q. When did Mr. Broadnax tell you he had been to Ansonia to see you?

A. He did not tell me when he had been there to see me. I asked him if he wasn't one of the gentlemen that came to see me, and he said he was.

636 Re-X Q. When?

A. I believe it was when I went with Mr. Man to his office; some time recently here in New York city.

637 Re-X Q. Was Mr. Man present at the time you allege you had such conversation?

A. I believe he was in the room with me.

638 Re-X Q. How long were you there?

A. Wasn't there more then two or three minutes.

639 Re-X Q. Didn't Mr. Broadnax deny seeing you at Ansonia?

A. I don't know that he did.

640 Re-X Q. Well, then, you don't know that he said he did see you?

A. I know that he said he did, or I very strongly thought he did. I don't like to say right out that he didn't or that he did.

641 Re-X Q. Are you prepared to say that Mr. Broadnax ever talked to you on this subject until you met him at his house in Brooklyn recently—I mean as to the lamps made by Sawyer & Man in 1878 and 1879? Please answer this question yes or no.

A. There was a few words said about the lamps. Mr. Broadnax hadn't time to speak about it. This was at Mr. Broadnax's office, or in the room next to his office, when I went there with Mr. Man.

642 Re-X Q. Are you prepared to say that Mr. Broadnax ever, before that time, spoke to you on the subject of Sawyer & Man lamps? Please answer yes or no.

A. Yes.

431 643 Re-X Q. That you swear was at Ansonia?

A. Well, I can't swear that that was really the man or not, only as I remember him by sight.

644 Re-X Q. After the year 1879, when did you next see Mr. Man?

A. I don't remember seeing Mr. Man from 1879 until the time that Mr. Man settled my house business; as near as I can think it was about two months ago.

645 Re-X Q. Did you ever use anything to pack the flanges at the base of the lamps?

A. Yes, we used to put paper between the metal and the glass.

646 Re-X Q. What was the shape of that paper?

A. Shape of that paper was in rings to fit over the glass globe and one on the bottom had a hole large enough to allow the bottom piece to come through—the cocks or caps—pieces that came through from the lamp.

647 Re-X Q. How did you get the paper washers?

A. I used to make them.

648 Re-X Q. How did you make them?

A. As near as I can recollect, we used to cut them out with a knife and a pair of scissors.

649 Re-X Q. Did you ever have any special tools to cut them out?

A. I don't remember ever seeing any.

250 Re-X Q. Were these paper washers all the same size?

A. They wasn't exactly the same size. I don't believe you could cut two exactly alike. We made a small washer for clamping the works of the bottom glass. That, I think, we had a little brass punch for; I won't be sure, though.

651 Re-X Q. Were the lamps all the same diameter?

A. So far as I can remember, they was towards the last. No, I don't think they were all the same size; not exactly. There might be a quarter or half an inch difference.

652 Re-X Q. What wages do you make now?

A. I don't understand that question.

432 653 Re-X Q. What are you paid for day's work at the present time?

A. I am paid three dollars a day. My wages for Sawyer & Man I don't think was ever more than two dollars and a half.

Question by defendant's counsel:

654 Q. Have you any correction to make as to your wages at Ansonia at the time you came to see Mr. Tomlinson in your answer to cross-question 571?

Said question read to witness.

A. I suppose about that time I was only getting two dollars and a half, but after the election of Cleveland my wages was reduced half a dollar a day.

WILLIAM SHARP.

Sworn to before me,

WILLIAM T. FARNHAM,
[L. S.] *Notary Public and Special Examiner.*

Complainant's counsel requests the defendant to put the sworn statement of William Sharp made by him in June, 1886, in evidence or a copy of the same made by the examiner and so certified.

WALTER K. GRIFFIN, being duly sworn on behalf of defendants, says:

I am one of the counsel for defendant. I first saw the witness, William Sharp, the morning before his examination was begun. I met him at the office of Mr. Dyer, 40 Wall street, New York city, and as the examination of the witness Hochhausen was about to proceed, I requested Mr. Sharp to come with me to my office, 11 Pine street. Mr. Russell accompanied us. On arriving at my office I failed to find a statement of Mr. Sharp which had
433 been given me some time ago, among my papers and I proceeded to ask Mr. Sharp such questions, as in my opinion, were necessary to prepare myself to examine him in this case. I

did not find the statement until the next day, and to the best of my recollection, I never referred to the statement in any way to Mr. Sharp. On Friday, I think it was, Mr. Sharp at the close of the examination for the day, said that as he had not been to the shop his pocket money had about run out or something to that effect. I had no change less than ten dollars and handed him that. He objected to take it, saying he only needed some small change, but I told him he had better keep it.

WALTER K. GRIFFIN.

Sworn to before me—

WILLIAM T. FARNHAM,
[L. S.] *Special Examiner and Notary Public.*

Defendant's counsel requests the examiner to note an adjournment to 2½ p. m. to enable him to procure the attendance of another witness.

Adjourned till 3½ p. m.

Met at 3½ p. m.

Present: Mr. Griffin for defendant and Mr. Kerr for complainant.

JOHN M. D. KEATING, recalled:

1 Q. Have you with you the book of account to which you referred on your former examination?

A. Yes, I have, and here it is.

2 Q. What was your custom as to making entries in the book as to work done for your customers?

434 A. I generally made the charge, and when paid, gave credit for it.

3 Q. Would you do any work which would not appear in the book?

A. Occasionally, when paid cash for it.

4 Q. What class of jobs would that be?

A. Small parts and parcels of experiments that would not be worth making an entry in the book.

5 Q. Do you find in the book any entries of work done in the year 1878 for Mr. Sawyer?

A. I do.

6 Q. Under what date is the first entry?

A. April 20th, 1878. I sent in a bill that day for three dollars.

7 Q. When and what is the next entry?

A. From April 30th to May 4th I charge for sundry jobs, six dollars, and from May 9th to May 18th I charge for sundry jobs, four dollars; May 23d to May 24th, three dollars.

8 Q. What did you charge per hour for your work?

A. As a general thing, fifty cents—at the rate of five dollars a day. I charged Mr. Sawyer fifty cents per hour.

9 Q. How many hours' work out of these entries in April and May, 1878, appear to be for work on electric lamps distinctly?

A. Twelve hours; being the bill for six dollars from April 30th to May 4th, 1878.

10 Q. Can you leave the book with us?

A. I can, but I would like to have it back in case I need — for some future day.

11 Q. With the exception of these entries in April and May, 1878, do you find any entries of work done during that year for Mr. Sawyer?

A. Not until June, 1880.

12 Q. Do you find any entries during 1878, against Albon Man?

A. I do, under date of May 20th and 24th, 1878, to ten hours' work on rise and fall ways, five dollars.

13 Q. Do you remember what these rise and fall ways were?

A. I do not remember.

435 14 Q. Do these entries represent the work done by you for Mr. Sawyer or Mr. Man during the year 1878?

A. Yes, sir.

Defendants offer said entries against Sawyer & Man in evidence to be marked Defendant's Keating Book Exhibit.

It is consented that the master make a copy of the entries in said book and the following is a copy of such entries, the production of the book being waived:

Wm. Sawyer to J. M. D. Keating.

		Dr.		Cr.
1878.				
April 20.	1 bill	$3 00		$3 00
April 30.	½ hour on nuts	$0 25	May 26.	
May 1.	5¼ h'r on electric light, 50c.	2 75	"	$3 00
2.	4 " " "	2 00	May 11.	3 00
	Paid.			
3.	½ h'r " " "	0 25		
4.	1½ h. " " "	0 75		
	12 h. week end'g Sat., May 4th, '78	$6 00		$6 00
May 9.	½ hour on job	0 25	May 18.	4 00
13.	5 hour on cylinder & piston	2 50		
14.	2½ h " sundries jobs	1 25		
		$4 00		$4 00
	Paid.			

Wm. Sawyer to J. M. Keating.

		Dr.		Cr.
May 23.	To 4 hours on sundries jobs	$2 00	June 24.	$2 00
24.	2 " " "	1	July 1.	1 00
		$3 00		$3 00
	Paid.			

3 MERCER ST., LORILLARD OFFICE.

Albon Man to J. M. Keating.

May 20.	10 hours on rise & fall way, 50c	$5 00	$5 00
May 24.	" " "		
	Paid.		

436 Cross-examination by Mr. KERR:

15 X Q. Do you wish to be understood that you did any work for Wm. Sawyer, or Wm. E. Sawyer, which does not appear in your book?

A. Occasionally I would have a small cash job that was not worth while to enter in the book.

16 X Q. How often?

A. Not very often because I always rendered a bill about once a week, as a general thing, whether of large or small amounts.

JOHN M. D. KEATING.

Sworn to before me,
[L. S.] WILLIAM T. FARNHAM,
Special Examiner and Notary Public.

United States Circuit Court, Western District of Pennsylvania.

CONSOLIDATED ELECTRIC LIGHT COMPANY
against
MCKEESPORT LIGHT COMPANY.
} In Equity.

ORANGE, N. J., *March* 6, 1889.

Met pursuant to adjournment.

Present: Messrs. Walter K. Griffin and Richard N. Dyer for defendant, and Thomas B. Kerr for complainant; also present, Mr. Henry M. Byllesby.

It is stipulated by counsel that the deposition of Thomas A. Edison, the witness present, taken in the interference case between 437 Sawyer & Man, and Thomas A. Edison, may be copied into this record (both direct and cross-examinations), as a part of the deposition of Mr. Edison in this case, subject to objections as to materiality, which may be taken *nunc pro tunc* at the hearing.

It is also stipulated that any objections found in said deposition, based upon peculiarities of Patent Office practice, such as that the testimony does not conform to the preliminary statement, shall not be considered pertinent in this case.

In accordance with said stipulation, and Mr. Edison being duly sworn, the examiner is requested to copy into the record at this point Mr. Edison's deposition in the interference case.

The following is Mr. Edison's deposition in the interference case:

THOMAS A. EDISON, a witness produced in his own behalf, being duly sworn, testified as follows in answer to questions proposed to him by GEORGE W. DYER, counsel for Edison:

1 Q. Please state your age and residence and occupation?

A. Age, 34; occupation, inventor; residence, Menlo Park, N. J.; for the time being living in New York city.

2 Q. Please relate in detail your earliest experiments in the carbonization of paper?

Question objected to unless the experiments were made, or to be used, or with a view of using the paper in electric lighting, and unless the intention was to make the paper in burners for electric lamps.

A. I carbonized paper in the summer of 1876. Such paper was to be used for battery carbons, for non-conductors of heat, and arti-

cles were to be made in different shapes and carbonized. A great many articles were so made and carbonized from paper.
438 Sheets of carbonized paper were used for electrical resistance about that time. Strips of card-board or bristol-board, about a quarter of an inch wide and five inches long were placed in gas tubes and carbonized by placing the same in a furnace and heating the tube to a white heat. The strips were packed in the tube one upon the other and the interstices filled with charcoal powder. Sheets of tissue paper were laid in iron boxes, fifty to a hundred deep, on the top of which was laid a weight of metal so that the carbon would remain straight after being carbonized. Also sheets of thick bristol-board several inches square were carbonized under strain to keep them straight. Some experiments were also made to carbonize small crucibles made out of bristol-board.

Counsel for Sawyer and Man objects to the answer as going to show that the invention was made before the date named in the preliminary statement, in so far as it bears on the making of the carbon-electrode of paper for the electric lamp.

3 Q. How extensive were these experiments, and what person, if any, had knowledge of them?

Same objection as to former question.

A. The experiments were quite extensive. My intention was to go into the business of making carbon wire for various purposes, electrical and chemical, for electric lighting and batteries. A company called the American Novelty Company was to handle the goods in connection with a gentleman named James, who is now dead. Mr. Charles Batchelor and, I believe, Mr. E. H. Johnson, saw many of the experiments. Mr. Adams, one of my assistants, now dead, helped me in the experiments. I would mention that we also carbonized wood made up in various shapes, as well as paper.

439 4 Q. What was the quality of the paper carbon produced at that time in the way you have described?

Question objected — on the same ground as before.

A. They were very fair carbons after we had got the idea of carbonizing them under strain and pressure.

5 Q. Did you, at that time, determine the quality of these paper-carbon strips as to electrical resistance?

Question objected to on the same ground as before.

A. Yes. We placed them in electrical circuits and worked sounders through them. We also placed one of the crucibles in circuit, and boiled water by the heat engendered by the passage of the current.

— Q. Did you test the electrical resistance of this carbonized paper as compared with various metals?

Objected to as impertinent.

A. Yes, sir; we did, as one of the uses of the paper was to make rheostats, and we concluded that the carbon would be suitable for rheostats. The resistances of the various strips were not wide apart from each other The resistance as compared to metal was very much higher.

7 Q. Please state in detail your next experiments with carbonized paper, and when such experiments were made.

A. My next experiment with carbonized paper was the use of the same in a telephone, about May or June, 1877. We made telephones in which a great number of sheets of carbonized paper and bristol-board paper were placed between the electrodes in a telephonic circuit, and were agitated by the movements of a diaphragm for the purpose of transmitting articulate speech. In fact, in 1877, we tried every conceivable form of carbon in telephones.
440 About August or September, 1877, strips of carbonized paper were placed *in vacuo* and brought up to incandescence. Many experiments were tried upon the incandescence of boron, silicon and carbon, in air and *vacuo*, about that time. My impression is, that two gentlemen, Dr. Cornelius Herz, now in Paris, and Stephen D. Field, were witnesses to some of these experiments, whether the boron, silicon or carbon experiments, I cannot say. Also Mr. Charles Batchelor Adams, who is dead, and others whom I cannot remember, saw these experiments. I think Herz and Field saw these experiments in September of 1877.

8 Q. Please explain as fully as you can how these last-named experiments, in 1877, were conducted.

A. Two rods of brass, sliding in bearings forming the two poles of the battery, had upon their ends small clamps in which different substances could be clamped. In these clamps strips of carbonized paper were placed, about an eighth of an inch wide and two inches long. The paper used for carbonizing was bristol-board. The carbon was brought up to incandescence, but quickly oxidized and was destroyed as it was in the open air. Attempts were made to coat the carbon with powdered glass, so it would melt and run over the carbon and thus preserve it. This did not work. Then experiments were tried on pieces of silicon, which the books stated did not oxidize when in incandescence in the open air. Also upon boron; but these did not succeed well as they were in very small pieces, and we could not make good contact at the electrodes. Afterwards we tried the experiment *in vacuo* with a common air pump, but the vacuum that we were able to get was so poor that the carbon oxidized almost as rapidly as it did in the air.

9 Q. Have you any sketch of the construction used for holding the carbonized paper conductor mentioned in your previous answer? If so, produce it. If you have not such sketch, please make one now, to be attached as an exhibit in this case.

A. I think I have the original apparatus which I believe I can produce, and will do so if possible.

441 10 Q. In this apparatus referred to, was the carbonized paper strip an incandescent conductor suitable for use in an electric lamp?

Question objected to unless the strip was afterwards used in an electric lamp, or intended for one at the time.

A. It was used as an incandescent conductor in an electric lamp, but not under proper conditions.

11 Q. When was this experiment made?

A. I think about September, 1877.

12 Q. Why did you not refer to these experiments in your preliminary statement filed in this interference?

Objected to as incompetent, irrelevant and immaterial.

A. The experiments had, I think, slipped my memory when I made out the preliminary statement.

13 Q. Please state in detail your next experiments in this connection.

A. The next experiments took place, I think, in October or November, 1878. My assistant, Mr. Batchelor, made a great number of paper carbons, fifty or upwards, which consisted of tissue paper, and other kinds of paper, coated over their surface with a mixture of lamp-black and tar, and then rolled up in the form represented by a knitting needle, and afterwards carbonized by heat. These were included in electrical circuits and brought up to incandescence *in vacuo*. They were also used in a lamp devised about the same time, which lamp is shown in my patent 224,329, where the light was given by the incandescence of the carbon at the point of contact between the electrodes. The carbon did not last very well *in vacuo*, and we found it very difficult to clamp it so as to prevent the large current used from producing an arc at the point of contact, but in a form of lamp similar to that shown in patent 224,329, they gave better results.

14 Q. What degree of use was made of the electric lamp last described?

442 A. We burnt them for several hours at a time, but the best results were obtained with wood carbons.

15 Q. Are any of those lamps now in existence?

A. I do not think so. I think there were one or two made and then used for other purposes.

16 Q. Does the drawing of the patent you have just referred to show fairly the construction of the lamp which was made and used at the time named?

A. It does; but we made other forms not shown in the patent. I have represented these in a sketch which I now produce, marked Edison Exhibit 1. In this exhibit figure 1 represents a spring *a*, secured to pillar B. Upon the extremity of the spring is a clamp *c*, for securing the carbon. The lower extremity of the carbon rested upon iridium-pointed prongs *e*, *d*, *f*, at the point *x*, the tension of the spring acting to press the carbon slightly against the iridium points. Sometimes the current was passed through the wire *g*, through *a*, thence through the carbon to the points and out by the wire *l*, which connected to all three points. At other times the current was passed through the wire *h*, thence through the point

d, across a portion of the carbon, thence to the point *e*, and wire *k*. This latter method is shown better in figure 4. In this figure the spring *a* is dispensed with, and a weight, *c*, is used to press the carbon against the two iridium-pointed electrodes *e*, *d*. The current passing from *d* to *e*, through a portion of the carbon, caused it to become incandescent, and as fast as the carbon wore away by oxidation it was fed down by the action of the weight, or even by the weight of the carbon itself. In figure 2 the current passed through the point *h*, across the carbon strip, thence down through the point *k*, rendering that portion of the carbon between the two electrodes incandescent. The contact between the two points was brought about by the weight of the carbon paper. The whole apparatus was placed at an angle. In figure 2½ is shown about the angle at which the paper was placed, *x* being a limiting stop for the downward passage of the carbon. It was so arranged that if the
443 points *h* and *k* were taken away the paper would fall between
the support *g* and limiting stop *x*. Figure 3 shows a modification of the apparatus in figure 1, a mercury cup being placed on the top of the carbon, in which a platina wire was in contact with the mercury, *a* being the mercury cup, *g* the platina wire. In the patent No. 224,329 a ball of iridium was used upon the upright metallic portion of the electrode, upon which the contact between the carbon and the iridium took place, as seen in figure 2 of the drawing of the above-mentioned patent.

17 Q. In the instances named of patent 224,329, and the modifications just explained by you and shown in your Exhibit No. 1, were the conductors of carbonized paper?

A. Yes, sir. A great many of them were carbonized paper—a few were made out of wood.

18 Q. In all the above-named instances was provision made to keep the electric continuity intact, and prevent the formation of an electric spark?

A. Provision was always made for the passage of a continuous current, the light given was partially due to an arc and partially to electrical incandescence.

19 Q. Can you give any instances of electric lamps of other inventors operating in substantially the same way?

Question objected to as incompetent, impertinent and irrelevant.

A. I believe the Werdermann lamp operates in the same manner, also the Joel lamp, now operating in London; and I also believe Mr. Sawyer's late lamps act somewhat on this principle.

20 Q. Are these experiments just described as having been made in October or November, 1878, referred to in your preliminary statement?

Question objected to as incompetent.

A. Yes, sir; these and other experiments made about the same time.

444 21 Q. Please relate fully the other experiments referred to in your previous answer?

A. We, in November or December, 1878, had our vacuum pump placed in order to conduct some experiments on incandescent carbon conductors *in vacuo*, and we tried a great number of experiments with paper carbons, wood carbons, and carbons made with carbonized broom corn. What we desired at that date, and had concluded as the only possible solution of the subdivision of the electric light, was that the lamps must have a high resistance, and small radiating surface, so as to be capable of being worked in multiple arc commercially, and our calculations showed us that the lamp must have at least 100 ohms resistance to compete successfully with gas, otherwise, if the lamps were of low resistance, the cost of the main conductors would be so great as to render the system uncommercial. What is meant here by a subdivision of the electric light is, that many thousand lamps could all be placed upon a single circuit, and be entirely independent of each other. We, from our previous experiments, knew that we could get the requisite resistance and small radiating surface necessary for a commercial use of the light by means of carbonized paper or wood; and therefore, while working to accomplish this end by means of platinum, we endeavored, by a more perfect vacuum, to obtain incandescent conductors of carbon, which would give us the result. But our experiments in November, as before mentioned, with a good pump, wherein we used paper and wood carbons, were not so satisfactory as the experiments we were conducting with platinum conductors. When we made the carbon in such a form as to have a small mass and high resistance to suit our purposes, it would last but several minutes. We then laid these experiments aside, and went on with platinum, to endeavor to obtain a lamp of high resistance, and small radiating surface. The results of our experiments are shown in patents No. 227,228, 227,227, 227,229. The great point we desired was a lamp of high resistance and small radiating surface, and it did not matter very much whether it was of carbon or of
445 platinum. The necessity of these features, and the necessity of the single-lamp multiple arc system, is more particularly set forth in a British patent No. 2402, dated the 17th of June, 1879, in lines 12 to 37, inclusive, 3d page. Also from line 98, page 1, to line 27, page 2, of U. S. patent 227,229. Also in U. S. patent 223,898. Nearly the whole of this patent gives information on the subject. Returning to the experiments mentioned at the beginning of this answer on incandescent paper, and other carbons, we found our endeavors blocked in the matter of obtaining incandescent conductors of high resistance, and small radiating surface, by the fact that we could not make them last for any length of time in the best vacuum obtainable with our air-pump, which was considered a good one. But when, in the course of our attempts to attain the same object by means of incandescent platinum, we had procured a Sprengel mercury pump, and ascertained that we could get exceedingly high vacua, it occurred to me that, perhaps, a filament of carbon could be made to stand in the sealed glass vessels which we were using, exhausted to a high vacuum, and in October, 1879, we made lamps of paper carbon, and carbons of common sewing

thread placed in a receiver made entirely of glass, with the wires sealed therein by fusion, and the whole exhausted by a Sprengel mercury pump to nearly the one-millionth of an atmosphere, and these filaments of carbon, although excessively fragile, owing to their small mass, had a similar radiating surface and higher resistance than we had hoped; we had reached the conditions where, notwithstanding the carbons were small in mass and filamentary, they were stable. Sufficiently so to allow of the economical subdivision of the electric light and the possibilities of competing commercially with lighting by gas. It was the new conditions which caused this lamp to be a success, which conditions were high vacuum in a receptacle in which no deterioration or lowering of the vacuum occurred to destroy the carbon. These experiments resulted in the lamp and various modifications and forms, 446 more particularly set forth in my patent 223,898, and in the application now in interference.

22 Q. Please state what you were doing in the way of experiments upon this subject between November or December, 1878, and October, 1879.

A. I was endeavoring to obtain a lamp of high resistance, for instance, a hundred ohms, with small radiating surface, the former to permit of economical subdivision, and the latter to permit of economy in the use of electric power, and I used platinum and platinum-iridium wire during that time to attain this result, all of which are more particularly set forth in the patents which I have heretofore recited; in conducting these experiments we made a great variety of platinum lamps in which a major portion of the wire was so coiled as to not radiate light, to the end that the lamp might have a high resistance; one of these forms is shown in my patent 227,229.

23 Q. At what date did you begin to make glass bulbs or shells especially adapted and used for electric incandescent lamps?

A. I think separate lamps, independent of the air pump, were made either in December, 1878, or January, 1879, except the device used in 1877, which was capable of being detached from the pump and placed in any position, but my impression is that the first vacuum bulb for an incandescent conductor that would hold its vacuum was made in June or July, 1879; this was made entirely of glass, with the conducting wires sealed therein and the vacuum obtained with a Sprengel pump; a platinum conductor was used with these lamps; it might have been as late as August, 1879; I will look over some of my memoranda to-night and refresh my memory on that point.

24 Q. When did you produce electric lamps with incandescent paper carbon conductors in vacuum bulbs, hermetically closed, so as to be a commercially complete lamp, capable of entering into competition with gas lights?

A. I made such a lamp about October 22d, 1879, which 447 had the characteristics of high resistance, small radiating surface, and sufficient stability and economy to allow of competition with gas.

25 Q. What was the extent of your manufacture and use of such lamps thereafter?

A. We commenced immediately to make a number of vacuum pumps and started to manufacture these lamps of paper carbon, with the pump we had on hand; during November we made a great number of lamps of this character, perhaps as many as one hundred; these were put up in the laboratory at Menlo park, and various experiments tried with them, among which was a test of their candle power, economy, resistance, lasting time at various degrees of incandescence; in the latter end of November, 1879, we commenced operations with a view to get our dynamo machines, regulators and wires in order, to make a public exhibition of these lights.

What I mean by a public exhibition is a more general exhibition, as everything that I did in my laboratory for the last three or four years was seen by thousands of persons from all parts of the world. A great many persons visited the laboratory to see the lights in operation in December, 1879, caused by an intimation in one of the daily papers that my electric lights were burning. But on December 21st, 1879, the "New York Herald" published an account of my experiments, a copy of which article is now furnished, marked Edison's Exhibit No. 2.

On December 25th, 1879, I had lighted up my laboratory, my office and two or three houses, situated about a fifth of a mile from the laboratory, and also about twenty street lights. On New Year's eve, 1879, about 3,000 people visited Menlo park, and thereafter to the present time all my experiments have been public. I have made probably 3,000 lamps containing the paper carbon conductor, now in interference.

Some time in the spring of 1880, I lighted up the steamship "Columbia" of the Oregon Steam Navigation Company, with about seventy-five to a hundred lamps containing paper carbons, which continued to light the ship satisfactorily for several months.
448 Exhibitions of the same were made on the steamship "Columbia" at Rio Janeiro, Brazil, Valparaiso, Chili, San Francisco, California, and Portland, Oregon. I understand some of the lamps were lighted during the voyage around Cape Horn, and were kept lighted from San Francisco to Portland on the regular trips for several months, and I have recently shipped several hundred lamps to replace the ones broken. Since that time I have tried an enormous number of experiments to cheapen the cost of my lamps, to increase their length of life, and economy and resistance. The nuclei for manufacturing the lamps, established at Menlo Park, in November and December, 1879, have been expanded into two large factories, one situated at Menlo Park and the other at East Newark, N. J. The factory at Menlo Park employs about one hundred hands, turns out about one thousand lamps per day, and has manufactured about sixty thousand lamps. The factory at East Newark is being arranged to manufacture fifty thousand lamps per day.

26 Q. Returning now to the paper carbon incandescent lamps made by you in the winter of 1879–'80, what actual use were they

subjected to, and what was the extent of their durability as lights; also what was the quantity of light produced by each lamp according to gas standards?

Objected to as incompetent, irrelevant and immaterial.

A. Each lamp gave about 12 to 16 candles of light. They were put up on chandeliers and run until they were destroyed. Some of them were run all day and night, and others by night. A record was kept of the hours each one ran, which record I have here. The lamps are numbered from 142 to 417. Examining this record to refresh my recollection, I am able to state that, for instance, lamp 142 lasted 404 hours; lamp 159 lasted 480 hours; lamp 189 lasted 217 hours; lamp 255, 294 hours; lamp 223, 262 hours; lamp 167, 15 hours; lamp 204, 16 hours; 203, 17½ hours; lamp
449 155, 280 hours; 201, 280 hours; 164, 322 hours; 172, 259
hours. Looking over the whole record, I should judge the average life was about 300 hours. I remember two lamps, one of which lasted 1,350 hours, and another one 940 hours, cut from the same mold and of the same size and same paper as the lamps I have mentioned by numbers. The numbers I have given occur on the pages of the book consecutively.

By agreement of counsel, here made, the book of record referred to in the above answer is tendered to counsel for Sawyer & Man for use in cross-examination, and copies of so much of the record as has been testified about by the witness, being pages 1 to 15 inclusive, are attached as exhibits and marked Edison's Exhibit No. 3.

27 Q. Since testifying on Saturday, have you made examination among your papers and exhibits at Menlo park with reference to your early experiments in electric lights in which carbonized paper was used as a conductor; if so, produce what you have found and explain the same?

A. I have made such an examination. I produce an electric lamp in which experiments were made with a paper carbon brought up to incandescence in vacuo. This lamp was used about September or October, 1877. The apparatus orig-ally was one for illustrating Geissler tube action in vacuo. The base of the apparatus fitted over the hole in the platen of the air-pump. It was then exhausted and the cock turned to preserve the vacuum in the globe of this lamp. We did not succeed in getting a higher vacuum than 2½ millimeters on the mercury gauge, and we could not make the carbons burn more than a few minutes at a time. Some of the crrbons were brought up to brilliant incandescence, and probably gave thirty or forty candles of light. The carbons were brought up to various degrees of incandescence. The carbons were made of sheet paper, of various widths and thickness. I think
450 they were made of bristol-board. They were from three-
sixteenths to a sixteenth wide and probably from eight to fifteen thousandths thick. I believe they were carbonized in tubes made of gas pipe. I cannot remember whether they were prepared at the time or were on hand; we had an immense collection of

carbonized paper and wood on hand, which we used in our telephonic experiments in 1877.

The lamp referred to in the above answer is put in evidence, and is marked "Edison's Exhibit First Incandescent Lamp."

Counsel for Sawyer & Man objects to the exhibit upon the ground that it goes to show, and is intended to show, that the invention was made previous to the date alleged in the preliminary statement of Mr. Edison, in this interference, and he objects to all that part of the answer that is intended to show or goes to prove that the invention was made previous to the time alleged in such preliminary statement, and gives notice that upon the hearing of this interference he will move to strike out the exhibit and all that part of the answer objected to.

28 Q. Can you explain now why you did not refer to this exhibit in your preliminary statement?

Objected to as incompetent, immaterial and irrelevant. Notice of motion to strike out at the hearing.

A. I had forgotten about the experiments. I had forgotten that
I had the exhibit, and it only came to my recollection Saturday, in
conversation with my assistant, Mr. Batchelor. The results were
probably not sufficiently satisfactory to impress it upon my mind.
I try so many thousand experiments in all branches of physics
that I sometimes forget some of them. The preliminary
451 statement was made at a time when I was under great
strain and crowded with people at my laboratory.

Answer objected to upon the same ground stated in the objection to the question. Notice of motion to strike out at the hearing.

29 Q. If you have any other exhibits found by you at Menlo Park on your late search, please produce such with full explanations?

Question objected to upon the ground that it is incompetent, unless it is intended to call out evidence to show that the invention was made subsequent to the date stated in the preliminary statement.

A. I present an exhibit which serves to refresh my memory regarding the experiments tried on electric light in 1877. The exhibit is dated November 1st, 1877, witnessed by Charles Batchelor, myself and John Kruesi, and I know the signatures to be their handwriting. In this exhibit is shown lamps giving light by the incandescence of boron, silicon and other substances included in the electric circuit, such lamps being arranged in series and in multiple arc. The experiments with carbonized paper in vacuum were made previous to the date of the exhibit of November 1st, 1877.

Answer objected to as intended to show that the invention in controversy was made previous to the date given in the preliminary statement of Mr. Edison.

Notice of motion to strike it out at the hearing.

Paper referred to put in evidence and marked Edison's Exhibit No. 4.

Exhibit objected to on the grounds stated in last objection, and notice of motion to strike out repeated.

452 I now produce another paper, dated December 3d, 1877, which serves, like Exhibit No. 4, to refresh my memory regarding experiments with the paper carbon. This paper is witnessed by myself, Charles Batchelor and John Kruesi, and I know the signature to be their handwriting. It refreshes my memory as to the fact that we were trying to subdivide the electric light into a small number of burners, where the circuit was closed by solid conductors, and the reason why experiments were conducted with boron and silicon was because they were not subject to oxidation like carbon, which we had previously tried, and which did not last as long at a white incandescence as pieces of graphitoidal silicon, forming part of the electric circuit, and rendered incandescent by the passage of the current. The results of the carbon experiments, and also of the boron and silicon experiments, were not considered sufficiently satisfactory, when looked at in the commercial sense, to continue them at that time, and they were laid aside.

The paper referred to in the above answer put in testimony and marked "Edison's Exhibit No. 5."

Paper exhibit objected to as impertinent and irrelevant, and as intended to show that the invention was made previous to the date mentioned in the preliminary statement.

Notice of motion to strike it out at the hearing.

30 Q. Please state whether or not the paper Exhibits No. 4 and No. 5 were written at the dates given upon each of them?

A. Yes, sir; they were.

31 Q. State whether or not your memory is distinct as to the fact that the experiments with boron and silicon, mentioned in these exhibits, were made after your experiments with carbonized paper conductors, and after the employment of such conductors in 453 the lamp marked "Edison's Exhibit First Incandescent Lamp?"

Same objection as before, and same motion.

A. I am certain it was before, because we used boron to get rid of oxidation, to which the carbon was very sensitive.

32 Q. If you have any other exhibits relative to the matter in question, found in your late search at Menlo, please produce the same with explanations.

A. I present a lamp which is one of my well-known carbon horseshoe lamps, made, I think, some time in December, 1879, and is of the same kind and character as those made in October, 1879. This lamp is illustrated in the New York Herald of December 21st, 1879, heretofore put in evidence.

33 Q. State, if you please, in that connection, whether or not this lamp was actually put in circuit, when and where burned, stating the length of time, and the amount of light given by it.

A. I find that its number is 235, and on referring to my note book, I find that the lamp either burnt seventy hours and eighteen minutes or 250 hours and forty minutes, as the record is obscure. It gave a light of probably from twelve to sixteen candles. It is one among a hundred that were burning at the same time. One lamp which I have previously mentioned, made in the same way and in the same manner of carbonized paper, lasted over 1,300 hours, and I believe that the lamps of this character made in the regular way had an average life of about 300 hours, which was sufficient to render them a commercial success in competing with lighting by gas. Had they but lasted an hour, or if the average life of a great number of these lamps were only a few hours, they would not have been a commercial success, and the results would have been of no benefit to the public.

But these lamps, in addition to the fact that they lasted for a long time, had other characteristics, without which, even with a long life,
they would not have been available for competing with gas.
454 These important characteristics were that they were of high
resistance, of small radiating surface, and hence economical, for the reason that smaller conducting wires could be used for conveying the current, as owing to the high resistance of the lamps weak currents were only necessary and sufficient energy to produce the result was forced through the wire and lamps by increasing the electric pressure or electro-motive force. If lamps of low resistance were pleced in multiple arc in a single circuit, the aggregate resistance of all the lamps would be very low, and conductors of correspondingly large dimensions would have to be used, otherwise a great loss of current in the form of heat would take place on the conductor. Hence, if the resistance of each lamp was made, say 100 times greater, then the conductors could have a hundred times less area, and the losses would be the same in both cases. With small radiating surface less energy is required to produce a candle power than on a larger surface. Again, economy is attained from the fact that these filaments of carbon, being small in mass, do not conduct any heat better than they do electricity, and therefore very little heat is conducted from the glowing incandescent conductor to the clamps and supports for the same. Hence no special appliances are essential to get rid of the heat of conduction, as are employed in the type of lamps experimented upon by Mr. Sawyer. Again, high vacua render the carbon horseshoe practically stable and at the same time result in great economy in the use of electricity, as practically all the energy is lost by radiation, and none by conduction. My experiments have shown that if the carbon horseshoe is placed in an atmosphere of nitrogen at the atmospheric pressure, which is the method adopted by Mr. Sawyer in his lamp experiments, it requires nearly twice as much electricity to bring the horseshoe up to the same candle power as it does when the horseshoe is in a high vacuum. As in the former case, heat is lost by conduction through the gas, which serves to carry it to the inclosing globe, from which it radiates invisibly. Hence this lamp is,

I believe, the first one ever produced that was commercially
455 available for competition with lighting by gas, and of great public utility.

This lamp, No. 235, was made at my own laboratory at Menlo Park, some time in December, 1879, was put up in a street lamp at the top of the stairs in front of the depot at Menlo Park, a fifth of a mile from the laboratory, and there burned until destroyed. I think it was made a few days before it was put up. According to its record I find it had burned forty hours, previous to January 3d, 1880. It was seen along with about a hundred others like it, by at least twenty-five thousand people, in December and January. At least, that is my impression.

All that part of the answer after the ninth line (fourth printed line) is objected to as irresponsive, and a mere lecture on the best proportion for making a lamp and burner, in Mr. Edison's opinion.

The lamp referred to in the previous answer is put in evidence and marked "Edison's commercial incandescent electric lamp."

34 Q. Please point out the peculiarities of construction which make this lamp of practical value as compared with other incandescent lamps, and particularly those produced in accordance with the inventions of Sawyer & Man?

A. I have already stated that in my previous answer, to which I refer as an answer to this question.

35 Q. Please state whether or not this exhibit is one of the class of lamps of which you have testified previously that about 3,000 were made, and if there were any differences in construction in any of the 3,000 lamps, please state what such difference were?

A. They were the same, except, perhaps, in the shape of the clamps for holding the carbon, and in the form and method of clamping the paper horseshoe carbon to the wires that passed through and were sealed into the glass.

456 36 Q. Calling your attention to this exhibit, please describe fully the bulb or globe, stating when and where it was made and by whom, and the advantages connected with its form and size?

A. The lamp was made some time in December, 1879, I think by a person named Boehm, who was employed as a glass-blower at my laboratory at Menlo Park. The great advantage of this form and kind of inclosing chamber is that, unlike all previous attempts made for lighting by the incandescence of carbon, the incandescent conductor is placed in a chamber made entirely of glass, the wires forming the leading-in conductors passed from the exterior to the interior of the chamber, and sealed by fusion of the glass where they pass through it. Hence, these glass chambers when exhausted to high vacuum preserved the exhaustion constant, and thus provide the all-essential condition for high economy and length of life of the thin filament of carbon which it is essential to use to attain high resistance, to permit of the economical subdivision of the electric light. All attempts, I believe, heretofore have failed to preserve the vacuum, where a vacuum is used, and thus preserve the carbon, for the reason that the chamber was not composed entirely of glass but of glass and metals, and materials between the glass and which there was a difference in coefficient of expansion, which at times admitted the air; hence, most inventors have used a supposably inert gas in the chamber at atmospheric pressure, and the leading-in wires have not been passed through the glass and fused therein, which is an essential feature. The form and size of this lamp are very convenient, as it is small, light, portable, durable, and admits of radiating the light in all directions so that practically none is lost. Its size is such that it contains very little air, hence, is quickly and economically exhausted of the same in the process of manufacture, and the whole lamp is so light as to be used on chandeliers now used for gas in great numbers.

37 Q. Referring to the same lamp, please describe the leading-in wires and the incandescent conductor, and state the advantages connected with the form and size of the same. 457

Objected to as immaterial, impertinent and not bearing upon any issue in controversy.

A. The leading-in wires to within a quarter of an inch of the glass are formed of copper. To these copper wires are secured, by soldering, platinum wires, which pass through and are fused in the glass. Upon the extremity of these wires, within the chamber, are clamps, which serve to clamp the broadened ends of the filament of carbonized paper. This broadened end is essential to permit of a proper clamping and electrical contact, as the increased conductivity of the broadened end to the electric current prevents it from becoming incandescent. Hence, little arcs and bad contacts at the point of clamping, which would tend to destroy the lamp do not take place. If the filament of carbon was of the same size all over, so that the portion clamped was no larger than the portion which was incandescent, the lamps of this character would be rapidly destroyed by the formation of small arcs at the point of clamping, which throwing out the vapor of carbon and platinum within the vacuum would permit of the formation of a large arc between the *the* two leading-in wires, and the lamp would be instantly destroyed. The paper horseshoe being of small radiating surface and small in mass, is very flexible, and after the passage of the electric current very tough. Hence the lamps may be handled, practically, with impunity as far as breaking the carbon horseshoe is concerned. In fact, after the current has passed through the horseshoe the two broadened ends may be taken in the fingers and pulled out nearly straight without breaking. The advantages of the horseshoe shape are, that it permits of the expansion and contraction of the carbon freely without injuring it, and also permits of nearly all the light being utilized—in fact nearly the maximum amount. The necessity of using platinum to seal in glass is, that of all metals its coefficient of expansion is nearest glass, and hence the glass and platinum will expand and contract together under differences of temperature and thus prevent leakage of air or cracking of the glass chamber. 458

Same objection to answer as to question.

38 Q. Please state how the carbon conductor in this lamp and those like it was made, and where?

A. The carbon conductor was made at my laboratory at Menlo Park, either in October, November or December, 1879, in the manner and of the material described in my application, now in interference.

39 Q. Please state how you exhausted the air from this lamp and others made like it?

A. We exhausted the air by means of a double glass pump—one part of the pump being known as a Geissler pump, and the other as a Sprengel pump, in which mercury was used in the well-known manner. The apparatus is shown on page 99 of my note book No. 85 (a copy of which sketch is produced and put in evidence and marked Edison's Exhibit No. 6).

Exhibit objected to, as being secondary evidence, being an alleged copy, and not the original referred to by the witness, and the copy not being produced.

Counsel for Edison states that the sketch referred to is one of the pages of a very valuable book of original records, which book is now tendered to the counsel for Sawyer and Man, for inspection, and that a tracing copy will be furnished as soon as it can be made and before the examination of this witness is closed.

40 Q. To what extent was exhaustion produced by the apparatus described?

A. I think the exhaustions were carried beyond the millionth of an atmosphere. We had on this apparatus a McLeon gauge to measure the degree of exhaustion. In the notes which accompany this sketch it is stated that a vacuum was obtained where the 459 jump spark from an induction coil jumped five (5) inches in air rather than pass across between electrodes a quarter (¼) of an inch apart in vacuum. This denotes exceedingly high vacua, exceeding the millionth of an atmosphere.

41 Q. When was the sketch referred to made?

A. It is dated October 2d, 1879, and witnessed by S. D. Mott and myself. The drawing was made by Mr. Mott, and it was I think made on the day of date. The notes are in the handwriting of Mr. Upton. I think the notes were made about the same time.

42 Q. Please read from these notes whatever refers to the construction and mode of operation of the vacuum apparatus shown in the sketch.

A. I will furnish a copy of the notes referred to, taken from the book, which copy will be marked Edison's Exhibit No. 7.

Mr. Broadnax objects to the notes, because it appears that they were not made by the witness himself or in his presence.

43 Q. Whose property is this book, and under whose direction and by whom were the entries made in it?

A. The book belongs to myself. It is one of about two hundred or more books in which my experiments in electric lighting are recorded. The entries relating to this exhibit were made by Francis Upton, my assistant, under a general direction from me. The sketch itself was made by Mr. Mott, another one of my assistants.

44 Q. Please describe briefly the manner in which the apparatus shown in the sketch referred to operates in exhausting air from lamps, and if necessary to make the sketch more clear, put additional letters of reference on the parts.

A. The bottle at the top of the pump is the mercury reservoir, leading from which is a rubber tube through which the mercury passed up to the first glass tube on the left-hand side of the pump board. The mercury then passes into the air trap G, then around
the bent tube to the contraction F, through a small tube
460 within a bulb, thence dropping down the second tube on the
right to D. These drops of mercury, in dropping, acted as pistons, between which the air was confined, after the manner employed by Sprengel. E X is the McLeod gauge for measuring the degree of exhaustion. A bottle on the left lower corner, containing mercury, was connected to the McLeod gauge by a rubber tube. When this bottle was lifted the mercury passed up in the round bulb of the gauge and forced what residual air there was up into a tube with a capillary base and with a paper scale behind it. The two tubes on the right of the pump stand form the well-known Geissler pump. The mercury bottle at the lower end on the right was connected to the second glass tube on the right of the pump board by a flexible rubber tube. A stop-cock B being turned so that no mercury could enter the main vacuum apparatus, the bottle was lifted and the mercury ran into the chamber in the upper part of the tube, filled it, and forced what air there was in it over into and down the first tube on the right to the trap D, and thence to the atmosphere. The mercury bottle was then lowered, and the mercury ran out of the chamber, leaving a vacuous space. The cock B was then turned so that the chamber formed part of the general vacuous space of the pump. The bulbs on the right-hand corner at the top were the lamps, which were all sealed by fusion with each other and then to a tube provided with a ground-glass stopper fitting into the vacuum apparatus. A stop-cock on the right near the top served to disconnect the pump from the bulbs or lamps when they were properly exhausted, so they could be sealed off and others put on without losing the vacuum in the pump entirely. The two bulbs on the top and above letters B and C contained phosphoric anhydride, to remove water vapor from the air, and gold leaf, to absorb mercury vapors. Above these is the Geissler spark gauge with the two electrodes. The major portion of the air was taken out by the Geissler pump and the rest of the exhaustion was
carried on by the Sprengel pump.

461 45 Q. In addition to means for making lamps completely,
like that shown in Exhibit Edison's Commercial Electric Lamp, and means for exhausting the air completely from such lamps, what else had you done in the latter part of 1879 towards a perfect operative system of electric lighting by incandescence?

A. I had been devising a complete system for the general distribution of electricity, so as to compete with gas. I had dynamo machines, a station regulator for keeping the pressure constant throughout the system, meters for measuring the amount of current consumed by each customer, street mains for distributing the electricity, sockets for holding the lamps and chandelier appliances, electro-motors for utilizing electricity for power on the light wires, vacuum pumps and devices for the manufacture of electric lamps, carbonizing furnaces, and molds and appliances therefor, and in fact a complete system of electric lighting by incandescence, upon the plan of general distribution over large areas. About the middle of December, the whole system was started and publicly exhibited to many thousand people. Several houses were lighted, besides my laboratory, and twenty street lamps were also lighted. What has been done since that date has been towards means and methods of manufacture, cheapening the processes of manufacture, and establishing factories. In the latter end of December, or in the early part of January, I accepted the proposition of Mr. Villard to light up the steamship Columbia. I immediately went to work preparing to do so. The apparatus was finished and placed on board a few days after she came out of the ship yard, which was, I think, in May or June, 1880.

46 Q. What was the resistance of the lamps made by you in the latter part of 1879?

A. Some of them were as high as 1,000 ohms, but the average resistance of the paper carbon was about 100 ohms when hot.

47 Q. In your late search at Menlo, did you find paper or model exhibits of experiments of 1878, which you are now ready to offer?

462 A. I did not find any apparatus that I was sure was used in 1878 with the paper carbons; but I have a man searching for them. My practice is that when I make apparatus to try an experiment, I keep making changes on this apparatus to try other experiments, many of which have nothing in common with the purpose for which the instrument was first devised. I conduct such a great number of experiments, that I could not afford to keep the original apparatus if it was required to try another experiment, even with a matter entirely dissimilar as to its object.

Counsel for Edison gives notice that, if at any time during the examination or cross-examination of his witness, any exhibits of experiments of 1878 are found, he will put the same in evidence.

48 Q. In all the instances of carbonization of paper given by you in this testimony, was there any other treatment of the paper besides simple carbonization?

A. In the lights made of paper horseshoes, of which there were about a hundred burning at a time, and which I have spoken of as being exhibited to the public, the paper carbons were not treated. Some lamps were made in December, 1879, to see what effect treatment would have, but only a few were made. In the experiments in 1877 with a paper carbon, no treatment of the carbon with any other substance was made except the incidental effect of the grease used in the lamp being decomposed and depositing carbon on the incandescent conductor in the Exhibit First Incandescent Lamp. This was not an intentional treatment. The carbons made in 1878 were generally composed of paper having its surface treated with lamp-black and tar. I believe a few of the carbons made in 1878 were soaked after carbonization in tar, and recarbonized.

49 Q. I call your attention to the printed record of the testimony of A. Man, near the bottom of page 7, where he says "we use principally ordinary blotting paper." Have you had any experience in the carbonization of ordinary blotting paper, and if so, with what results?

463 A. Yes, sir. I have carbonized blotting paper. It makes a loose, non-coherent, friable carbon. Some kinds of blotting paper separate in carbonizing into two or three layers. When a current is passed through it, little arcs occur throughout the carbon, due to the loose contact of one fibre with another. I have made incandescent carbon conductors out of it, but they were not satisfactory.

50 Q. I further call your attention to another paragraph upon the same page of Mr. Man's testimony, at the bottom of the page, where he speaks of "rubbing down and working out by hand the carbon," and ask if you have ever had any experience in this kind of manipulation of paper carbon?

A. I do not conceive how it is possible to rub down a paper carbon made out of blotting paper, without it is very large, such as an eighth ($\frac{1}{8}$) of an inch square, and then I judge it would be exceedingly difficult. I never did this, nor did I ever see any one do it. If the carbon was anything like the flexible filament as shown in my flexible commercial electric lamp, I should say it is impossible. Further, I do not see the necessity of it, as any thickness of paper could have been used, and any desired shape could have been obtained from the paper in the first instance. It is not an easy matter to rub down blotting paper before it is carbonized.

51 Q. I call your attention further in the testimony of Albon Man, answers to the 4th and 18th questions, and ask if paper carbonized electrically as described can afterwards be made incandescent?

A. I have tried many experiments on the carbonization of paper, both by the passage of the current through a filament with plumbago on its surface and also by the passage of current through a platinum conductor on which the paper rested, and always found that the decomposition of the cellulose and water of the paper produced sufficient oxygen to consume all the carbon of the paper, and the result was that nothing was left but the natural ash. These experiments were conducted *in vacuo*. I do not see how it is possible to produce a carbon which could be used in a lamp by
464 simple carbonization of the paper by the heat produced by
the passage of the electric current in an atmosphere of nitrogen, hydrogen, or air.

52 Q. Referring to the 57th and $57\frac{1}{2}$ questions and answers of

Albon Man, what would become of a Florence flask filled with gas as described and subjected to currents of electricity?

A. I have placed illuminating gas in flasks similar to a Florence flask and in which there was an incandescing conductor of carbon, and on heating the same to high incandescence the globes exploded, due to the enormous expansion of the gas and decomposition of the same.

53 Q. Referring to answer to Q. 61 in the testimony of Albon Man, what comment, if any, have you to make on the statement that the oxygen of the salts would consume the paper?

A. I do not see how any oxygen salt would cause the paper to become a conductor. I do not believe there is a dry oxygen salt that is a conductor of electricity sufficient to allow a current to pass through a strip of paper impregnated with it. If it was moistened to permit of conductivity, the moisture would be evaporated before carbonization, because the water could not exist at a high temperature sufficient to carbonize. And if the water was dissipated the oxygen salt would not be a conductor.

54 Q. Referring to the answer to Q. 67 of Albon Man, what comment, if any, have you to make upon that?

A. I do not see that the treating of the paper carbon by a hydrocarbon gas, to deposit hard carbon, improves the paper carbon. If the paper carbon was originally bad, it will always remain so. If it is coated by deposition of hard carbon, the light is radiated then from a hard carbon and not from a paper carbon. If the paper carbon is to have a deposit of this hard carbon placed over it, and within it, it doesn't matter whether the paper carbon is good, bad or indifferent, or is any other form of carbon, or even a metal. The incandescing conductor of the lamp becomes really and truly 465 a hard-carbon conductor, as the major portion of the current passes through the hard carbon and all the light is radiated from it. If a paper carbon is dipped in different hydrocarbons several times and recarbonized each time, a deposit of hard carbon takes place on the surface as well as within the paper. The use of a hydrocarbon for depositing hard carbon by electrical incandescence, is only a method for rendering a useless carbon available in an electric lamp.

It is, in fact, an evidence of the imperfection of the carbon paper.

Answer objected to as being mere argument and not any statement of facts responsive to the question, the answer being mere criticism.

55 Q. In the foregoing answer have you expressed an opinion simply as an expert or spoken from knowledge derived from experiments made by yourself?

A. Derived from experiments made by myself.

56 Q. Referring to the answer of Albon Man to the 80th question, what effect would the glue mentioned in the answer have in the employment of the paper carbon for incandescence in a lamp?

A. The effect would be that when the same was placed in the lamp it would be carbonized, and a great amount of smoke would come out and obscure the globe. This is from my actual knowledge.

57 Q. Calling your attention to the answers of Albon Man to questions 83, 84 and 85, I ask what would be the result of carbonizing the paper described, in the way described, and working it down after carbonization as described?

A. The result of using several thicknesses of blotting paper pressed together would be that when they were carbonized they would all separate, each would be contorted in a different manner, and I do not believe they could be used or worked down, as stated by Mr. Man. I know this from my own experience. Could they have been kept together, which was impossible according to 466 the method of carbonizing described by Mr. Man, they might possibly have been worked down by emery paper, providing they were large enough, but from the sizes given by Mr. Man in another part of his testimony, I do not see how it is possible. It would seem that the proper method would have been to cut the paper in the form desired and then carbonize it, instead of cutting it in a form not desired and then working it down after it was carbonized.

That is a method of manufacturing by machinery or appliances.

58 Q. I call your attention to the sketch Sawyer's Exhibit No. 3, Albon Man, and ask if it would be possible for the spring clamp there shown to clamp the ends of the carbonized paper described.

A. I do not see how a practical lamp could be made with such clamps. Mr. Man has testified that the width of the carbon was from $\frac{1}{12}$ to $\frac{1}{20}$ of an inch, and as these carbons rest upon the plate of platinum *c* in the sketch, the length of the spring portion of the clamps would only be from $\frac{1}{12}$ to $\frac{1}{20}$ of an inch. This is manifestly absurd.

59 Q. I call your attention to the answer of Wm. E. Sawyer to the sixth question, and ask if such a carbon was used as an incandescent conductor in an electric light, what would be the source of light in the incandescent conductor?

A. The source of light would be a hard gas carbon and not the paper carbon.

60 Q. I call your attention to the answer of Wm. E. Sawyer to the eighteenth question, and to what is there stated about candle power, duration of burners, and fracture, and ask you to state from your own knowledge the results that would follow from the various conditions named in the answer.

A. The life of the lamp would depend upon the unit incandescence. Referring to Mr. Sawyer's answer to cross-question fifty-three, I have made a calculation as to the radiating surfaces of the carbon, whose size has been given by Mr. Man, and as to that of the carbon in my exhibit marked "Edison's Commercial In-467 candescent Lamp," and find that the candle power per unit surface is greater in my lamp at sixteen candles than in the lamp described by Mr. Man, giving thirty candles. In giving candle powers, the total radiating surface is the main factor which should be always given.

Had I the same radiating surface in my lamp, it would have given about thirty candles, and lasted just as long, theoretically. Practically, it would last longer, as the smaller and lighter the carbon the more difficult it is to manufacture it so perfect. To show how absurd it is to give candle power without the radiating surface, one might make a lamp that would give twenty-five candles when only brought up to a yellow heat. From my experience I should judge that the carbon made of the material and in the manner specified and used under the conditions specified, would last on an average about as long as was stated by Mr. Sawyer in his communication to the New York papers, about December 22d or 23d, 1879, that is, they would not last more than a few minutes. In fact, Mr. Sawyer stated in a communication to the N. Y. Sun, December 22d, 1879, which is now before me, and dated from 78 Walker street, December 21st, that a carbonized-paper lamp would not last three hours, and also stated that in practice it would not last twenty minutes in a perfect vacuum. Now, as Mr. Sawyer did not get anywhere near a perfect vacuum, and yet from his experiments predicated the statement that even in a perfect vacuum they would not last twenty minutes, the results obtained by Messrs. Sawyer & Man can be readily surmised. They were undoubtedly very dismal failures.

The article from the N. Y. Sun of December 22d, 1879, referred to in the foregoing answer, is put in testimony and marked Edison's Exhibit No. 8.

The exhibit is objected to upon the ground that there is no evidence that it was published in the N. Y. Sun, or that Mr. Sawyer wrote it. All reference made to the article in the witness' answer is objected to on the same ground. And upon the further ground that the article is not evidenced in any sense. 468

61 Q. Refer, if you please, to the descriptions given by the witnesses for Sawyer & Man and the sketches and drawings referred to by them in the printed record of Sawyer & Man's testimony, and taking into view the incandescent conductors employed, and the heat-radiators employed, and the other parts of the lamp, would such a lamp, in your opinion, be a practical lamp or not, giving reasons for whatever opinion you may express?

A. No, sir, it would not be a practical lamp. The testimony of even Messrs. Sawyer & Man, and the statements of Mr. Sawyer and his witnesses prove that it is not a practical lamp. No lamp has ever yet been devised up to the present date that was practical which had an inclosing chamber partially made of a cup of metal and secured to the glass by cements. In fact, Mr. Sawyer states the same in his patents, and shows many devices to obviate this defect. A sufficiently high vacuum cannot be obtained in chambers of this character to prevent oxidation and electric convection of the carbon. When the globe is filled with nitrogen, the atmospheric gases will still pass in, in the manner described by Graham in his experiments upon the transpiration and diffusion of gases. A great many inventors, including Messrs. Sawyer & Man, place their carbons in an atmosphere of nitrogen, on the theory that nitrogen is inert

towards carbon. It is well known that carbon at high incandescence combines with nitrogen to form cyanogen, and the cyanides due to ash of the carbon. My assistant, Dr. Moses, has obtained a chemical reaction for cyanogen compounds, formed by electrical incandescence of carbon in an atmosphere of nitrogen. To obviate the defects of an imperfectly sealed chamber, Messrs. Sawyer and Man introduce nitrogen gas, upon the theory that if the atmosphere in the globe is at the same atmospheric pressure as the exterior atmosphere, there will be no tendency of the oxygen of the exterior
469 atmosphere to pass within the globe, and that nitrogen is inert towards carbon. Both of these theories are wrong.

Another reason why the lamp would not be a practical lamp, is that the carbon in the lamp which Mr. Sawyer testifies was the perfected lamp, is not provided with thickened ends, whereby the incandescence of the carbon is reduced; hence it can only have its incandescence due to the passage of the current reduced by conduction of the heat away from the carbon at the point of contact. The carrying capacity and heat conductivity of these clamps are so small, compared to the size of the carbon, and the incandescence which it is necessary to bring the carbon up to, to give, say twenty candles, that the carbon at the points of contact would be partially incandescent, as the heat could not be conducted away fast enough, and a bad contact between the carbon and the clamps would necessarily follow, accompanied by small arcs, which would gradually increase and ultimately destroy the contact. The amount of energy lost by conduction would be far greater than that lost in the form of useful light. My assertions in this respect about the conduction of heat are verified by the construction of the lamp itself, where special means are employed in the way of radiators whereby the heat of conduction may be radiated so that the lamp will not get too hot. This energy is of course useless for light-giving purposes, and consumes nearly as much electricity as is required to produce a light of twenty candles in the carbon. The great heat also produces great differences of temperature in the inclosing case, and therefore difference in the expansion of portions of the case, which causes leakage from the atmosphere into the case. Another thing is, that if when the lamp is cold, the gases within it are at the same pressure as that of the atmosphere, this result will be changed when the lamp is lighted. The gas within the globe becomes expanded, and there is a different pressure, the tendency of which, if there is leakage, is to force the gas out of the lamp until the pressures are constant. If this takes place, and the lamp is allowed to cool, then the atmospheric pressure will be the
470 highest and there will be a tendency for the atmosphere to pass into the globe. For these and other reasons which could be mentioned the lamp which Mr. Sawyer calls his perfected lamp, is in my view entirely impractical, commercially, scientifically or otherwise.

I have previously stated the reasons why it would not be practical commercially in a previous part of my testimony. Its resistance would be too low to admit of practical subdivision, on account of the great investment required for copper conductors. It would not be sufficiently economical, on account of the energy lost by conduction and by convection through the residual gas.

Counsel for Edison gives notice that reserving the right to put in certain patents, the data of which he will procure, and exhibits of experiments in 1878, for which search is now being made during the course of this examination, he here rests his examination of Mr. Edison, and offers him for cross-examination. Counsel for Sawyer and Man gives notice that his cross-examination of the witness will be *de bene esse* as to all that part of the witness' testimony that is intended to show or goes to show that he made the invention previous to the date alleged in his preliminary statement, and that he does not intend that his cross-examination shall be construed as a waiver of any objection he may have entered of record, and that he will object and move to strike out, either before or at the hearing of the interference, any re-examination of the witness, or any testimony or exhibit put in that does not refer to new matter brought out in the cross-examination.

Cross-examination by AMOS BROADNAX, Esq., counsel for Sawyer and Man:

62 X Q. In answer to question 1 of your examination-in-chief, you say you are an inventor by occupation. Please state what inventions you were working on in the summer of 1876? 471

A. I was working on telephones, acoustic electrical transmission, electric pens, multiple copying apparatus, duplicating ink, galvanic batteries, sextuplex telegraphs, duplex telegraph, manufacture of carbon articles, and other things which I cannot now remember.

63 X Q. How much of your time during the summer of 1876 were you engaged in working on telephones? I mean, what time in the summer did you begin to work on telephones, and what time did you leave off?

A. I commenced to work on telephones in 1875. I have never left off since that date.

64 X Q. How much of your time was given to telephones during the summer of 1876?

A. It would be a difficult matter to divide my time up between all the things I was working on. I should say one-tenth of my time was given to speaking telephones.

65 X Q. Were you working in the summer of 1876 at one and the same time, or during the same period of time, upon all the inventions you mentioned in answer to 62 X Q.?

A. Yes, sir; I think I was.

66 X Q. Was there any exigency in the development of either of the inventions referred to by you that moved you to carbonize paper?

A. I have stated that one of the things I was working on was the carbonization of paper to form different articles. One of my assistants, Mr. Johnson, had formed or was about to form a company called the American Novelty Company, whose purpose was to work off some of the small inventions which I was making. The manufacture of a great many articles from carbon was one of these inventions. Among other things was an electrical sheepshearing machine, an electrical drill, an electrical engraving machine, ribbon mucilage, and other inventions which I cannot now remember. They were small things. I think he had a list of about twenty.

472 67 X Q. What articles did you propose to manufacture of carbonized paper?

A. Battery carbons, strips of carbon for electrical resistances, dishes for use in making chemical reactions, and tissue paper as a non-conducting packing.

68 X Q. How many of these articles did you make?

A. We made four or five crucibles, a great many flat sheets, and a half a pound to a pound of carbonized tissue paper.

69 X Q. How long did you continue to work at your experiments in the manufacture of articles of carbonized paper, in the summer of 1876?

A. I should say we tried experiments on and off for perhaps two months.

70 X Q. Please to state when you began your experiments and when you discontinued them, as near as you can recollect.

A. As near as I can recollect it was in the summer of 1876.

71 X Q. Can't you state at what time in the summer of 1876 you commenced your experiments, and at what time you discontinued them?

A. I should judge that it was about June or July, 1876.

72 X Q. State, if you please, when it was that you next took up the subject of carbonizing paper.

A. I think about January, 1877.

73 X Q. What circumstances moved you to return to the carbonization of paper in January, 1877?

A. Using it in a telephone.

74 X Q. How long did you continue to use carbonized paper in your telephone?

A. I think I used it as late as January or February, 1878; perhaps later. All my exhibits are in the telephone interferences, and I have nothing here to refresh my memory.

75 X Q. For what other purpose did you use carbonized paper in January, 1877?

A. I used it for resistances.

76 X Q. After January, 1877, did you discontinue the carbonization of paper?

473 A. No, sir. I think we carbonized paper when we wanted it, although we generally had plenty of it around the laboratory If none of it suited our purpose, we generally carbonized what we required.

77 X Q. Why did you use carbon made of paper in — telephone and in your battery, in preference to *your* carbon made of anything else?

A. Because it was in convenient form. We could get it in all the forms we wanted it. We also carbonized wood of various kinds, as well as paper.

78 X Q. Had the carbon made of paper no other superiority for the purpose for which you wanted it beyond that of mere convenience in manufacture?

A. In our telephones we had to have it in a great many experiments very thin. Hence paper was the most convenient material to use. For nearly all the purposes for which we used carbon, it was the most convenient material. In our telephone experiments we used every kind and character of carbon, and every form and shape. In 1877 most all our thoughts were on carbon and plumbago. It was carbon from Monday morning to Saturday night, month in and month out, and always in connection with its interpolation in an electric circuit.

79 X Q. When did you turn your attention to the subject of electric lighting?

A. In September or October, 1877.

80 X Q. Please to describe the first electric lamp you made or caused to be made.

A. I think my first experiments were with heating platinum wires to incandescence. Afterwards heating carbon paper up to incandescence in the atmosphere. Also, coating the carbon with powdered glass, which, in melting was to protect it from the atmosphere.

Also with powdered silicon. Also in the lamp marked "Edison's First Incandescent Lamp." Afterwards by the passage of current through pieces of boron and silicon, rendering them incandescent. Also silicon and boron placed between carbon points. All
474 these experiments, I believe, were conducted between September, 1877, and January, 1878.

81 X Q. You do not answer my question, which is repeated.

A. The first carbon electric lamp, if it may be called an electric lamp, was a piece of carbonized paper, about an inch long, one-sixteenth of an inch broad, and six or seven thousandths of an inch thick, the ends of which were secured to clamps, which clamps formed the poles of a battery. The carbon was brought up to incandescence, and of course oxydized immediately. That was one of the '77 experiments. The first lamp in vacuo, if it may be called a lamp, was Edison's Exhibit First Incandescent Lamp. This consists, as will be seen, of two clamps, forming the poles, between which a strip of carbonized paper was placed and secured by clamping. The base of the lamp being placed over the mouth of the hole on the platen of the air-pump, had the air exhausted from the globe as far as possible by our air-pump, and the carbon brought up to incandescence after the air due to the first heating had been pumped out.

82 X Q. Did your first experiment in electric lighting consist of a section of carbon made of paper placed in an electric circuit in the open atmosphere, to which you applied a current and burnt up the carbon?

A. I have already stated that I first tried platinum, but we will leave this out of consideration, and my answer will be yes. It was a mere experiment with the carbon in open air. I knew beforehand what it would do. It was to ascertain, I think, the amount of current required to bring it to incandescence.

83 X Q. When was that experiment made? State the date, as near as possible.

A. It might have been in September or in October, 1877.

84 X Q. Was it surely in one or the other of those months?

A. I am not absolutely sure, but my impression is it was in either one of those months.

475 85 X Q. You are certain that it was in the year 1877?

A. Yes, sir; I know it from my Exhibits Nos. 4 and 5.

86 X Q. Was that the first attempt that you made to use carbon made of paper in electric lighting?

A. The first premeditated attempt to use paper for lighting by incandescence. I have stated that one of our objects in 1876 was to make carbons for electric lighting, but not by incandescence.

87 X Q. When did you make your next attempt to use carbon made of paper in incandescent electric lighting?

A. In September, October or November, 1878. I should say October is the month we started to make paper carbons.

88 X Q. You say that your first premeditated attempt at using carbon made of paper for incandescent electric lighting was in September or October, 1877, when you placed a piece of carbonized paper in circuit in the open air, for the purpose of ascertaining the amount of current to make it incandescent. And that your next attempt was in the fall of 1878. Now please to state whether this second attempt embraced the Exhibit "Edison's First Incandescent Lamp."

Question objected to by counsel for Edison as containing a misstatement of the witness' testimony.

A. My second attempt was not in the fall of 1878. I have already stated in my testimony that my first attempt at making an incandescent carbon lamp, if it can be called a lamp, was made in September or October, 1877, and consisted in bringing a strip of carbonized paper up to incandescence in the air. And my next attempt to make an incandescent lamp with carbon paper, if it may be called a lamp, was that shown in Edison's Exhibit First Incandescent Electric Lamp, which was also made in 1877, within a day
or two of the first experiment. The attempts made at coat-
476 ing the paper with glass and silicon are not taken into con-
sideration in this answer.

89 X Q. Then, as I understand you, your first and second attempts at electric lighting with carbon made of paper were made either in the month of September or October, 1877, the second attempt being made within a few days of the first?

A. Yes, sir; lighting by incandescence of carbon paper.

90 X Q. The first attempt was the use of the carbonized paper in

the open air, and the second embraced the lamp marked "Edison's Exhibit First Incandescent Lamp"?

A. Yes, sir.

91 X Q. Do you fix the times at which these attempts were made by the Exhibits Edison No. 4 and Edison No. 5?

A. Yes, sir; these exhibits refresh my memory, as to experiments conducted at that time, and previous thereto.

92 X Q. What is there upon Exhibit No. 4 that calls your attention to any experiment made in electric lighting by incandescence with carbonized paper?

A. The exhibit merely refreshes my memory so as to enable me to state the date of the time when I did try experiments with carbonized paper. The exhibit is headed "electric light," and explains itself.

93 X Q. Do you find anything on the exhibit that makes any reference to electric lighting by indandescence with carbonized paper?

A. No, sir; I do not. I have already stated that the exhibit serves only to refresh my memory as to the date. The reason why boron and silicon were used is that they are not so sensitive to oxidation as the paper previously tried.

The last part of the answer is objected to by counsel for Sawyer & Man as irresponsive.

94 X Q. In whose handwriting is Exhibit No. 4?

A. Most of it is in my own handwriting.

477 95 X Q. There is a strip of Exhibit No. 4 torn out between the names of Mr. Charles Batchelor and J. Kruesi. Who tore that out?

A. I do not know. Those papers were originally in books, and the books were all destroyed, and the sheets forming the same numbered and bundled together. The most of them were used as exhibits in my telephone interference.

96 X Q. Was there any one else's signature written upon this paper between the names of Charles Batchelor and J. Kruesi?

A. I do not know. I do not think so. It looks as if it had been stuck on a paper file and torn off.

97 X Q. Who made the diagrams upon this paper Exhibit No. 4?

A. I did.

98 X Q. When were the diagrams and writing made upon this paper—so much of them as was made by you?

A. At the date stated thereon.

99 X Q. There are two dates on the paper. Which date do you mean—the date on the right-hand corner at the top, under which your name is signed?

A. I refer to the date November 1st, 1877.

100 X Q. There is a memoranda at the bottom of the paper as follows: "Copied in volume No. 1, experimental researches, page 115, September 28, 1878." Signed William Carman. Who is William Carman?

A. He was at that time, and is now, my book-keeper at Menlo Park.

101 X Q. Does that memoranda show the correct date of the record of this paper?

A. It shows the date when it was recorded in the book, as set forth.

102 X Q. Why was it not recorded until September 28th, 1878?

A. Because about that date we commenced collecting all the scraps and memoranda relating to experiments together, for the purpose of preserving them, and especially those relating to telephones, of which there were several thousand, now used as exhibits in the interferences on telephones.

478 103 X Q. Have you got that book in which this paper is recorded, and, if so, will you produce it for my examination?

A. I have it at Menlo park, I think. I will have it brought in.

104 X Q. It appears by this paper that some time previous to November 1st, 1877, you had "tried boron, ruthenium, chromium, and the almost infusible metals for separators in my electric-light device. Boron is very high resistance, and would do if arranged thus." Then follows a diagram. It is then stated that "cilicium, on the other hand, is of very low resistance, and would have to be arranged thus." Then follows another diagram. Then follows these words: "I think powdered silicium, mixed with lime or other very infusible non-conductors or semi-conductors, would be good." Now, if previous to the making of this paper by you, you had attempted the use of carbonized paper for incandescent electric lighting, how did it happen that you didn't mention it on this paper with the other substances or materials referred to by the paper?

A. Because I had got done with my experiments on carbonized paper. The results were so unsatisfactory, even when the carbonized paper was in the vacuum which we obtained. Its sensitiveness to oxidation was one of the factors which led me to try experiments on silicon and boron, which were not so sensitive to oxidation. I thought that as we could not get carbon to stand, that these non-oxidizable materials might be made to stand. I have had pieces of silicon, separating the two electrodes, incandescent for an hour at a time. Had the carbon experiments been as satisfactory, I would undoubted- be able to present an exhibit in which some of them would be recorded.

104½ X Q. Do the experiments referred to by this paper, Exhibit No. 4, make part of your efforts at electric lighting by incandescence?

A. Yes, sir; as well as my Exhibit No. 5.

105 X Q. Did you, at the time referred to by this paper, keep written memoranda of all your attemps at electric lighting?

479 A. No, sir; I do not think I did.

106 X Q. Did you keep a written memoranda of all the experiments that yielded results of any value?

A. No, sir; I do not think I did. The exhibits themselves state that I tried experiments, and yet I have no record of them.

107 X Q. What is there in the paper, Exhibit No. 4, that satisfies your mind, that your first and second attempt at electric lighting by incandescence with carbonized paper was previous to the date of the paper?

A. It refreshes my memory as to the fact that I was trying experiments on electric lighting by incandescence, and it permits me to remember that my first experiments were with platinum and carbonized paper.

108 X Q. Then, as I understand you, you know certainly by this paper, that the experiments noted on it were made on or before its date, which is November 1st, 1877, and to the best of your recollection, the experiments with the carbonized paper embraced in your first and second attempt at electric lighting by incandescence, were made previous to the date of the experiments noted on that paper?

A. Yes, sir; that allows me to fix the date.

109 X Q. Did Mr. Charles Batchelor and Mr. J. Kruesi sign their names upon this paper in your presence at the time the paper was made?

A. I cannot say; our habit was to have the papers witnessed within a day or two of the date placed upon them.

110 X Q. Please to mark the diagrams on this paper, Exhibit 4, figures 1 and 2 respectively?

A. I have done so, as requested.

111 X Q. Does Fig. 1 of these diagrams represent a number of lamps set in multiple arc, and if so, please to designate the lamps by letter *a*?

A. It does so represent, and I have designated them by letters a, a^1, a^2, a^3.

112 X Q. State, if you please, whether figure 2 represents lamps set in series, and if so, please designate the lamps by letter *b*?

480 A. It does so represent, and I have designated the lamps b, b^1, b^2.

113 X Q. The word "magneto," as I understand it, written by the two diagrams, is intended to designate an electric generator?

A. Yes, sir.

114 X Q. Who is Mr. Charles Batchelor?

A. He is one of my assistants.

115 X Q. How long has he been in your employ?

A. About ten (10) years.

116 X Q. Who is Mr. J. Kruesi?

A. A machinist in my employ.

117 X Q. How long has he been in your employ?

A. I think about (7) years.

118 X Q. In whose handwriting is Exhibit Edison No. 5?

A. Nearly all in my handwriting.

119 X Q. When was it made?

A. On the day of its date, that is, December 3d, 1877.

120 X Q. Was this paper, Exhibit No. 5, witnessed by Charles Batchelor, M. N. Force, and J. Kruesi in your presence?

A. I cannot say.

121 X Q. Do you know the signatures of those gentlemen?

A. Yes, sir.

122 X Q. Can you swear that their signatures are signed upon this paper?

A. Yes, sir.

123 X Q. Can you swear when the signatures were made?

A. No, sir; but my impression is, they were made within a day or two after the date on the paper; that was our habit.

124 X Q. And this paper, Exhibit No. 5, assures you that the experiments noted on it were made on or before the day of its date, and that to the best of your recollection, your first and second attempt at electric lighting with carbonized paper was made before the date of that paper?

481 A. I have already testified that it was made before the date of Exhibit No. 4, which is an earlier date than Exhibit No. 5.

125 X Q. Does either Exhibit No. 4 or No. 5 make any reference to your experiment with carbonized paper in electric lighting?

A. No, sir; they merely refresh my recollection as to dates.

126 X Q. Who made Edison Exhibit First Incandescent Lamp?

A. I don't know; we bought it. It was a well-known school apparatus for illustrating the electric brush *in vacuo*. The changes necessary to try the experiment on carbonized paper were made by or through the orders of Mr. Charles Batchelor.

127 X Q. Did you buy the lamp yourself?

A. I do not know, I cannot remember, but my impression is I did.

128 X Q. Where did you buy it?

A. I cannot remember that, but my impression is I bought it of a firm called Luhme & Co.

129 X Q. Where?

A. New York.

130 X Q. Give the street and number in New York?

A. I don't know the street or number. It was down near the post office.

131 X Q. Do you recollect what you paid for it?

A. No, sir.

132 X Q. Was the place at which you purchased it, north or south of the post office?

A. It was south of Chamber- street and north of Vesey street.

133 X Q. Was it west of Broadway?

A. And west of Broadway.

134 X Q. Is that as near as you can locate the place where you purchased the lamp?

A. Yes, sir.

135 X Q. Have you now a distinct recollection that you did purchase the lamp yourself?

A. No, sir; I have only an impression.

482 136 X Q. Who do you think would have purchased it if you did not?

A. It might have been purchased by letter or by messenger boy.

137 X Q. You are sure it was purchased of the firm of Luhme & Co., in the city of New York?

A. No, sir; I am not; but my impression is that it was.

138 X Q. Were you in the habit of dealing with that firm?

A. I was in the habit of dealing with that firm, and a firm named Benjamin & Co., I think.

139 X Q. Where is the firm of Benjamin & Co.?

A. I think it was somewhere south of Chambers, north of Vesey, and west of Broadway.

140 X Q. What does Luhme & Co. deal in, and what does Benjamin & Co. deal in?

A. In philosophical apparatus.

141 X Q. This lamp, Edison Exhibit First Incandescent Lamp, that you say you think you purchased, what was the name of the apparatus when you purchased it?

A. My impression is, it is called a "Gassiot cascade."

142 X Q. What alterations did you make in this cascade to adapt it to your purpose in making your experiments in incandescing electric lighting with carbonized paper?

A. Clamps were placed in it to hold the carbon, and binding posts outside to hold the conducting wires.

143 X Q. How many experiments did you try with this lamp?

A. My impression is that we tried two or three experiments.

144 X Q. How large was the piece of carbonized paper which you used in this lamp? Give the length, the breadth and the thickness of it.

A. My impression is that it was about an inch long, $\frac{3}{16}$ broad, and I think somewhere less in width than $\frac{3}{16}$; I should say they were eight-thousandths of an inch thick.

483 145 X Q. Did you carbonize the paper especially for these experiments?

A. I do not remember whether we used some carbonized paper we had on hand, or carbonized it expressly for the occasion.

146 X Q. How did you get the carbonized paper in the lamp?

A. Mr. Batchelor put it in.

147 X Q. You don't know how he got it in?

A. No, sir; I don't.

148 X Q. What degree of vacuum did you get in this lamp?

A. My impression is we got two and half millimeters of mercury on a gauge, which represents, if the gauge was correct, that the column of mercury was within two and a half millimeters of a perfect vacuum.

149 X Q. How much is a millimeter in inches?

A. It isn't an inch; two and a half millimeters are about a tenth of an inch.

150 X Q. What was the resistance of the carbonized-paper burner that you used in this lamp?

A. I did not measure it.

151 X Q. What strength of current did you have on it?

A. We had about 50 cells of carbon battery, but I do not remember how many we used on it.

152 X Q. Did you get the carbonized paper to brilliant incandescence?

A. No, I do not think so.

153 X Q. How long did the carbonized paper last in the lamp?

A. My impression is that it only lasted six or eight minutes.

154 X Q. How long was you engaged upon these experiments with this lamp?

A. I do not think more than a day.

155 X Q. Were they made at your laboratory, Menlo park?

A. Yes, sir.

156 X Q. How did you exhaust the air out of the lamp?

484 A. By an air-pump.

157 X Q. Was it a pump you had on hand, or did you buy it for the occasion?

A. A pump I had on hand.

158 X Q. Did you prepare the lamp for the experiment yourself, or did Mr. Batchelor prepare it?

A. Mr. Batchelor.

159 X Q. Did you see Mr. Batchelor put in the paper carbons?

A. I don't remember it.

160 X Q. How do you know that paper carbons were actually put in the lamp?

A. Because I told him to put them in, and I saw them after they were in.

161 X Q. How could you distinguish a carbon made of paper from any other carbon?

A. Very easily, by its looks.

162 X Q. How does it differ in appearance from carbon made of wood?

A. It is very difficult to describe the difference in appearance, still, when once a person has seen the two, he can distinguish them readily. The fibres of the paper are still visible after carbonization, while the wood shows the cellular formation.

163 X Q. Why did you not continue your experiments upon the use of carbonized paper for incandescent electric lighting in this lamp?

A. Because the results didn't warrant it.

164 X Q. Upon the conclusion of your experiments with this lamp, did you abandon the attempt at electric lighting by incandescence with carbonized paper?

A. No, sir; we laid it aside and took up what we thought at the time was more promising—the use of silicon and boron for incandescent lighting.

165 X Q. State, if you please, whether the paper marked Edison Exhibit No. 1 is an illustration of your first attempt at electric lighting by incandescence, with carbonized paper, in the fall of 1877, about which you been testifying.

A. No, sir; it is an illustration of experiments conducted in the fall of 1878.

485 166 X Q. In answer to question 9 of your examination-in-chief, which is as follows (counsel reads question and answer

to witness), state, if you please, whether in that answer you referred to Edison Exhibit First Incandescent Lamp, which you subsequently produced.

A. Yes, sir.

167 X Q. Then, as I understand you, the attempt illustrated by Edison Exhibit No. 1, followed the attempt embraced in Edison Exhibit First Incandescent Lamp; the latter being made in September or October of 1877, and the former in October or November of 1878? I mean, of course, in incandescent electric lighting with carbonized paper.

A. Yes; this Exhibit No. 1 is an illustration of experiments conducted in September or October, 1878, with incandescence of carbonized paper.

168 X Q. Then this paper, Exhibit No. 1, as I understand you, represents your third attempt at incandescent electric lighting with carbonized paper?

A. No, sir; it represents the second in point of date. My understanding of "attempt" at incandescent lighting is, that it means all those experiments made within a few days of each other, forming a group. The experiments in 1877 are my first attempt, those in 1878 my second attempt, and those in 1879 my third attempt.

169 X Q. Well, then, referring to Edison Exhibit No. 1, as your second attempt, please to state whether the exhibit is intended to represent the whole or a part of an experiment with carbonized paper in incandescent lighting in vacuum.

A. They represent a few of the experiments tried at that time on the incandescence of carbonized paper, but not *in vacuo*.

170 X Q. Please to describe the first electric lamp or apparatus in which you used carbonized paper for incandescent electric lighting *in vacuo*, in October or November of 1878?

A. My impression is that it consisted of a piece of carbon-
486 ized paper coated with tar and lamp-black, and carbonized,
placed in clamps connected to the circuit, and placed under
the bell jar of the vacuum pump. I am not absolutely sure that this experiment was tried in September or October, but it was tried not later than December, 1878.

171 X Q. What do you mean by the "bell-jar" of the vacuum pump?

A. The bell-jar that usually accompanies vacuum pumps, in which the vacuum is obtained.

172 X Q. Was the bell-jar of glass?

A. Yes, sir.

173 X Q. Please to illustrate the arrangement, and describe it by letters of reference?

A. This sketch represents the arrangement as I recollect it. A represents the platen and bell-jar of the vacuum pump; B is the bell-jar, *c* is the platen, *d* and *e* are binding posts; *f* and *g* of figure 2 are metal pieces, connected through the iron of the platen to the binding posts; *h* and *k* are insulating pieces; *m* and *n* are metallic prongs which fit against these metallic pieces *f* and *g* when pressed down on their sides. This connects the circuit with *m* and *n*. The electrode *p* holding the carbon is connected to *n*, while the other electrode connecting the other end of the carbon and marked Q is connected by a wire with *m*. Thus the circuit was complete from one binding post to the other through the carbon when the bell-jar was on. The bell-jar represents the vacuum chamber of the pump in which the light was produced.

This sketch is put in evidence by counsel for Sawyer and Man as an illustration of the witness' testimony, and marked Edison Exhibit No. 9.

174 X Q. How many experiments did you make with carbonized paper in the vacuum chamber of this pump as you have described?

A. My impression is that we made three or four experiments.

487 175 X Q. Were the experiments made by you personally or in your presence?

A. I think they were made by myself and Mr. Batchelor, and perhaps Mr. Upton.

176 X Q. Who prepared the pump for the experiments?

A. I don't remember.

177 X Q. Did you witness the experiments yourself?

A. I witnessed some of them.

178 X Q. Did you see the carbonized paper put in the vacuum chamber?

A. I saw it in the chamber. I don't remember seeing it put in.

179 X Q. Are you able to swear, of your own knowledge, that the carbon in the vacuum chamber was made of paper?

A. Yes, sir; some were made of paper, and some of carbonized broom corn.

180 X Q. Were the papers carbonized expressly for the experiment?

A. I think they were carbonized for the experiment shown in Exhibit 1, and had been carbonized previous to this last experiment.

181 X Q. Do you mean that they were carbonized expressly for those experiments which you say were made in October or November, of 1878, and were they carbonized at the time of the making of those experiments?

A. Mr. Batchelor, I believe, had made fifty or more of these carbons for experiments in September or October, 1878, some of which are illustrated as used in Exhibit No. 1.

182 X Q. What size were the carbons used in the experiments made with the pump?

A. My impression is that they were about one thirty-second in diameter, and an inch or two inches in length.

183 X Q. Was the carbon that you used in Edison Exhibit First Incandescent Lamp, straight or curved?

A. Straight.

488 184 X Q. What was the success of your experiment with carbon in the vacuum chamber of the pump?

A. We could not make the carbon stand, although we had pieces of potassium, and also sodium, within the chamber.

185 X Q. What was the resistance of the burner?

A. We didn't measure it.

186 X Q. What was the strength of the current?

A. I think the strength of the current was four or five vebers, or four or five thousand foot pounds.

187 X Q. What degree of vacuum did you have upon the burner?

A. I think about $2\frac{1}{2}$ or 3 millimeters, which we read off from a mercury gauge which came with the pump, and was the best vacuum generally obtainable with a pump.

188 X Q. Please to describe the next lamp you made, if any, in October or November of 1878, in which you used carbonized paper for incandescent lighting in a vacuum.

A. I don't think we tried any other experiments than the ones I have here recited *in vacuo*, in 1878.

189 X Q. That, then, as I understand you, completes what you call your second attempt at electric lighting by incandescence with carbonized paper?

A. That, and including the devices illustrated in Exhibit No. 1, and patent No. 224,329, this arrangement being similar to that shown in Mr. Sawyer's patent 219,771, dated September 16th, 1879.

190 X Q. Do you wish to be understood as saying that you made a lamp in the fall of 1878 like that shown and described substantially in patent 224,329, dated February 10th, 1880, and used carbonized paper in it for incandescent electric lighting?

A. Yes, sir; we used carbonized paper and carbonized broom corn in it in September, October or November, 1878.

191 X Q. Does the specification making part of that patent, make any reference to the use of carbon made of paper?

A. No, sir; it does not; it merely mentions carbon, and does not mention the kind of carbon.

489 192 X Q. Why did you not describe in that specification the use of carbon made of paper in that lamp?

A. Because that was not part of the invention. We made these slender pencils of carbon, because it was the easiest way to make carbon, as we had no mill for grinding carbon or mold for molding it, and hence made the pencils in the most convenient way, such as coating paper with tar and rolling it up and carbonizing it, and also by carbonizing broom corn.

193 X Q. Did you make and use an electric lamp like that of the patent last referred to in the fall of 1878?

A. Yes, sir.

194 X Q. Then, in addition to the experiments made with the paper carbons in the vacuum chambers of the pump in the fall of 1878, you also experimented with the same kind of carbons in the lamp of the patent 224,329, as I understand you?

A. Yes, sir.

195 X Q. Were the experiments with the lamp of the patent referred to made *in vacuo?*

A. No, sir; they were made in the open air, and were to obviate the use of a vacuum.

196 X Q. At the time you experimented with this lamp of the patent referred to, had you discovered the superiority of carbon made of paper for incandescent electric lighting over other carbon?

A. No; only it was very convenient material to use.

The witness desires to add to his answer the following:

My answer is changed to this: No; only it was very convenient material to use, and was organic carbon.

197 X Q. Referring now to Edison's commercial incandescent electric lamp, state when it was that you first made a lamp of the form and substance of this exhibit.

A. I think duplicates of this lamp, as to form, shape and material, were made some time in October, 1879.

198 X Q. Have you got the original lamp of the form of this exhibit?

A. I have not been able to find it within the last two or three days, but my impression is that I can produce one of the first six made.

199 X Q. Was the first one of the same size that this exhibit is?

A. The globe was about the same size. It was made in the same manner, except that the paper, which was parchmentized paper, was wider than it was thick, and was bent over in the form of an arch.

200 X Q. Were the metal conductors put in in the same way they are put in this exhibit?

A. Yes, sir.

201 X Q. Was there a section of platinum interposed in the conductor between the copper and the carbon?

A. Yes, sir.

202 X Q. And the interior glass bulb was contained in it the same as in this one, was it, and the lamp sealed in the same way?

A. Yes, sir.

203 X Q. Please to give the dimensions of the carbons used in those first lamps like this exhibit.

A. The first lamp of this peculiar character with paper carbon had a carbon about a thirty-second of an inch wide, six or eight thousandths of an inch thick, and about two inches and a half to three inches in length before carbonization. It was cut straight and had thickened ends, and was bent in the form of an arch before carbonization. After being put in the lamp, the height of the arch, I should judge, was about an inch or an inch and an eighth. Within a day or two afterwards we cut loops out of paper of the form desired, the same as shown in my Exhibit Commercial Incandescent Electric Lamp, and the same as shown and described in my application in this interference.

204 X Q. Referring still to the first lamps like this exhibit, state, if you please, what resistance the carbon had in those lamps?

A. The rssistance of a unit length and mass of paper carbon is generally the same, whether the lamp has one ohm or a thousand

ohms resistance. The resistance of the whole carbon probably was
a hundred and twenty-five ohms cold, and perhaps seventy-
491 five ohms at sixteen candles. Carbon decreases its resist-
ance when heated, but not in direct proportion to the rise of
temperature. I do not think we measured the resistance of the
carbon in the first lamp, but only judged it.

205 X Q. To what degree of perfection did you get the vacuum in the first lamps like this Exhibit Edison's Commercial Lamp?

A. My impression is that they were exhausted to the one-millionth of an atmosphere.

206 X Q. To what degree of luminosity did you raise the carbon?

A. I think we raised it as high as 30 or 40 candles.

207 X Q. How long did it last, raised up to that degree of luminosity?

A. We did not keep it for more than half an hour at that degree of luminosity. My impression is that at from 12 to 16 candles it lasted over a hundred hours.

208 X Q. Of continuous illumination?

A. Of continuous illumination; yes, sir.

209 X Q. Referring now to this particular lamp, Edison's Exhibit Commercial Incandescent Lamp, you say in answer to Q. 33, examination-in-chief, that it burnt either 70 hours and 18 minutes, or 250 hours and 40 minutes. Can't you state any more definitely than that the time that the lamp did actually burn?

A. No, sir, I cannot. In my book, in which is recorded the life of 150 or more lamps, I find that the record of the life of this lamp is put down in ink as 251 hours and 41 minutes; but this has been partially scratched off, and 70 hours and 18 minutes substituted.

210 X Q. And you cannot tell which is the correct data, as I understand you?

A. No, sir

211 X Q. Please to read from your record book all the memoranda
and data you have in writing that refers to this particular lamp—
Edison's Exhibit Commercial Incandescent Lamp?
492 A. I think I have other records of this lamp, and will try
and find them. I read now from the book referred to,
page 39:

"Street lamp top of stairs, right hand, 235.

Resist. —— January 2d, noon. Burnt .40. January 3d, 19.30; Jan'y 4th, 9.58; Jan'y 5th, 20.50; Jan'y 5th, 3.47;

6, 20.26; 7, 12.15; 8, 22; 9, 9; 9, 6.50; 10, 19.15; 11, 7; 12, 11. Total time burnt, 70.18. Carbon bu-sted.

Total time burned 207.36 up to 5 p. m.

251.41 up to noon."

A portion of the record is scratched out.

212 X Q. Please to permit me to examine the record from which you have read in answer to the last question.

(Witness hands the record to the counsel.)

213 X Q. Does this record show the resistance of the lamp?

A. No, sir.

214 X Q. Does it show the luminosity of the lamp?

A. No, sir.

215 X Q. Does it show the degree of vacuum in the illuminating chamber?

A. No, sir.

216 X Q. Does it show when the record was made?

A. It shows that it was January 2d, at noon, but does not state the year; but on page 38, one page before this record, lamp 153, a date, January 2d, 1880, is recorded, and I know that this was in 1880. Lamp 153 had a resistance of 132 ohms, and lasted over 200 hours.

Last part of answer objected to by counsel for Sawyer & Man as irresponsive and impertinent, as no inquiry is being made about the record of lamp 153.

217 X Q. Can you swear that this record you have quoted was made January 2d, 1880?

A. I can swear it was made within four or five days of that date. I think I shall be able to produce a witness who made these records. 493

218 X Q. In whose handwriting is this record you have quoted?

A. In Mr. Batchelor's handwriting, and Mr. Herrick's, I think.

219 X Q. Which of it is in Mr. Charles Batchelor's handwriting, and which of it is in Mr. Herrick's handwriting?

A. The words "street lamp, top of stair, right hand. Resist. Burnt 40," are in Mr. Charles Batchelor's handwriting, and all the rest is, I think, in Mr. Herrick's handwriting.

220 X Q. How does it happen that the date of the record is January 2, noon, and the burning of the lamp appears to have commenced on January 3d, and continued down to January 12th, taking the whole of the dates into account, including those that are crossed out?

A. It could not have commenced on January 3d, because the record states that up to January 3d it had burned 19.30, which means 19 hours and 30 minutes from January 2d; it had also burned 40 hours before January 2d.

221 X Q. Apart from this record, have you any distinct recollection of the burning of this lamp?

A. I have an indistinct recollection. It would be a hard matter to recollect any particular lamp out of a hundred nearly all alike. Upon the lamp it is marked "depot," and I remember it there. It was in a very conspicuous place and must have been seen by many thousand people.

222 X Q. You did not make this record yourself, as I understand you, and did not see it made.

A. I did not make it myself. I don't remember that I saw it made: but I remember that I watched these records pretty closely, and must have seen it within a day or so after it was made.

223 X Q. How does it happen that the whole record was not made by one person?

A. I think because Mr. Batchelor started the record, and
494 then got an assistant to carry it out more in detail. He will doubtless be able to testify on that subject.

224 X Q. Are you able to swear that the record was made as it appears here, all at one time, and that that time was during the performance of the lamp that is noted here?

A. I am able to swear that I believe it to have been made in the manner and on the dates set forth in the record.

255 X Q. Is part of the record in lead pencil and part of it in ink?

A. Yes, sir.

226 X Q. Please to state what part is in lead pencil?

A. Figures "235, street lamp, top of stairs, right hand. Resist. Burnt 40. Jan'y 2, noon, 70.18;" and some cross pencil marks.

227 X Q. Please to state what part of the record remains intact—that is not crossed out?

A. "235, street lamp, top of stairs, right hand. Resist. Burnt 40. Jan'y 3d, 19.30; 4, 9.58; 5, 20.50. Total time burned: 70.18; Jan'y 2, noon."

228 X Q. Is the rest of the record crossed out with ink and lead pencil?

A. Yes, sir.

229 X Q. Who crossed it out, and when was it done?

A. I don't know who did it, or when it was done.

230 X Q. Now, this lamp, Edison's Exhibit Commercial Lamp, and those few that preceded it, about which you have testified this morning, embrace, as I understand you, your third attempt at electric lighting by incandescence, with carbonized paper?

A. I testified regarding a few, but there were more than a hundred made by the end of December, 1879, all of this character, with carbonized paper. These constitute my third attempt in connection with all that I have done since.

231 X Q. What I want to know, Mr. Edison, is whether this lamp and all the lamps that you made having the form and substance of this lamp: "Edison's Exhibit Commercial Incan-
495 descent Lamp," embraced your third attempt at electric lighting by incandescence, with carbonized paper?

A. In October we commenced making lamps of the same character as to form, with paper carbon, as shown in Exhibit Edison's Commercial Incandescent Lamp, and have continued to make them ever since. This is my third and successful attempt at lighting by the incandescence of carbon made from paper.

232 X Q. Do you mean to swear, now, that your first and second attempts at electric lighting by incandescence with carbonized paper, were successful?

A. The first attempt I did not consider successful, except that it showed that if carbon could be made to stand, that it could be made successful; and my second attempt was successful in the form shown in patent No. 224,329, but *in vacuo* it was not successful, except that it proved that carbon from paper or organic material, would be a success for lighting by incandescence, if it could be made to stand.

233 X Q. How long did you use the lamp of patent 224,329?

A. My impression is, that we used it several days.

234 X Q. Have you got any memoranda in writing of its performance?

A. I do not think I have, that is dated.

235 X Q. Have you got any written record that you can swear represents the performance of this lamp?

A. I think among my records I may have something, but in hunting I neglected generally those records that have no dates.

236 X Q. How much of the time did you use this lamp with carbonized paper?

A. I should say carbonized paper was used in it on and off several hours, burning. In this lamp we used both carbonized broom corn and carbonized paper.

236½ X Q. Is the illuminating portion of this lamp intended to be inclosed in a glass chamber?

A. Yes, sir, partially of glass.

237 X Q. Between the time that you discontinued your experiments in the electric lighting by incandescence with carbonized paper, in the fall of 1877, and the time you commenced 496 to experiment again upon the same subject in the fall of 1878, as you have testified, was you engaged any of the time in experimenting upon electric lighting by incandescence?

A. My impression is that I did try some experiments in electric lighting by incandescence, but I can find no record to refresh my memory.

238 X Q. If you have any distinct recollection of any experiments made within the period mentioned in my last question, please to describe them?

A. I only have an impression.

239 X Q. You can't describe any experiments?

A. No.

240 X Q. Now, between the time that you discontinued your experiments in incandescent electric lighting with carbonized paper in the fall of 1878, and the time you commenced them again with carbonized paper in the fall of 1879, did you make any experiments in electric lighting by incandescence?

A. Yes.

241 X Q. What substance or material did you use for the illuminating portion of your lamp in such experiments?

A. Platina and other materials.

242 X Q. How much of the time embraced within my question (240 X Q.) were you engaged in experimenting with plantinum and material other than carbon?

A. Except perhaps some experiments with carbon, in January, 1879, we were engaged night and day between the times named.

243 X Q. During the period included in my X Q. 240, how many experiments did you make in incandescent electric lighting with carbon that was not made of paper?

A. I don't remember any experiment made with carbon that was not made with carbon paper or carbonized broom corn.

244 X Q. What experiments did you make with carbon made of paper in January, 1879?

A. In some form of lamp analogous to that shown in patent 224,329.

497 245 X Q. Please to describe the lamp in which you employed carbon made from paper for incandescent lighting in January, 1879.

A. It was a lamp similar to Fig. 2 in the patent 224,329.

246 X Q. How did it differ from the lamp described in the patent mentioned in your last answer?

A. I think the carbon was shoved down by a spiral spring.

247 X Q. How much carbonized paper did you use in such lamp?

A. Perhaps a length of it; about two or three inches.

248 X Q. Can you produce that lamp?

A. No, sir; it is substantially the same kind of a lamp as that shown in Fig. 2, patent 224,329.

249 X Q. Was the carbonized paper used *in vacuo?*

A. No, sir.

250 X Q. What was your object in making this experiment with carbonized paper in January, 1879?

A. To make what we called a "shop lamp"—one in which the current only had to be subdivided in a shop and not over a large area, where high resistance was not absolutely essential.

251 X Q. Why did you use carbon made of paper in preference to carbon made of anything else in that lamp and for that experiment?

A. Because it was easy to make, and produced the proper kind of contact desired, and we had no means of making hard carbons with any degree of facility.

252 X Q. Was the paper specially carbonized for that experiment?

A. I cannot remember.

253 X Q. Was the experiment made in your presence?

A. I think I made it myself.

254 X Q. What was the result?

A. It worked fairly.

255 X Q. Why have you not mentioned this experiment in your previous testimony?

A. I forget why; perhaps, because the question has not been asked me.

498 256 X Q. Did you make any other experiments between the fall of 1878 and the fall of 1879 with carbonized paper for incandescent electric lighting than those you have already testified about?

A. No; I think not with carbonized paper.

257 X Q. Have all of your attempts of electric lighting been by incandesence?

A. No, sir; not all, but most all.

258 X Q. Is it your conviction now that electric lighting by incandescence can be successfully accomplished with carbon made of paper *in vacuo?*

A. Yes, sir; it was successfully accomplished by me.

259 X Q. State, if you please, when it was that you first reached the conviction that electric lighting could be successfully accomplished by carbonized paper *in vacuo?*

A. In September or October, 1879; that it could be accomplished by the use of carbonized paper in high and stable *vacuo*, which were the proper conditions.

260 X Q. Did you, previous to September or October, 1879, make and use carbonized paper for electric lighting by incandescence *in vacuo*, successfully?

A. I have already testified on that point quite clearly. My answer will be the same as answer to X Q. 232.

261 X Q. The answer to X Q. 232 does not answer my last question, which is repeated?

A. My previous answer answers it perfectly.

262 X Q. What do you understand by the word "successful," in the relation that I used it in X Q. 260?

A. Several understandings have passed through my mind. Sometimes an experiment is a successful experiment when it don't work, if it proves positively or negatively, or shows possibilities. It may or may not be considered successful, and in my answer to X Q. 232 I have stated fully about the success and non-success of these experiments.

499 263 X Q. In cross-question 260 I did not ask you anything about experiments, but about successful lighting, and I now ask you again, when you first succeeded in lighting successfully by incandescence with carbonized paper *in vacuo?*

A. If you mean when I first succeeded successfully in lighting up a piece of carbonized paper *in vacuo* by electrical incandescence I will state that it was done in Edison's Exhibit First Incandescent Lamp.

264 X Q. How long did you say you succeeded in illuminating that lamp with carbonized paper *in vacuo?*

A. Several minutes, but the vacuum was a poor one.

265 X Q. Well, how many minutes?

A. Perhaps ten minutes.

266 X Q. Do you consider an electric lamp that goes out in ten minutes successful lighting by electricity?

A. It is the successful lighting of the lamp for ten minutes by electricity.

267 X Q. Are you now making and using incandescent electric lamps in which you use carbonized paper for the illuminating portion of the lamp *in vacuo?*

A. Yes, sir.

298 X Q. How do the lamps you are now making and using differ from the Exhibit Edison's Commercial Incandescent Lamp?

A. Differ only in shape.

269 X Q. How does the shape differ from the exhibit?

A. The carbon is in the form of an arch, but does not come together at the electrodes so near as in the exhibit.

270 X Q. Is the glass chamber of the same form?

A. Some lamps are, and some are pear-shaped.

271 X Q. Is the carbon of the same dimensions that you have given of the carbon in the exhibit?

A. Pretty near the same, I think; I have none here for comparison.

272 X Q. How many of these lamps have you in use?

A. I cannot say; they have been sent all over the wor-d. We have a stock on hand for use when other necessary appliances are ready.

500 273 X Q. State approximately how many you have sold or have in use.

A. We have sold three or four hundred.

Counsel for Edison produces record book containing the copy of Edison's Exhibit No. 4 and 5, and submits it to the inspection of counsel for Sawyer & Man.

274 X Q. Referring now to your record book No. 67, pages 1 to 15 inclusive, of which Exhibit No. 3 is an alleged copy, please to state whether this record was kept by you personally.

A. No, sir; it was not.

275 X Q. Please to state by whom it was kept.

A. Partially by Charles Bachelor, and partially by a man named Herrick, I think.

276 X Q. Was it kept by those persons in your presence?

A. I was present. I should say almost all the time in the room with the parties when this record was made.

277 X Q. In whose handwriting is the record?

A. Partially in Batchelor's, partially in Herrick's I think, and some of my writing is on it.

278 X Q. Were the entries made in that record by the different persons mentioned, all made at the same time?

A. About January 1st, 1880, it was decided to keep the burning time of the lamps manufactured, and this record was the starting point of the time, and was started in a systematic manner by Mr. Batchelor, I believe, on January 2d, 1880, and he, I believe, put down on January 2d the numbers of the lamps, their position, and the time they had burned previous to January 2d; and thereafter the exact burning hours were kept by him and Mr. Herrick; and the entries, I believe, were made the day after the date on the entries.

279 X Q. These lamps to which the record refers, when were they made?

A. Some time in December, 1879.

501 280 X Q. Is a portion of this original record in lead pencil?

A. Yes; a very small portion.

281 X Q. By whom was that portion of it made?

A. One portion by myself and the other portion by Charles Batchelor.

282 X Q. When did Mr. Batchelor make his entries in lead pencil, and when did you make yours?

A. I made mine January 5th, 1880. Mr. Batchelor has dated his entry January 2d, 1880, 8 p. m. I believe that I know that he made that entry at that time.

283 X Q. Are the figures in ink that notes the day of the month, the number of hours and minutes the respective lamps burned, in the handwriting of Mr. Herrick?

A. I think part of them are in Mr. Batchelor's handwriting, and part in the writing of Mr. Herrick.

284 X Q. And these figures were made, you think, either on the day of the date or the day after?

A. Yes, sir; I think they were.

285 X Q. Do you know that of your own knowledge?

A. Yes, sir; I am almost certain.

286 X Q. When did you get the vacuum pump illustrated by Edison Exhibit No. 6?

A. That particular shape vacuum pump was made some time in September, 1879.

287 X Q. Previous to getting that pump, did you succeed in getting a satisfactory vacuum in your lamps? I mean a vacuum in which your carbon burners will endure incandescent for any reasonable length of time?

A. Yes, sir.

288 X Q. When did you first succeed in getting such a vacuum?

A. I think it was in August, 1879, that we had a pump that would produce a vacuum up to perhaps the hundred-thousandth part of an atmosphere.

289 X Q. Was that the first — you obtained the necessary vacuum in your lamp?

502 A. My impression is that that was the first pump by which a partially satisfactory vacuum was obtained.

290 X Q. Referring now to Edison's Exhibit No. 2, being the New York Herald, or part of it, dated December 21st, 1879, state, if you please, whether you wrote or caused to be written the article headed "Edison's light," on page five, and to be illustrated as there illustrated.

A. No, sir; I did not write it, nor did I cause it to be written.

291 X Q. Did you revise or examine it after it was written, and approve of it?

A. No, sir; I did not.

292 X Q. Are its statements true?

A. Some are and some are not. The article seems mostly to be made up from my patents, into which a great deal of romance has been injected.

293 X Q. Are the illustrations true illustrations of the lamp referred to in the article?

A. Not strictly true. Most of them have been taken from the patents. Two I recognize as having been taken from the Scientific American.

295 X Q. Which of the illustrations are correct, and which are erroneous? Please mark the figures.

A. The figures are substantially correct as illustrations. Figures eight and nine are copied from the Scientific American's articles. Figures 1, 2, 3, 4, 5 and 6 seem to be taken from patents or caveats. Figure 7, I do not know how that was obtained. It is substantially correct, but not correct in detail.

296 X Q. State, if you know, who is the auther of the article.

A. I believe a reporter of the New York Herald, named Edwin Fox, was the author.

297 X Q. What part of the article is true, and what part romance?

A. That which is descriptive of the apparatus is substantially correct. The rest is an ingenious weaving in of the experiments and talk at the laboratory, and imagination of the reporter, into a separate article, in a proper form to appeal to the imagination.

503 298 X Q. Within a few days after the publication of that article, do you recollect of telling any-one, that it was true every word of it, or something to that effect?

A. No, sir; I don't recollect of telling any one that it was true every word of it. I might have been asked by a number of people if that Herald article was correct, and might have replied that it was correct, meaning that the results I had attained had been attained.

299 X Q. What degree of vacuum is it necessary to maintain in the chamber of your lamp to make the carbon endure in a state of incandescence for one hour, so as to produce a luminosity equal to 15 candles?

A. Never having tried that exact experiment I cannot state.

300 X Q. What degree of vacuum would be necessary to be maintained to ensure the endurance of the carbon in a state of incandescence equal to a luminosity of 15 candles for two hours?

A. Never having tried that exact experiment I cannot say.

Q. 301 X Q. Same question, during a period of three hours, or four hours, or five hours, or any number of hours of which you have actual knowledge, as to the endurance of the carbon illuminated to the degree of incandescence mentioned in my question No. 299?

A. I cannot give exact results, but my impression is from noticing lamps having poor vacuums, and lamps on the pump where there was a g*ua*ge, that generally the carbon would not last at that incandescence more than four or five hours when the barometrical mercury column showed a vacuum of only about a millimeter. This has reference to my lamp, when it is to be worked in vacuum.

302 X Q. Does the invention described in your application for a patent in this interference include a vacuum in the illuminating chamber of the lamp?

Question is objected to, upon the ground that as the application itself is in testimony, it is the best evidence.

A. The application itself is the best evidence of that.

504 303 X Q. What does the application say upon the subject?

Same objection as before.

A. Being in evidence it can be referred to, to ascertain what it says.

304 X Q. I have no complete copy of the application, nor has any been put in evidence; please to read from the specification, if you have one, what is said upon that subject.

Question objected to, for the reason that the application by the rules of the Patent Office is a part of the record testimony, and counsel for Sawyer & Man is entitled to a copy at any time by asking for it at the Patent Office and paying for it.

Counsel for Sawyer & Man states that counsel for Mr. Edison prompts the witness by putting a copy of the specification in his hands and telling the witness to say that he would very cheerfully read the specification if he had a copy of it, but does not know whether his copy is a correct copy, his copy being the retained papers or roughs of the specification, in which many alterations seem to have been made.

A. I have no specification which I am sure is a correct one.

305 X Q. Do you know whether the carbonized-paper burner, making the subject-matter of this interference, is intended to be illuminated in vacuum?

A. That is one of the intentions, according to my recollection.

306 X Q. Do you know whether the carbonized burner, making the subject-matter of this interference, is intended to be illuminated in a glass chamber from whence the air has been exhausted, and an inert gas substituted in the chamber?

505 A. It was intended mainly to be worked in vacuum, but I also intended and did try some of these paper-carbon loops in a sealed glass receiver containing an inert gas, or intended to be inert.

307 X Q. How long did the paper-carbon loops, tried in the inert gas, endure when they were illuminated?

Question objected to, as not being proper cross-examination.

A. I do not remember.

308 X Q. State as nearly as you recollect.

A. The ones I saw, I think lasted five minutes; and, perhaps, one of them lasted an hour, or even two hours.

309 X Q. Did you make the experiments yourself?

A. No, sir.

310 X Q. Who made them?

A. I think one of the parties was named Francis Jehl.

311 X Q. Where were they made?

A. At my laboratory at Menlo park.

312 X Q. When were they made?

A. My impression is that they were made either in December, 1879, or January, 1880.

313 X Q. What gas was used in the chamber?

A. I did not analyze it.

314 X Q. Don't you know?

A. I know what we intended to use.

315 X Q. What did you intend to use?

A. Hydrocarbon gas, hydrogen gas, nitrogen gas, hydrochloric acid gas and chlorine gas, I think.

316 X Q. How many experiments did you make?

A. I saw two or three.

417 X Q. What kind of gas was the chambers filled with in the experiments that you saw?

A. I didn't analyze it.

318 X Q. Don't you know?

A. I would not absolutely know without analyzing it.

319 X Q. Do you know what was intended to be used?

A. I have already testified what gases were intended to be used, but cannot be certain as to which gas was used in the experiments I saw.

506 320 X Q. Do you know whether any of these gases were used in a state of purity in charging the illuminating chamber of the lamp?

A. I don't know that they were pure.

321 X Q. Do you know at what pressure the gas was put in the chambers of the lamps?

A. My impression is, at atmospheric pressure.

322 X Q. Have you made or caused to be made any other experiments in illuminating by incandescence with paper carbon in a sealed lamp filled with inert gas, than those you have referred to in the immediate preceding answers?

A. Yes, sir; I have made them with a gas which is supposed to be inert.

323 X Q. When were these other experiments made?

A. While not intended, the lamp Exhibit Edison's First Incandescent Lamp, did have a gas in it formed by the decomposition of the grease used in the lamp at the joints, as I have already stated in my evidence, and at times, since January, 1880, lamps have been made in which simple and compound gases have been used experimentally, to determine theoretical points. I have also used in the early part of 1879, perhaps in December, 1878, gases, especially hydrogen, in a lamp giving light by incandescence, but in this case platinum was used.

324 X Q. Does electric lighting by incandescence with carbon in sealed lamps charged with inert gas, make any part of the invention described in your application for a patent in this interference, or intended to be described in that application, or does it make any part of your system of electric lighting by incandescence?

Counsel for Mr. Edison objects to all that portion of the question which relates to the specification, on the ground that the specification itself is the best evidence.

507 A. The specification itself will be the best answer that I can give the question, and I do not desire to state what I intend or what I do not intend to use in my system of electric lighting.

325 X Q. Has electric lighting by incandescence with carbon in sealed lamps, charged with inert gas, heretofore made any part of your system of electric lighting by incandescence?

A. I have already testified that I have tried the same, and as I had a system of electric lighting at Menlo Park at the time, these formed a part of the system at that time.

326 X Q. Do you mean to swear that you have used at Menlo Park a system of electric lighting by incandescence in which carbon was used as the illuminating portion of the lamp, in an atmosphere of inert gas in a sealed lamp?

A. Yes, sir; such a lamp formed part of a system of lighting by incandescence of carbon at Menlo Park.

327 X Q. When?

A. In December, 1879, or in January, 1880, I think.

328 X Q. What kind of carbon did you use?

A. Carbon made out of paper.

329 X Q. How long did you use that system?

A. The system is still there.

330 X Q. How many lamps did you use of the kind I have described in my question No. 326?

A. We have used on that system at Menlo Park, I should say, as many as thirty lamps, but as to the inertness of the gas on the carbon, I am not sure as any gas whatsoever has an effect on the carbon.

331 X Q. How many sealed lamps have you used that were charged with gas that was intended to be inert, and the illuminating part of which was made of carbonized paper?

A. I have already testified that no gas is inert and therefore I could have made no lamps in which it was inert.

332 X Q. Question repeated.

A. No lamps that were inert, because I knew that no gas could be used that was inert, all gases having effect on the carbon.

Answer objected to as irresponsive.

508 333 X Q. Question repeated.

A. I have already testified to that question.

334 X Q. How many sealed lamps have you used that were charged with gas, commonly called inert, and the illuminating part of which was made of carbonized paper?

A. My impression is that a half dozen were made.

335 X Q. How long did you continue to use them?

A. I did not see more than two or three and those didn't last more than from fifteen minutes to an hour.

336 X Q. State, if you please, whether the Exhibit Edison's First Incandescent Lamp is the apparatus referred to in answer 9 of your examination-in-chief?

A. Yes, sir.

337 X Q. What experiments have you made in treating carbons for electric lighting, made of paper, electrically in a hydrocarbon gas?

A. The experiment with the first incandescent lamp might be considered an experiment with a hydrocarbon gas; I have tried other experiments in treating paper with an atmosphere of a hydrocarbon gas since that time.

338 X Q. Please to relate what experience you have had in treating carbon electrically in a hydrocarbon gas, for the purpose of enlarging or purifying the carbon, or consolidating it?

Question objected to as a cross-examination upon matter not involved in this interference, and involved in another interference to which Sawyer & Man are not parties.

Counsel for Sawyer & Man says that the witness in his examination-in-chief has expressed opinions about the utility and practicability of treating carbons in that way, and that the question is pertinent to matters testified to by the witness in his examination-in-chief.

A. I have brought up to incandescence a carbon within a lamp
containing a hydrocarbon; I have done it in a great number
509 of lamps, a hundred or more; I have tested the economy, the
conductivity and other properties of the carbon, and have
examined the same many times under a powerful microscope.

339 X Q. When did you make the experiments?

A. They were made previous to the declaration of this interference; a hydrocarbon gas was used, I think, in December, 1879 and '80, but not for the purpose set forth in your question.

340 X Q. Have you had any experience in treating carbon for illuminating purposes in electric lamps, electrically in the presence of hydrocarbon gas or fluid, previous to putting them in the sealed illuminating chamber of the lamp?

Question objected to as improper cross-examination, no inquiry having been made about the same in the examination-in-chief.

A. Yes, sir.

341 X Q. Please to relate what experience you have had in treating carbons in that way, and give the dates of your experiments?

A. I have no memorandum with me which would refresh my memory as to the dates, but it was previous to the declaration of this interference that I tried experiments of heating to incandescence a carbon conductor in a hydrocarbon gas within a fluid, and also heating a carbon conductor to incandescence by an electric current in a gas within a chamber not sealed.

342 X Q. How many carbon burners have you treated in that way?

A. I should say twenty or thirty.

343 X Q. When did you do it? State as nearly as you can recollect?

A. Some time between March and September, 1880.

344 X Q. Is that as near as you can give the date?

A. Yes, sir, as I have no memoranda here, not thinking that this question would come up.

345 X Q. Please to describe your method of treating these
510 carbons in hydro carbongas electrically, including the apparatus you used in your experiments?

Same objection as before was repeated.

A. As the details of the mechanism which I used is the subject-matter of another interference, I refuse to answer.

Counsel for Sawyer and Man insists upon a responsive answer to this question, and gives notice that unless the witness answer the question he will move to strike out the deposition.

346 X Q. Question repeated.

A. I have already described them sufficiently. I stated that the carbon was brought to incandescence by electricity when within a gas within a liquid, and also when within a gas within a chamber not sealed.

347 X Q. What kind of a chamber was it, and how was the carbon conductor arranged in the chamber, and what kind of hydrocarbon fluid and gas did you use?

A. It was a glass chamber, the carbon was within the chamber arranged so that the electricity could pass through it, and gasoline was used.

348 X Q. How did the treatment affect the carbon treated?

A. It brought its resistance down and deposited a crust of hard carbon over its surface which under the microscope showed a multitude of projecting points which were found to be hollow when broken.

349 X Q. Of what material was the carbon made, that you treated?

A. Both paper and bamboo.

350 X Q. After you had treated the carbon did you put it in the sealed chamber of an electric lamp and raise it to incandescence, and if so with what result?

A. Yes, sir; some of them we did. The result was that it
511 was lower resistance and seemed to be more susceptible to destruction by electrical carrying than the untreated carbons.

351 X Q. To what degree of luminosity did you raise it?

A. Varying degrees of luminosity.

352 X Q. Please to name them?

A. I think as high as a hundred candles.

353 X Q. How long did the carbon burner last raised to the luminosity of a hundred candles?

A. My impression is that it lasted about two hours. It was a very fine filament.

354 X Q. Please to give its dimensions.

A. I cannot give its dimensions. We had carbons of various dimensions. These were tried on very fine filaments. It was a thinner one than that shown in the Exhibit "Edison's Commercial Incandescent Electric Lamp." It was a little longer. I should say it was a quarter of an inch longer. I am referring to the one that lasted two hours, yielding a hundred candle power.

355 X Q. Was it in vacuum?

A. Yes; in very high vacuum.

356 X Q. Does the successful use of the lamp described and illustrated in the application for the patent involved in this interference necessitate a high vacuum in the illuminating chamber?

A. In a commercial sense it is my opinion, which results from my experiments, that it is essential to have a high vacuum in the lamp chamber, for the reasons I have heretofore stated.

357 X Q. Are you now manufacturing incandescent electric lamps substantially like that described and illustrated in the application for the patent involved in this interference, commercially?

A. The electric lamp company, with which I am connected, are manufacturing lamps of this kind and selling them to electric light companies.

358 X Q. What company do you refer to as that with which you are connected, that is manufacturing these lamps commercially?

A. The Edison Electric Lamp Company.

512 359 X Q. What proportion of the lamps so manufactured by the Edison Electric Lamp Company are fitted with carbon burners made of paper?

A. From one and a half to two per cent., I should say. I have not looked over their books lately. I know that a man is now engaged, and has been at different times in the last three months, in making paper carbons for use at the lamp factory.

360 X Q. Are the carbon burners with which these lamps are fitted made upon the plan described in the application for the patent involved in this interference?

A. Yes.

361 X Q. Please to give the dimensions of these carbon burners.

A. I should say they were about an eighth of an inch, perhaps a quarter of an inch shorter than the one shown in the Exhibit Edison's Commercial Incandescent Lamp.

362 X Q. How does it compare in diameter to the burner referred to in your last answer?

A. I should judge that it was a shade wider, but have no idea as to how thick it is.

363 X Q. What, no idea as to how thick it is?

A. If it was a foot thick, I think I should probably have an idea; but as these filaments are always made out of thin paper, I cannot state whether it is thicker or thinner than the one in Edison's commercial incandescent lamp.

364 X Q. Please to give as nearly as you can the dimensions of the carbon burner in Edison's commercial incandescent electric lamp.

A. I guess it is about an inch and a quarter from the top of the clamps to the top of the loop; about seven-eighths of an inch from one side of the loop to the other. I should judge the width was twenty-thousandths of an inch, and five-thousandths of an inch thick.

365 X Q. To what degree of luminosity are these lamps, which
you say the Edison Lamp Company are manufacturing com-
513 mercially, fitted with carbonized-paper burners, brought or
intended to be brought in practical use?

A. Sixteen candles, I believe.

366 X Q. How do you measure the candle-power of a burner?

A. With a photometer.

367 X Q. What photometer do you use to measure your candle-power?

A. The Bunsen spot photometer.

368 X Q. Referring again to the Exhibit Edison's Commercial Incandescent Electric Lamp—please to state, as near you can, what its luminosity was during the time of its burning, as noted in the record about which you have heretofore testified, and of which you have given a transcript of, page 39?

A. My impression is that the average candle-power would be about from twelve to sixteen candles.

369 X Q. You say that about one or one and a half per cent. of the lamps that are manufactured by the Edison Electric Lamp Company are fitted with carbonized-paper burners. Please to state what is the whole number of lamps manufactured by that company per day?

A. About a thousand per day.

370 X Q. Have you ever made any carbons from several thicknesses of blotting paper, pressed together under a hydraulic press?

A. I have made carbons of several thicknesses of blotting paper pressed together under a screw press, but not under a hydraulic press.

371 X Q. Where is the Edison Electric Lamp Company situated—I mean its factory?

A. At Menlo park and at Newark.

372 X Q. Does that company sell lamps to any who may wish to purchase them?

A. Yes, in foreign countries, and in this country by the permission ot another company—the Edison Electric Light Company.

373 X Q. Does that company treat the carbon burners of
514 their lamps electrically in the presence of hydrocarbon gas
before they use them for illumination—I mean the Edison
Electric Lamp Company?

A. Not lately.

Cross-examination ended.

Counsel for Edison, in pursuance of the notice given at the close of his examination-in-chief, puts in evidence letters patent of Thomas A. Edison, No. 224,329, dated Feb. 10, 1880; 227,227, dated May 4, 1880; 227,228, dated May 4, 1880; 227,229, dated May 4, 1880; 223,898, dated January 27, 1880; also specification of English patent of Thomas A. Edison, No. 2,402, June 17, 1879; also letters patent 205,144 of Sawyer & Man, dated June 18, 1878; 210,152 of Sawyer & Man, dated November 19, 1878; 210,809 of Sawyer & Man, dated December 10, 1878; 219,771 of Wm. E. Sawyer, dated

September 16, 1879; 211,262 of Sawyer & Man, dated January 7, 1879; 229,335 of Sawyer & Man, dated June 29, 1880; 227,118 of Albon Man, dated May 4, 1880.

It is stipulated between counsel for Edison and Sawyer and Man, that the Government printed copies of these patents may be read in evidence with the same force and effect as if they were certified copies put in evidence and marked as exhibits in the case, counsel for Edison agreeing to furnish counsel for Sawyer and Man with at least three of each of such printed copies; and it is further stipulated that the said Government printed copies of all the patents put in and referred to as evidence on behalf of Sawyer and Man, with like effect, counsel for Sawyer and Man agreeing to furnish counsel for Edison with at least three of such printed copies. Said patents to be subject to all legal objections, nevertheless, that might be taken or urged against them if they were regularly put in evidence as exhibits; and counsel for Sawyer and
515 Man objects to the above-mentioned patents as evidence in this case, on the ground that they are not pertinent or relevant or competent as evidence upon any issue in this controversy, and request counsel for Edison to state upon the record how such patents are competent, relevant, or material upon any issue in this controversy.

Counsel for Edison replies that when the matter comes up for hearing an attempt will be made to show that such evidence is material.

Re-examination of the witness by GEORGE W. DYER, of counsel for Edison:

371 Q. Referring to your answer on cross-examination, as to your experience in making and using carbons of paper in 1876 and 1877, did anything remain to be done by you prior to 1878 to determine the qualities essential in the paper carbon for an incandescent conductor for an electric lamp?

Question is objected to upon the ground that it does not appear by any of the witnesses' answers on cross-examination that he made any carbons of paper in 1876 and 1877 for electric lamps, nor does it appear from anything the witness has said, either upon his examination-in-chief or his cross-examination, that he successfully used carbonized paper for electric lighting by incandesence previous to the fall of 1879, and upon the further ground that all of the witness' testimony intended to prove or going to prove that he made the invention, or any part of it, previous to the date alleged in his preliminary statement, is inadmissable under the rules of the Patent Office and its well-established practice; and upon the further ground that the question is intended to bring out matter upon which the witness was previously examined in chief, and not upon anything new brought out in cross-examination.

A. No, sir.

516 372 Q. Referring now to your answers upon cross-examination, when did you first determine the sufficiency of car-

bonized paper *per se* for an incandescent conductor for an electric lamp?

Question objected to because it is indefinite as not referring to any particular answer to any question on cross-examination; and upon the further ground that the question is not when he first determined the sufficiency of the carbonized-paper burner, but when he first proved its sufficiency by actual use; and upon the further ground that the question refers to experiments made before the time given in the preliminary statement.

A. I knew from my experiments in 1876 and 1877, where I employed carbonized paper and other carbonized organic substances for resistances, that carbon in that state of aggregation had high resistance as compared to hard or coke carbon, and was the proper form to use for incandescent conductors for electric lamps, if they were to be worked up in multiple arc, and the experiment with the strip of carbon in the open air, and in the Exhibit Edison's First Incandescent Electric Lamp, used in 1877, also showed its adaptability and sufficiency for multiple arc lighting.

373 Q. In 1877, did you require any farther information or experiments to determine the sufficiency of incandescent conductors for electric lamps made with carbonized paper?

Question objected — as referring to a date previous to the date of the preliminary statement, and also as not bearing upon the question of when witness did make the invention in the interference by its actual and successful use, and on the further ground that the witness has already been examined in chief on that very point.

A. No, sir.

517 374 Q. Referring again to your answer upon cross-examination, wherein you stated that since your experiments in electric lights had been resumed in 1878, you had been working upon the same day and night, please give in a general way the nature of your labors in electric lights up to 1880, and the assistants employed by you and the general nature of their duties?

A. In the fall of 1877, having about finished my labors with my carbon telephone, I had several ideas which I desired to work up, one of them being the subdivision of the electric light, hence I commenced experimenting for that purpose, as my testimony and exhibits show. These experiments continued, I think, until January, 1878, when my time and attention was absorbed by the excitement caused by the invention and exhibition of the phonograph. This continued until July, when my health being broken down by several years of continuous labor, I went to California and other places West, spending about two months. On my return, in August, 1878, I immediately took up the experiments made in 1877, but interrupted by the phonograph and the state of my health, and have continued them night and day ever since. About December, 1878, I engaged a mathematician named Mr. Upton to assist me in working out the complicated problems as to economy and adaptability of the various devices necessary to make a complete system

of electric light by incandescence which would be capable of replacing or competing with gas, over large areas, such a system, comprising main conductors, house conductors, lamps of various characters, meters, dynamos, electro-motors of various kinds and characters, apparatus for regulating the pressure of the flow of electricity through such system, arrangement of the system of conductors for equal distribution of the electricity, safety devices, boilers, steam engines, electrometers, photometers and other appliances. I had other assistants, among whom may be mentioned Francis Jehl, John Kruesi, Charles Clarke, Charles Batchelor, William Hammer, Mr. Herrick, Dr. Haid, Mr. Lawson, Martin Force, Dr. Moses,
518 E. H. Johnson, and many others who were employed in 1878 and 1879. Possibly Clarke and Hammer may have started work in the early part of 1880.

Answer objected to, as to all work and experiments made before the date given in the preliminary statement, in so far as such relates to the issue in controversy.

375 Q. In your answer to question 374 you have not stated the nature of the duties of the assistants employed by you. Please do so now?

A. Francis Jehl was employed generally to assist in any kind of experiments. John Kruesi was foreman of the machine shop; Charles Clarke, mathematician and mechanician; Charles Batchelor, principal assistant on general experimenting; William Hammer, assistant on vacuum pumps; Mr. Herrick, time-keeper for the lamps; Dr. Haid and Mr. Lawson, chemists; Martin Force, assistant on any experimenting; Dr. Moses, chemist and assistant on general experimenting; E. H. Johnson, assistant outside of laboratory generally.

376 Q. Have you been present this morning during the examination of J. Kruesi, and have you seen the memorandum book produced by Mr. Kruesi and marked Edison's Exhibit No. 12?

A. Yes, sir; I have.

377 Q. In view of the testimony of Mr. Kruesi, and of your examination of his memorandum book, Exhibit 12, are you able to refresh your memory as to dates of early experiments with electric lamps?

A. I undoubtedly tried some experiment with an electric lamp about the time stated in the book Edison's Exhibit No. 12, but I cannot remember the nature of the lamp or recall to memory the results of these experiments.

378 Q. Are you satisfied in your own mind that the repair of an air pump noted in the memorandum book Exhibit No. 12, under date of January 29, 1877, had some connection with an electric lamp?

519 A. Yes, sir; my impression is strong that the pump was used in connection with the electric lamp, as I cannot conceive what other use it could be used for about that time, and could conceive that it could be used for an electric lamp.

379 Q. Since ceasing to give the testimony which you have now

resumed, has search been prosecuted for exhibits relating to early experiments in electric lights, and if so, with what results?

A. Yes, sir; Mr. Batchelor has found two or three exhibits, one of which is in my handwriting, which I now produce.

Witness produces a paper which is put in evidence and marked Edison's Exhibit No. 13.

Exhibit objected to upon the grou*n*nd that it is intended to prove the invention in controversy was made or conceived of previous to the time stated in the preliminary statement, and upon the further ground that it is immaterial to any issue in controversy.

380 Q. Please examine the paper, Edison's Exhibit No. 13, state when it was made, how you know that fact, and what it shows?

A. The sketch was made October 5th, 1877. It is signed by myself and is in my handwriting. It is witnessed by Charles Batchelor. It is headed, electric light, and illustrates the principle for subdividing the electric light. The top figure represents a circuit in which there are resistances, around which are incandescent electric lamps consisting of two electrodes with silicon between them. The second figure represents the same kind of electric lamps worked in multiple arc. The third represents them worked in series.

381 Q. Does this Exhibit No. 13 refresh your memory as to the production of, and experiments with Edison's Exhibit First Incandescent Lamp, about which you have testified, and if so, how does it refresh your memory?

520 Objected to, as going to show that the invention was made previous to the date alleged in the preliminary statement of Mr. Edison.

A. It does. It refreshes my memory as to the date that I tried the first incandescent lamp. Because I went from the carbon on to experiments with silicon; owing to the sensitiveness of the carbon to oxidation, and I know that the carbon experiments were previous to the date of this exhibit, October 5th, 1877.

382 Q. Since you gave your testimony before in this case, have you been constantly absent from this office?

A. Yes, sir; I have.

Counsel gives notice that he here closes his re-examination of Mr. Edison, and offers him for recross-examination.

383 X Q. What qualities must paper carbon have to render it sufficient for an incandescent conductor in an electric lamp?

A. The paper should be free from adulterations, and compact and well carbonized. It will then have a high resistance per unit length and thickness, and if cut as a filament the lamp in which it is used will have high resistance.

384 X Q. What qualities must any carbon have to render it sufficient for an incandescent conductor in an electric lamp substantially like Exhibit Edison's Commercial Incandescent Electric Lamp?

A. My impression is that all kinds of carbon, except, perhaps,

the diamond, are the same, and their different appearances are due to their structural arrangement. I think that hard gas-retort carbon and paper carbon are the same kind of carbon, and the difference consists in their structural arrangements. Paper carbon, wood carbon, and in fact, all carbon derived from vegetable organic matter of cellular formation when carbonized are very porous, hence the resistance to the passage of the current through a square millimeter section, and one inch long of paper carbon or wood carbon, would be very much less than if the same was made of hard
521 retort carbon, and as a high resistance is a desirable thing to make a commercial incandescent lamp, then paper and other organic carbon has the desirable property, owing to its cellular structure of giving such high resistance. Almost any kind of carbon could be used under the conditions of the lamp, marked Edison's Commercial Incandescent Electric Lamp, and the same results could be obtained as to candle power and amount of energy. But the quality, or rather the aggregation of the carbon to form the incandescent conductor should be such as to offer high resistance to the passage of the current to allow of commercial subdivision. And this quality organic carbon is possessed of.

Answer objected to by counsel for Sawyer and Man as irresponsive.

385 X Q. Question repeated and counsel disclaims any desire to induce the witness to reveal any new discovery he may have made in the treatment or quality of carbon, but asks him to state merely the qualities that he thinks the carbon should possess to make it suitable for an illuminating conductor in an incandescent electric lamp?

A. I do not think I can make my answer any plainer than I have already done.

386 X Q. Must it have the quality of hardness and uniformity of texture?

A. It must have uniformity of texture, but it is not essential that it should be hard—that is, the carbon as a whole.

387 X Q. Must the texture of the carbon be fine?

A. No, sir; it is not essential.

388 X Q. Must it be solid?

A. No, sir; I prefer to have it structural—formed of cells.

389 X Q. Must it be cellular, and must the cells be small or fine?

A. It must be aggregated together in such a manner that the total weight of the carbon between the two electrodes shall,
522 with a given radiating surface, be far less than if the carbon was perfectly dense, and the interstices may be large or small within the carbon?

390 X Q. Then, as I understand you, it does not matter whether the interstices or cells be large or small, provided the total weight of the carbon between the two electrodes shall, with a given radiating surface, be far less than if the carbon was perfectly dense?

A. No, sir; I speak within the limits of the ordinary size of organic vegetable cells.

391 X Q. Must the carbon have a high resistance?

A. The burner, as a whole, should have a high resistance, for reasons I have already stated.

392 X Q. When did you first discover that carbon made of paper would offer a high resistance to the passage of the current, to allow of commercial subdivision, so as to make it a suitable illuminating conductor for your lamp. I mean Edison's Commercial Incandescent Electric Lamp?

A. I knew that it had high resistance from my use of it in 1876 in rheostats, and in my telephonic experiments in 1877, and that it had a proper resistance to admit of subdivision in multiple arc. In my Exhibit No. 4 I have placed the boron, which is high resistance, in multiple arc, and the silicon, which is low resistance, I was compelled to use in series, and I was perfectly aware when I made the Exhibit First Incandescent Lamp that organic carbon was the proper kind to use, as with a small mass it had high electrical resistance.

Last part of the answer objected to by counsel for Sawyer & Man as irresponsive.

323 X Q. What was there in the experiments you made with Edison's Exhibit First Incandescent Lamp that enabled you to determine that carbon made of paper would offer a high resistance to the passage of the current, so as to allow of commercial subdivision, as you have stated?

A. I have already stated that I knew it beforehand.

523 394 X Q. Then there was nothing, as I understand you, in the experiment that added to your store of knowledge upon that point?

A. Not regarding the resistance of organic carbon, except confirmatory of what I already knew.

395 X Q. Then, as I understand you, when you made or caused to be made the lamp, Edison's Exhibit Commercial Incandescent Electric Lamp, you knew, not from any experiment upon the subject, but from your knowledge of the properties of paper carbon, that it would make a suitable illuminating conductor for your electric lamp, that it would offer a high resistance to the passage of the current and would allow of commercial subdivision?

Question objected to upon the ground that it does not correctly state the testimony of the witness upon this subject, he having testified to experiments in 1876 which resulted in his knowledge of certain qualities pertaining to paper carbons.

A. I have already stated that I knew from my experiments in the use of carbonized paper in rheostats in 1876, in telephones in 1877, confirmed by the experiments in 1877 on the first incandescent lamp and in 1878 also on paper carbons, that such carbon had such a high resistance as compared to its radiating surface as to admit of commercial subdivision, providing the incandescent conductor could be made small enough and be burned under proper conditions.

396 X Q. When did you ascertain whether or not the conductor could be made small enough and burned under the proper conditions?

A. I ascertained and obtained the proper conditions to allow of the conductor being made small enough some time in October, 1879. This was when it was placed in high vacuum.

397 X Q. Without any reference to your experiments with your
first incandescent lamp, did you know from your experiments
524 with paper carbon in rheostats in 1876, and in telephones in
1877, that it would make a suitable illuminating conductor
for an incandescent electric lamp?

Question objected to as obscure and misleading.

A. I knew upon the day that I tried the experiment on the first incandescent lamp that such carbon would be suitable, which knowledge, as far as its resistance was concerned, was derived from experiments in measuring its resistance in 1876 and 1877, as I have stated.

398 X Q. Then, as I understand you, by your experiments with carbonized paper in rheostats in 1876, and in telephones in 1877, you had ascertained the resistance of carbon made of paper. Now, how did your experiments with Edison's first incandescent lamp prove to you that carbonized paper would be suitable for an illuminating conductor in an incandescent electric lamp?

A. That experiment was not to prove the resistance of the paper carbon, but to ascertain if it could be made to stand at a high temperature.

399 X Q. Then, as I understand you, it was by that experiment that you determined the sufficiency of incandescent conductors for electric lamps, made of carbonized paper, as stated in answer to question 373 of your redirect examination?

A. I did not require any further experiments to ascertain whether paper carbon was applicable to incandescent lighting. I knew it was applicable, if conditions could be obtained under which filaments of it could be made stable at high incandesence.

400 X Q. When did you first ascertain that carbon made of bamboo possessed the requisite qualities for an illuminating conductor in an incandescent electric lamp?

Question objected to by counsel for Edison, as not being proper
cross-examination, nor pertaining to any matter brought
525 out in direct examination and not involved in this interfer-
ence, and advises the witness not to answer the question.

A. I decline to answer.

401 X Q. Why do you decline to answer?

A. In the first place, I do not see as the counsel has any business to ask the question; second, it is not in the controversy; third, my counsel advises me not to answer it; and fourth, that it would require hunting for exhibits, dates, and other data to give the proper answer, which I am not prepared to do.

Counsel for Sawyer and Man, in view of the witness' refusal to answer, declines to further cross-examine the witness, and requests the examiner to certify the question to the judges of the United States circuit court of the southern district of New York.

The witness, THOMAS A. EDISON, being further interrogated, as a portion of his direct examination by R. N. DYER, Esq., counsel for the defendant, testifies as follows:

402 Q. Referring to your answer to question 61 in the interference, and which has now become a portion of your deposition in this case, is the opinion therein expressed as to the practicability of the Sawyer-Man lamp changed by an inspection of the description and drawings contained in that patent, No. 317,676, as issued, giving your reasons for any opinion you may express?

A. I find that the patent as issued; that is to say, No. 317,676, is, in a great many respects, different from the application which was in interference at the time I gave my testimony. It has been changed so much from what it originally was as filed that the answer will be somewhat different to that given in the interference case. In my interference testimony I stated that no lamp has 526 ever yet been devised, up to the present time, that was practical, which had an enclosing chamber partially made of a cup of metal and secured to the glass by cement. I find in the patent of 1885 that a plate of glass has been substituted for the metal case, which I understood they had in the original application; but, as this glass portion of the lamp performs no new function, the substitution in my answer of glass for a cup of metal arranged as shown in the new patent does not change the fact that no practical lamp has ever yet been devised, up to the present day, whereby the enclosing chamber is made in two parts, and a cementing substance, or air-excluding substance, is the medium for joining the said two parts of glass together to form a chamber. All incandescent lamps, to my knowledge, at the present date, have this union sealed so that the lamp shall be one which is utterly, absolutely and wholly of glass, and not of two parts of glass put together by some substance which is not glass. At the time of the first interference I understood from the specifications, before they had been amended, that the lamp was to be used in an atmosphere of an inert gas, but, in the altered specification, more prominence is given to the use only of a vacuous space. Hence, my answer to question 61 would be modified by this fact. I cannot see how a vacuum can be maintained in a lamp made according to the specifications of the 1885 patent to Sawyer and Man. Up to the present date I am entirely unaware of any person constructing a vacuous transparent space, which would maintain a stable vacuum of the character shown in the said patent of 1885, where the lamp is not wholly of glass. On the ordinary air pump, where a bell-jar of glass rests upon a platen of glass, and where unct*i*ous and other substances are used between the two ground surfaces, stable vacuums are impossible to obtain with the present state of perfection of air pumps. This being the case, and the*ir* being no difference between the air pump and the Sawyer-Man patent of 1885 in respect to the case (and, in fact, it is against the patent and in favor of the air pump), and the facts being as I have stated, I cannot see how 527 a commercial and practical lamp could be made by any means set forth in the specifications. I have no other amendment to make to my answer to question 61 in the interference case.

403 Q. What advantages, if any, would a construction such as is described in the patent in suit, having a glass plate secured to the bottom of the chamber, have over a similar construction provided with a metal plate or cap so secured?

A. I can see no advantage scientifically; and commercially a metal plate would be very much easier to get in shape; and, as a vacuum must be maintained by some substance at the junctures, the difference as to glass or metal would be immaterial. The metal might perhaps have some advantage by slowly oxidizing and taking up some of the residual oxygen in the vacuum, due to the heat which would be conducted through it by conduction through the electrode strips.

404 Q. The patent in suit speaks of the fact that the wall forming the chamber of the lamp is "made wholly of glass, by which all danger of oxidization, leaking, or short circuiting is avoided." What is your opinion as to the validity of these advantages?

A. I do not find in the patent that the chamber is made entirely of glass. It seems to be made of two parts of glass, with some material between the joints to prevent leaking.

405 Q. What I want to know is, whether, in your opinion, the advantages stated in the matter I have quoted from the patent in suit are fanciful or real?

A. Leaving out the misstatement in the patent, that the chamber is made wholly of glass, the mere substitution of glass for metal does not diminish the leakage, because the leakage will not take place through the metal, or the glass, but at the joints. As to the glass avoiding the danger of oxidation—if this refers to the oxidation of the carbon—then I should say that the metal had an advantage, as it would actually take up oxygen that might be left in the lamp. Regarding short circuiting, the same cementing material which is now used around the electrodes could be used to insulate the 528 same from the metal. If such cementing material failed to prevent short circuiting, it would also fail to maintain the vacuum.

406 Q. To what character of construction in incandescent lamps do you understand the expression "made wholly or entirely of glass," applies?

A. Where the chamber is really and truly made wholly of glass, through which the platinum wires are passed, and are sealed thereto, and not to glass chambers in two parts, cemented or held together by material which serves to prevent the joints leaking. The great improvement in the art, and one which made the conditions for the use of fine filaments practical, and which advanced electric lighting to a commercial basis, was the use of a chamber entirely of glass, so that no possible leakage of air could take place, even in the most minute degree, for the slightest leakage, going on continuously, would render the excessively fine filament necessary for the commercial subdivision of electrict light, impracticable to use. Were this class of lamps, with this chamber as shown in the patent of Sawyer and Man the only means known to-day, lighting by incandescence with filaments of carbon could not be a commercial success.

407 Q. Please explain the construction of the incandescent-lamp chambers which you consider answer to the description of being made wholly of glass?

A. A chamber made wholly of glass, with no other material whatsoever, through which the platinum conducting wires pass and are sealed to the glass chamber itself by fusion—such platinum wires having the same coefficient of expansion as the glass itself.

408 Q. Do I understand you to mean a chamber made in one continuous piece of glass, and without joints?

A. No; but one wholly of glass as the result of the manufacturing operation.

409 Q. Would a glass chamber having a separable joint be such a chamber?

A. If there was nothing in between the joints; but in that case you could not maintain the vacuum.

529 410 Q. Have any patents been issued to you in which the lamp chamber is described as being wholly or entirely of glass; and if so, please state what they are, or the earliest of them?

A. My electric lamp patent No. 223,898 of January 27th, 1880, has such a chamber entirely of glass. This patent states the different advantages of chambers made entirely of glass, over those made with joints. My patent No. 227,229, of May 4th 1880, also shows a chamber made entirely of glass, containing the incandescent burner. The latter specification also contains subject-matter relating to the advantages of a chamber made entirely of glass in contradistinction to being made with joints.

411 Q. When were the applications for these two patents filed?

A. The patent No. 223,898 was filed November 4th, 1879; the patent No. 227,229 was filed April 21st, 1879.

Printed Patent Office copies of the two patents referred to by the witness are offered in evidence, and are marked respectively "Defendant's Exhibit Edison Patent 223,898," and "Defendant's Exhibit, Edison Patent No. 227,229;" and it is stipulated by counsel that these printed Patent Office copies may be used in evidence in lieu of regularly certified copies of the patents; and the same stipulation is now entered into between counsel as to all such copies hereafter offered in evidence, and also as to blue-book copies of English patent.

412 Q. Referring to your answer to question 4, what do you mean by "carbonizing under strain and pressure"; and of what importance is this in the manufacture of carbons for incandescent electric lamps?

Objected to by Mr. Kerr as incompetent.

A. It is important in carbonizing conductors for incandescent lamps, that they should be restrained from free movement 530 during the act of the decomposition of the cellulos or other compounds, into carbon; otherwise, especially if they are filaments, they are greatly distorted, so as to be useless; and if distorted, there is an unequal stress among the particles of carbon, which caused unequal resistance, and a liability to rupture by the expansions produced by the high temperature used with the carbon. If this decomposition or change from the vegetable to the carbonaceous state takes place under strain and pressure, equal conductivities of heat to the same necessarily takes place through the means used to cause the carbonization under strain and pressure. It is one of the most important things in the production of an incandescent conductor, especially if the same is filamentary in character, as more or less life of the filament depends on a greater or lesser perfection in the devices for producing this result. I have a number of patents showing means and methods of carbonizing incandescing conductors under strain and pressure; and I have done a large amount of experimenting, and even to this day I am still experimenting on more perfect means of producing absolute equality and simultaneous decomposition of the whole of the incandescing conductor, so that it will be as nearly homogeneous as it is possible to make it; as the life of the filament when in the lamp depends very largely on such even carbonization.

413 Q. Kindly call attention to the patents, or some of them, that you have in mind in making your last answer?

Objected to by Mr. Kerr as incompetent.

A. Patent No. 248,423 of October 18th, 1881; patent No. 263,144 of August 22d, 1882; patent No. 263,139 of August 22d, 1882. I think I have more of those, but I do not see them at present.

414 Q. Would the disastrous distortion and unequal carbonization be prevented by packing the slips in powdered carbon, without any additional devices?

531 A. To a certain extent; but there is very little strain or stress on the carbon in this condition of carbonization, and you do not get so homogeneous a carbonization, although you prevent in a great measure distortion. Such incandescing conductors will not have the same life as those which are carbonized under proper conditions as to strain and pressure, although such incandescing conductors are sufficient where the same are to have a coating of hard carbon put on their exterior by what is known as the "flashing" process. Absolute homogen-ity of the carbon is not so essential as where the same is to be used without any subsequent treatment by the deposition of carbon, which deposited carbon really diverts the current from the original carbon, and which hard deposited carbon relieves the carbonized carbon from doing as much work as it would if used without the deposited carbon.

415 Q. In your deposition in the interference case (which is now

a part of your present deposition), you refused in answer to cross-Q. 400, to state when you first ascertained that carbon made of bamboo possesses requisite qualities for a conductor of an incandescent electric lamp. Have you any objections at the present time to making that statement? If not, kindly do so?

A. About the last of January, or near the 1st of February, 1880, we found that lamps which we made out of bamboo splints gave us abnormally greater life at high incandescence than any of the incandescing conductors made from other materials.

416 Q. What is the present material you use for your carbon filaments?

A. Bamboo.

417 Q. Do you use all kinds of bamboo, or some special kinds?

A. We use a special kind of bamboo. This quality of bamboo is found and cut for us especially in Japan. As soon as I found that bamboo had such great advantages over other materials that we had been using I dispatched a man to China and Japan to make investigation and send me samples of all the different qualities of 532 bamboo which he might find there. He went to different parts of China and Japan and sent me about forty different varieties of bamboo in such quantities as to enable me to make a number of lamps of the qualities which were suitable; and from the results of the life-test on these lamps I ascertained which was the best species of the bamboo family for my purpose. He then made further investigation to ascertain the best parties to furnish a continuous supply—bamboo being an industry in Japan, and plantations in certain districts being the principal industry. From that time on I have got my supply of bamboo from the same place. However, I have kept up my search for different qualities of bamboo which might prove better, and also for all kinds of other material. Since 1880 I have sent one man up the Amazon; afterwards another was sent to Uruguay and Paraguay, and up the River De La Platte; and two more men were afterwards sent up the Amazon to near its headwaters; and two other men were sent to the West India Islands, and thence to the north coast of South America, from British Guinea to the United States of Colombia, up the Magdalena river to the headwaters at Honda. Another man was sent down to Mexico. One man just returned the other day from a year's search through Ceylon and India, and I have now a man down in the Cauca valley in the United States of Colombia. In fact, I have, since that date, always had men out searching for vegetable material which had the quality that I desired. Also through numerous correspondents I have received an enormous number of samples. I should say that I have received and carbonized, made into lamps, and tested their enduring qualities, not less than six thousand different species of vegetable growths.

418 Q. How large a proportion of these vegetable growths did you find at all suitable for your purpose?

A. Only about three species of bamboo, and one species of a peculiar cane that grows up in the regions of the Amazon, but of

which I have never been able to procure a supply, owing to
533 the malaria and fevers there; and one or two species of
fibres from the agava family.

419 Q. Out of these vegetable growths that you have found suitable, did you find it possible to use the entire plant, or only particular portions? State what the fact is?

A. Of the bamboo, which we now use, only the extreme outer edge of the cylinder, after the removal of the silicious epidermis, can be used.

420 Q. How large a portion is that of the entire thickness which is suitable?

A. The thickness of the walls of the cylinder is about three-eighths of an inch; and we use twenty-thousandths of this; but the best portion is the first ten-thousandths of an inch from the edge. It is at this point where the fibres are more nearly parallel, and where the cell walls of the fibres are apparently the smallest and where the pithy matter between the fibres is at its minimum.

421 Q. In cutting or forming the filaments from the bamboo or other vegetable fibre, is it necessary that it should be done in any particular way; or will cutting in any way or direction answer the purpose?

A. No; it must be cut parallel with the fibres. We cut them as nearly parallel with the fibres as possible, and then by a system of inspections after the bamboo blank is ready for carbonization, we throw out as far as possible all those slips in which the fibres were not cut parallel. If we did not do this, and should cut so that the fibres at one end did not extend continuously to the other end, but one set of fibres, or rather one or two fibres of the several fibres only extended half way up, where by the cutting tool they ran to a taper, and then to nothing, and nearly joining two similar fibres, running to the other extremity, there would not be a continuous fibre from end to end in the blank. Hence, on carbonization there would be a break between the two fibres, composed of light, porous, and pithy matter; and, after the filament had been carbonized, put in a lamp, and brought up to incandescence, the total weight of carbon
being less at this particular point, and therefore offering a
534 greater resistance to the passage of the current, it would become more highly heated than at the other points, and develop a "spot" as it is called by lamp-makers, and the life of the lamp would be rather short.

422 Q. What would be the effect of attempting to cut a conductor from bamboo, the direction of the cut being at right angles to the length of the fibre?

Counsel for complainant objects to this line of examination in reference to bamboo, as incompetent and irrelevant; and states that this objection would have been entered sooner, but that it was agreed that it might be entered at the end of the examination. Counsel, however, prefers to enter it now, as the examination seems to be an undue waste of time, and entirely irrelevant to the controversy. So much of it as relates to anything done by the witness subsequent to the filing of complainant's application for a patent, is further objected to as incompetent and immaterial.

A. It would be impossible to cut a filament in that way, and even if it could be done I should not imagine that it could be carbonized successfully, or used at all.

423 Q. Referring to an incandescent conductor of the size shown in the patent in suit, what would be the effect of attempting to make a conductor by cutting a piece from vegetable fibre, the cut being at right angles to the fibres and then carbonizing the piece so cut? Would such a carbon have any value in the art in your opinion?

A. If the fibres of the material were all parallel, and they were cut at right angles, of course they would be of no earthly use.

424 Q. Why would such a conductor be of no use?

A. In all vegetable growths formed of fibres, that I have ever seen, the fibres are separated from each other by pithy growths, having a cellular structure enormously greater in size than the cells
535 of the fibres; and the proportionality of carbon which this
light porous matter gives, as to the proportion given by the fibre itself, would be several times less; that is to say, in the bridge between fibre and fibre there would be several times less carbon than in the fibre; and if such a filament could be cut, and if cut could be carbonized, and if carbonized could be put in a lamp, the passage of the current sufficient to render the fibres themselves incandescent, would bring the temperature of the intervening carbon, due to the pith, so extremely high that the lamp would immediately break. It would be like taking a lot of shot, placing them in a row, and cementing them together with mucilage, to make a wire, and using this wire to sustain heavy loads.

425 Q. How far would these defects which result from cutting across the fibres, be present in woods generally?

A. We soon found out in our experiments that filaments could not be successfully made from wood, for two reasons: First, all the woods which grow from the outside have fibres which are not parallel—the parallelism being more or less distorted in different woods by fibres which run towards a centre at right angles to the principal fibres, and which are called, I believe, medullary rays. Wherever these pass, the fibres on each side are bowed to permit these fibres to pass; and as the fibres at right angles are only connected by the other fibres, with pithy matter, we would in a measure obtain a filament from ordinary wood like cutting bamboo at right angles to the fibre. In the mechanical operation of cutting, these small fibres which run at right angles to the principal fibres, would pull out. The fibres of the filament would very seldom be continuous on account of the want of parallelism due to the bowing of the same around the medullary-ray fibres; and all the lamps that we made from this class of material were of no commercial value whatever. The second objection to the woods is that the microscope shows that the cells composing the fibres are of very large dimension—so large that the resulting carbon is very porous

and friable; while in the slips cut from vegetable growths,
536 like bamboo (that grows from the inside and not from the
outside, like wood) the cells are of a very much smaller size, and consequently greater in number; and are greatly incrusted and filled with resinous and other amorphous material, which on carbonization softens, and serve to lock the whole together in a homogeneous mass. There is not sufficient of such material in ordinary woods; and, where the resinous matters are very great, as in the conifers, the most of it distills off as hydrocarbons of the turpine series, and leaves every little asphaltic residuum to lock the carbonacious residuum together.

426 Q. Do the objections which you have spoken of as arising from the presence of the medullary rays apply to all exogenous vegetable growths, or to only a part of them?

. A. I do not remember any exogenous growths that do not have medullary rays.

427 Q. How many of the exogenous woods have you tried for the purpose of making carbon filaments; and how extensively have been your experiments in that direction?

A. When I first started we made filaments of everything that we could get hold of. I think we used as many as thirty or forty different woods of exogenous growth, but soon gave them up as hopeless, for the reasons I have already stated.

428 Q. Would an incandescent lamp having a filament made from wood of exogenous growth be, in your opinion, a practical lamp?

A. Not with any woods that I know of.

429 Q. As I understood you, in speaking of woods you mean exogenous vegetable growths?

A. Yes; that have medullary rays, or right-angle fibres.

430 Q. How did you come to strike the idea of using bamboo?

Objected to by Mr. Kerr as incompetent.

A. We were carbonizing everything that we could get hold
537 of, with the idea of getting a carbon that would have life
under commercial conditions, and also which would give even manufacturing results; that is to say, one where we could make a thousand lamps, and not find that three or four hundred of them were spotted and useless, but an incandescing conductor, which in making a thousand lamps would be so perfect that only a small percentage would be bad and necessitate the uselessness of the lamp. I remember the circumstance about the bamboo. We had an ordinary palm-leaf fan on one of the tables, and I was then investigating everything with a microscope, and I picked that up and found that it had a rim on the outside of bamboo cut from the outer edge, a very long strip. I gave this to one of my assistants and told him to cut it up and get out all the blanks he could from it and carbonize them, and put them in lamps, and run on the light current to ascertain their availability; and we were surprised to find that these lamps were several times better than any we had then succeeded in making. By a microscopic examination and by

other experiments we ascertained the reason why; and I felt so convinced that we had got on the right track that after a short while I dispatched a man to Japan, as I have previously stated.

431 Q. What are the characteristics in bamboo which you have found to make it particularly suitable for your purpose?

A. I have already stated that the characteristic is that the fibres run more nearly parallel in that species of wood than in any other, except in the one instance of this particular reed which I have stated we found up on the Amazon. Owing to this parallelism we are enabled to form a blank by cutting, in which the majority of all the fibres are parallel, and thus produce unspotted lamps; that is to say, lamps which, when brought up to a dull red, show an even degree of color. The contraction of the filament in carbonizing is also more homogeneous, due to the fact that the fibres are parallel and similar in character, and to the immense amount of
538 resin as cellulose present in this species of material, the great advantage of which I have already recited.

432 Q. Is there any generic quality in vegetable fibres, because they are fibrous, which adapts them for the manufacture of carbons for electric lamps?

A. No; certainly not. They are rather a disadvantage. If bamboo grew solid, without fibres, but had the cellular formation just the same, I should consider it absolute perfection; and I have not the slightest doubt but what incandescent lamps would have a life at least six times longer than they have now. What is wanted is a cellular structure, even and homogeneous in every direction, without fibres, but amorphous so to speak; that is to say, the same in all directions; so that on cutting it into shape it will have the same mass per unit section everywhere; and will on carbonization give the same amount of carbon; so that the carbon thus produced will have the same stress, like well-annealed glass, throughout its whole body. The object of the cellular structure is to produce as a whole a filament in which the whole of the carbon is a continuous conductor of electricity, so that the whole of it takes part in performing the work; and by reason of the cellular structure its total resistance as a conductor will be great. Taking such a theoretically perfect filament of carbon (composed of carbon cells, with air spaces in each cell) the amount of investment in copper conductors will be in proportion to the amount of carbon in the filament. If the cells were filled solid, full of carbon, the investment in a station using such a lamp, covering a mile area of the city of New York, would probably be, say two hundred thousand dollars for the copper; whereas, if the cells were not filled solid, the investment would be, say one hundred thousand dollars; yet the economy and life of the lamp would practically be the same. The carbon in the interior of a filament is a positive disadvantage, because it does not give light, and requires a large investment in copper to carry the current necessary to keep it up to such a degree of incandescence as to permit the exterior of the carbon to emit light.

539 433 Q. Do I understand that out of the six thousand kinds of vegetable growths which you say you have tried, that the

three or four which you have mentioned are the only ones having the proper cellular structure to make them suitable for incandescent lighting?

A. No; not exactly that; but none but these three or four that I have stated were sufficiently good for my purpose; that is, the production of a perfect commercial lamp and one easily and cheaply manufactured. Some of the inferior kinds of material could be used; and if, in the manufacture, those which were defective, as shown by bringing them up to a dull red, were thrown out, the residuum would be commercial; but the percentage or good to bad lamps would be so enormously great (that is to say, the proportion of bad lamps would be infinitely greater than the good ones), that the cost would be prohibitory. Out of all these several thousand materials there are remarkably few that are of any value whatsoever.

434 Q. Have all vegetable fibrous growths a suitable cellular structure, with regard to the size and form of the cells, to make them adapted generally for the manufacture of conductors for incandescent lamps?

A. Oh, no. For instance, in pith the cells are so large that it is utterly valueless. It seems, from the experiment, that the smaller the cells the greater will be the life of the conductor.

435 Q. How large a percentage of vegetable growths, in your opinion, would have a cellular structure suitable for the manufacture of carbon filaments, which would make even fairly operative lamps?

A. I am not aware of the existence of an exogenous wood which would answer at all. The endogenous (having parallel fibres) are the only ones that would be of any value; and these are not all capable of use. For instance, take the palm fibres. They seem to be of the same generic family as the fibres composing the bamboo; but the fundamental fibres of the visible fibres (but which can only be seen with a microscope) are very much greater in diameter in the palm than in the bamboo; and the cells of the charcoal are much larger in the palm than in the bamboo; so much so that our tests have shown that filaments cut from apparently perfect palm fibres did not give one-fifth the life as corresponding bamboo fibres. There exists great diversity in endogenous woods in the amount of ash and silica between the fundamental fibres and of the fibre as a whole, or the aggregated fibres; and this seems to produce some result in the chemical action or decomposition which takes place in carbonization. I have never been able to ascertain definitely what effect is produced; but it does produce an effect not desired, I know from experiments.

436 Q. Have you any patents covering the use of bamboo and similar fibres for this purpose which describe the proper way of cutting the material?

Objected to by Mr. Kerr as immaterial and incompetent.

A. Yes; I have a patent on bamboo and similar fibre. It is No. 251,540, of December 27, 1881.

A printed copy of the patent referred to is offered in evidence and marked "Defendant's Exhibit Edison Bamboo Patent, No. 251,540."

437 Q. What other materials besides carbonized fibrous material is used in the manufacture of filaments for commercial incandescent lamps?

A. One manufacturer makes a filament for carbonization by acting on hard-twisted thread with sulphuric acid, to destroy its fibrous texture, and make it amorphous like, and continuously cemented throughout its mass. Another manufacturer takes films of collodiate, cuts blanks for carbonization from the same, reduces the nitric acid from the compound by means of a reducing agent, thus making a non-fibrous structure which gives a very beautiful and perfect carbon filament. If its residuum, which is transparent like glass, was as dense as bamboo, it would be as nearly theoretically perfect, in my mind, as any material that could be used for the purpose. Another maker, I believe, uses a solution of 541 cellulose in sulphuric acid, reduced to a syrupy consistency and squirts it through a die into a chemical liquid which precipitates it as fast as it issues from the die, making a filament for carbonization, non-fibrous, but as the original cellulose can be regenerated, I believe that it does not alter the cells, or destroy its properties, to any great extent. Another maker uses a solution of melassic acid, which he forces through a die. This is purely a chemical compound, artificially made. Another maker I have heard of uses a chemical artificially made, which he squirts through a die into a solution which precipitates it. Other makers use bamboo. I think Sawyer and Man use bamboo or, at least, did so at one time. The Siemens Brothers use the fibre of the agave, which I believe is of the same family as that of the fibre of the bamboo. Other makers have used silk thread, twisted and treated by some chemical means to lock the fibres together, and render it as a whole, non-fibrous, although not to the same extent as the use of collodion films.

The answer is objected to by Mr. Kerr as incompetent.

438 Q. Have you yourself made filaments from other than fibrous material; if so, state the facts?

A. Yes. I have made filaments from chemical combinations, compounds and mixtures, by squirting, by flowing in sheets, by cutting therefrom, and in many other ways.

439 Q. When did you stop using paper in the construction of filaments for your electric lamp?

A. We only made a few hundred paper carbon filaments when we discovered the efficiency of bamboo, and made none after that discovery—that is to say, no paper carbons. We might have made a few, but only for experimental purposes

440 Q. State approximately the date when you adopted bamboo, as nearly as you can now recollect it?

Objected to by Mr. Kerr as immaterial.

542 A. I think about January 30, 1880, or within a month of that.

441 Q. What defects, if any, in paper, caused you to discontinue its use for commercial purposes?

A. It did not give sufficient life; and if it was attempted to make fi*al*ments of high economy, the life was very short. Another difficulty was, that paper is so uneven. In the manufacture of paper, the pulp runs out on the wire cloth very unevenly. The fibres are not perfectly mixed, but some lie more in one direction than in another; and these vary. The paper was not always pure. It was loaded with different things. While the paper, after being calendered, seemed to be of the same thickness—really, before passing it through the calender rolls, it was very uneven in thickness. Passing it through the rolls pressed down the higher parts, and seemed to produce some harm to the texture. Another trouble was the cutting of these blanks from paper. It was very difficult to cut them even. Another defect was the carbonization, as the resulting carbon would be useless since without the tarry matter which comes from the decomposition of the cellulose flowing in between the fibrous, and on carbonizing locking them together, the paper could not be used. But fortunately this tarry matter flowed while exuding from the decomposing cellulose between the fibres, and in carbonizing locked them together. It was enough to prevent cohesion between those kinds of carbons and the carbon of the cellulose. Great care was necessary to be exercised in causing the heat during the act of carbonization to be conducted equally and simultaneously to all parts of the decomposing cellulose, so that no one part should be decomposed before the other, as great contraction took place, and this would make a very unhomogeneous conductor, (carbon being internally under great strain in various directions, like unannealed glass), and it also produces greater or less contraction in different parts of the resultant carbon, so that when put in a lamp and brought up to a red heat, some parts would be a dull red, and others would be a bright yellow, the filaments being destroyed
543 at the hottest part. In fact, at the time that we used paper
we found extreme difficulty in getting a great number of lamps free from spots so that they could be used; but when we got bamboo our troubles practically disappeared, as all these difficulties, or nearly all, were absent when bamboo was used.

442 Q. I call your attention to the original application for the patent in suit, which is contained in the Complainant's Exhibit File-wrapper and Contents. What was there, if anything, known generally in the art at the date of the filing of the application for the patent in suit, which was known as carbonized paper covered with powdered plumbago?

A. I never heard of carbonized paper covered with plumbago being used in the arts.

443 Q. Would the statement contained in that original specification, "We have tried carbonized paper covered with plumbago" be, in your opinion, a sufficient description to enable a person skilled

in the art at the date of the application to make an incandescent conductor, without further experiment?

A. If it is meant that the carbonized paper is rubbed over with plumbago, I think an expert skilled in the art could do it. It is not certain, from the description, if it was to be coated with plumbago before carbonization or after. I should infer that it was meant that carbonized paper was rubbed over with plumbago. I do not exactly see what this would do.

444 Q. Assuming that the statement means to first fill paper, such as blotting paper, with powdered plumbago, and then passing a current through it to carbonize it, do you find a sufficient description in the specification to enable you to make a carbon in that way, without experiment?

Objected to by Mr. Kerr, that the specification speaks for itself.

A. I do not find anything in that specification that elucidates the meaning of the sentence about carbonized paper covered with
plumbago. It does not state in the specification how it is to
544 be used, but I infer that the paper was carbonized and then
rubbed over with powdered plumbago. That is the nearest
meaning that I can come to.

445 Q. In your opinion could a practical carbon for incandescent lamps be made by impregnating paper, such as blotting paper, with powdered plumbago, and then carbonizing it by passing an electric current through it?

A. Do you mean in a vacuum, or how?

446 Q. Either in vacuum, or air, or nitrogen, or illuminating gas.

A. My opinion is that it would require a great stretch of the imagination on the part of any expert skilled in the art, to conceive of a practical filament being made in this way. If you carbonize in vacuum there is never any carbon left in the paper. There is about forty-seven per cent. of carbon in paper, the balance being water, and the oxygen of the water is sufficient to burn up all the carbon.

477 Q. What would you understand by the expression "wood carbon or charcoal" contained in this original specification, considering the same from the standpoint of the knowledge of those generally skilled in the art at the date of the application for the patent?

A. Charcoal from ordinary wood.

448 Q. Does that statement, in your opinion, give any information of value to others skilled in the art, which would enable them to make a practical incandescent lamp?

A. The paragraph states that they have tried three different kinds of carbon, but which is the best they do not state; as and everything depends on the kind of wood from which the wood carbon or charcoal is made, it would of course be necessary to ascertain by experiment the proper kind to use. I think a fuller description of incandescent conductors made from wood carbon or charcoal may be found in some of the earlier foreign patents of ten or fifteen years ago.

449 Q. What do you mean by charcoal from ordinary
545 wood, in your previous answer? Do you make any distinction between the species of the wood?

A. By "ordinary wood" I mean exogenous woods—woods of medullary rays, ordinary domestic woods.

450 Q. Was that the character of the charcoal generally known in the arts as charcoal, at the date of the filing of this specification?

A. Yes, sir.

451 Q. Do you find in this specification, or in the specification of the patent as issued, to which I also call your attention, any statement as to the selection of a particular wood or charcoal having suitable characteristics, or any description of necessary methods of cutting and preparing the fibrous material for carbonization?

A. The patent as issued seems to be very much expanded, in fact it is a somewhat fuller description of what was hinted at in the patent as first filed. I find that the patent of 1885 mentions carbonized paper, and drops the use of powdered plumbago, covering it, and it doesn't give any instructions of what wood to use to obtain the wood carbon, or any details as to precautions necessary to carbonize the same.

452 Q. The question also includes any suggestion as to methods of preparing it for carbonization?

A. I do not see any description either in the first or in the amplified application, explaining the methods of preparing the wood for carbonization.

453 Q. Does the original specification or the patent as issued, in your opinion, contain a sufficient description of the fibrous or textile carbon or original material from which it is made, the methods of preparing for carbonization, and method of carbonization, to enable any person skilled in the art at the date of the filing of the application, to make practical incandescent carbon for electric lamps?

A. The original specification indicates the use of three different incandescent conductors. It doesn't state which is the best. It gives no details as to manufacture, nor does it indicate the kind or quality of the paper or of the wood. It describes no means
546 of putting them in shape for carbonization, nor any means of getting the ordinary gas carbon into shape, and the patent itself gives very little more details; in fact it leaves everything for experiment to determine the materials and operation best suited to produce a practical lamp.

454 Q. Please state specifically whether in your opinion the original specification or the patent as issued contains a sufficient description of the fibrous or textile carbon, its method of preparation, and the selection of material to enable a person skilled in the art to make a practical, fibrous or textile carbon for incandescent lamps?

A. Do you mean now in the present state of the art, or at the time the patent application was filed?

455 Q. I mean at the time the application was filed, and from the standpoint of information of those generally skilled in the art at that time.

A. Of course not. The patent would not indicate anything which has not been already indicated in other patents years before.

456 Q. That is, as I understand you, the patent in suit does not describe any advance in the art over what was before generally known?

Objected to by Mr. Kerr as incompetent.

A. No.

457 Q. Are all kinds of paper suitable for the making of incandescent conductors?

A. No.

458 Q. How many papers have you tried for that purpose?

A. I should say thirty different kinds of papers.

459 Q. What percentage approximately would you consider suitable for even a fairly operative lamp, and what percentage entirely useless for any kind of a lamp?

A. It depends on the maker. Some load their paper with so much China clay that you cannot use it; others make their paper but slightly different from makers of similar qualities of 547 paper; same parchmentize their paper, so as to destroy the fibrous nature of it; some produce a very even texture of paper, and other manufacturers produce very uneven texture, and then try to smooth it down by hard calendering. Paper is a very uncertain thing, and the same manufacturer will vary from time to time in the same brand.

460 Q. Do you know of any paper that would be entirely useless for the purpose?

A. Blotting paper, roofing paper, and glazed paper—that is to say, enameled paper.

461 Q. Do you find any statement in the original specification of the patent in suit, or the patent as issued, which shows how to select the paper for carbonization for the purpose?

A. No; it just says "paper;" that could be determined experimentally.

462 Q. As the art stood at the date of the application in the mind of those generally acquainted with the art at that time, would that have been a sufficient description to enable a proper paper to be selected without experiment?

A. No.

462½ Q. Do you find any statement in the original specification of the patent in suit, or in the patent as issued, which indicates whether the material is to be cut and shaped to size before carbonization or not?

A. There is nothing at all on this subject in the application as filed. In the patent as issued it contains a description somewhat general, saying that the material is conformed to the desired shape and size, and then carbonized when confined in retorts in powdered carbon. It doesn't give any description of how it is to be cut.

463 Q. Is there any description in the original specification, or the patent as issued, with regard to the wood carbon, to show whether it is to be cut lengthwise of or across the fibers?

A. No; it gives no description.

464 Q. Would you consider thin Japanese, dental and rice paper as a suitable material to make an incandescent conductor from?

A. No.

464½ Q. Would it be entirely useless, or only partly so?

548 A. Useless.

465 Q. The complainant's expert, Mr. Pope, takes the position that the mention of the carbonized paper in the original specification is a sufficient statement to enable those skilled in the art to understand that the material is to be cut to size and shape before carbonization. Do you agree with him in this opinion?

A. The original specification calls for carbonized paper covered with plumbago. As it doesn't say whether the plumbago is to be put on the carbonized paper or on the paper before carbonization, I do not see as Mr. Pope's answer is relevant as applied to the original application as filed, while it might be so in the patent as issued; but I differ with him about the implication that it had to be cut to size before carbonization. I do not know that an expert would necessarily do that, because thick carbonized paper of the size implied in the sketch accompanying the application could be cut out of the carbon itself. It is somewhat difficult for me at this late date to know what I would do at the date when the original application of Sawyer-Man was filed. I would probably have shaped it before carbonization, because I was already familiar previous to that date with carbonized paper in connection with incandescent lighting, telephones and their uses. If the patentees did cut the thing to shape before carbonization, why do they not fully set that out in the application so that it would not be requisite to call experts at this date to ascertain that fact?

466 Q. In your opinion, is the statement in the original application that the inventors have tried carbonized paper covered with plumbago any indication to those skilled in the art as to whether the wood carbon or charcoal is to be cut to shape before or after carbonization?

A. No indication that the wood carbon is to be formed out of wood previous to carbonization.

467 Q. Look at the drawings of the patent in suit. What,
549 in your opinion, would be the advantage, if any, in using a
carbon from fibrous or textile material in such a lamp?

A. The lamp shown is one only suitable for working in a series and not in multiple arc. It is constructed to work in a series where large currents are necessary. In lamps of this kind of a system the endeavor is to diminish the resistance of the incandescing conductor as far as possible in contradistinction to multiple-arc systems where the object is to increase the resistance of the incandescing conductor as far as possible. The ordinary gas carbon is suited to the lamp of the patent of 1885 on account of its low resistance. The use of an incandescent conductor of carbonized paper is taking a *contra* direction to what is necessary. This only defeats the great object to be attained—that is to say, low resistance, as the carbon residuum from the carbonization of paper being porous, has per square millimeter a very much greater specific resistance than gas-retort carbons; but of course, if the carbonized paper was not used, but the carbonized paper coated with plumbago or impregnated with plumbago by some means, and carbonized, as is indicated in the application as originally filed, the resistance of the incandescing conductor might be got down quite low and possibly utilized. But using all carbonized paper alone in a lamp of this character, suitable only for a series system, makes the patent very ambiguous, and rationale, taken from a scientific standpoint, would probably puzzle any expert not acquainted with the exigencies of the patentees in amending the application.

468 Q. Would there be any difficulty in making a carbon of the size and shape shown in the patent in suit from a hard-carbon mixture such as Carré used in making his pencils?

A. No difficulty; that would be an easy matter, as their manufacture was well known.

469 Q. Would such a carbon made from a hard-carbon mixture such as Carré used be suitable for a lamp of the construction
550 shown in the patent in suit; and what would be its value in such a lamp compared with the fibrous carbon?

A. It would be better than paper, but not so good as bamboo.

470 Q. Would it be better than ordinary charcoal, such as would be known by the expression "wood carbon or charcoal," at the date of the filing of the application for the patent in suit?

A. My impression is that it would be better than ordinary wood charcoal from domestic woods.

471 Q. How much of a test as to the capacity of an incandescent electric lamp would it be necessary to make in order to arrive at any certain conclusion as to its practical or commercial character?

A. For two or three years, in our test-room at the lamp factory, we were in the habit of checking our experimental results as to the efficiency of any change in the methods of carbonization, or materials, or otherwise, by setting up ten lamps at five times the normal candle power which they would burn in practice to determine the results of such experiments in terms of lamp life; but we found, after an enormous number of experiments, that the results based on such a small number as ten lamps were, in a great many cases, utterly fallacious, and we arrived at the conclusion, by experiments of lamps of definite character (and also mathematically), that no results of an experiment could be predicated upon any less number of lamps on a full test than fifty; and where great certainty was requisite, one hundred lamps are employed by us. For instance, I have now two sets of one hundred lamps each in my laboratory, which have been running, if I remember rightly, nearly a year at normal incandescence, to determine experimentally whether the multiplied factor of lamps set up at five times their normal, is a correct one. To the end that we may reach quicker results, for instance, if it was desired to ascertain the efficiency of a peculiar quality of a new material which some of my men had sent in from outlying countries, we would make up fifty lamps, put them

on a life test at eighty candles (instead of 16, at which they
551 would be used in practice), and we would arrive quickly at
the average life of the whole, because the lamps at this high temperature did not last very long; and we would from the average life of these lamps determine their relative value as compared to another and similar set of lamps made from another material; and also determine what their life would be if run at sixteen candles in place of eighty, from an empirical law which we had established from our experiments. The lamps which I have referred to as set up in my laboratory, and which have been running nearly a year, are to determine the correctness of the formula as to the lasting powers of a lamp at sixteen candles, which would have a given life if set up at eighty candles.

472 Q. Would the fact that a single lamp ran for many hours be even a reasonable indication, in your opinion, that the carbon in the lamp was made of proper material and under the proper conditions for the general manufacture of a commercial lamp?

A No result can be obtained from one lamp. If the average life of one thousand lamps is two thousand hours, and they are all set up at sixteen candles, three or four will be destroyed in the first two hours, and they will follow along one after the other over a period of six thousand or seven thousand hours, but the average of the whole would be, say two thousand hours.

473 Q. What do you understand is the meaning in the art of a "lamp chamber made wholly or entirely of glass and hermetically sealed"?

A. In incandescent lighting it means wholly of glass and all joints in the act of manufacture being sealed by fusing the glass. Hermetically sealed, as applied to the modern art of incandescent lighting has probably a different meaning than when applied to canning fruit and such things. Hermetically sealed means sealed in such a way that it maintains its vacuum continuously for any length of time. I know of no means whereby this hermetical sealing for preserving a continuous vacuum can be done except by a
fusion of the glass, the chamber being made wholly of glass,
552 through which the platinum electrodes having the same
coefficient of expasion, pass. A chamber made wholly of glass might be made in two parts and ground together, but this would not maintain a vacuum, if some wax or similar material was put into the joint in a fruit-jar sense it would be hermetically sealed, but not in the sense applied to modern incandescent lighting, where, owing to the extreme minuteness of the incandescent conductor and the quantity of carbon an extremely stable vacuum must be continuously maintained. It was the very fact that I could not maintain my vacuum which prevented me from continuing the experiments right along in the endeavor to make a multiple-arc lamp with a filament of carbon of high resistance.

In endeavoring to get a high-resistance lamp by the use of platinum, coiled, I arrived at conditions gradually wherein I was enabled to get an enclosing globe entirely of glass, all fused together, through which the platinum wires passed. Arriving at these conditions I resumed experiments on the use of carbon, knowing that I had a chamber which would preserve a vacuum continuously. The old style of obtaining a vacuum was so crude as compared with the modern method that not only could not a sufficient degree of exhaustion of the air be obtained, but even with the exhaustion obtained it was not continuous, owing to the leakage at the joints of the apparatus.

474 Q. What do you mean by the statement that the old means of obtaining a vacuum was so crude as compared with the modern?

A. I mean the mechanical air pump and bell jar, and Gassoit cascade and other devices.

475 Q. As I understand you, then, you did not consider it necessary for the purpose of increasing your information to make further experiments with carbon until you had produceed such a vacuum chamber.

A. No. It was the conditions that I desired; and once I saw that I had reached the conditions experimentally, and had proved that a chamber made entirely of glass, by fusion, through which
553 the platinum wires passed maintained a stable vacuum, I
saw at once that it would be possible to make a lamp of high resistance, from carbon. In my early experiments with platinum lamps, the thing I desired is therein detailed, to wit, a lamp which as a whole would give high resistance when giving the ordinary unit of light, that is, sixteen candles, so as to permit its being used in the multiple-arc system of distribution. I had known for a long time, and knew in 1877, that carbon had the requisite resistance to afford a very simple conductor to accomplish the object; but I also knew in 1877 that it would have to be made hair-like; and as my results showed that carbons which were far from hair-like, but many times larger in bulk approximately, were soon destroyed by my not being able to get sufficient vacuum to maintain the same, I knew that it would be useless to try a filament which would have the qualities I desired under such adverse conditions. But the moment that I had got apparatus and means and methods whereby I made a chamber wholly of glass, and with the McLeod gauge on the Sprengle pump had determined that it held a vacuum continuously, I knew that I could make the hair-like filament permanent, provided the filament itself could be made sufficiently homogeneous.

476 Q. To your knowledge are there any incandescent lamps now sold in which the atmosphere is either of nitrogen or of hydrogen?

A. None sold. The art has so advanced that the experts now know that with an electric current of one horse power, giving eight lamps of sixteen candles each per horse power, when the filament was in a vacuum, the same lamps would not give more than one lamp per horse power, or sixteen candles, when nitrogen was in the globe at the atmospheric pressure; and would give no light at all if hydrogen was in the globe at the atmospheric pressure. In other words, if eight lamps, each giving sixteen candles, run by one horse power of electricity, the chambers of which lamps were highly exhausted (that is to say, a vacuum) and so arranged that hydrogen

554 could be let into each of the chambers, so that the same should be at atmospheric pressure, and then sealed, the filament would go down to a dull red, and practically give no light at all, the whole of the heat being carried to the chamber, and radiated by conduction and convection, and not by radiation as in a vacuum. It is a most absurd thing to use nitrogen or hydrogen.

The further examination of the witness is adjourned to March 7th, 1889, at 11 a. m., at the same place.

CONSOLIDATED ELECTRIC LIGHT COMPANY
against
McKEESPORT LIGHT COMPANY.

ORANGE, N. J., *March* 7, 1889.

Met pursuant to adjournment.

Present: Messrs. Walter K. Griffin and Richard N. Dyer, for defendant, and Mr. Thomas B. Kerr, for complainant.

The witness, THOMAS A. EDISON, being further examined by Mr. DYER, testifies as follows:

477 Q. Referring to figure 5 of the patent in suit, do you consider that it would be practically possible or feasible to secure a glass plate *y* to the flange *x* by the fusion of the two glass parts together? Please state your reason for any opinion you may express.

A. I suppose that it would be possible, as an illustration of how expert a glass-blower may be in the manipulation of glass; but I do not think it would be capable of being brought to a commercial operation. If it were to be done, of course it would not be 555 necessary to grind the two faces perfectly together; and if intended to be sealed by fusion of the glass of course it would be made different than as shown in the patent. But taking the figure 5 of the patent as the real size, it would be rather difficult, and the difficulty would increase with the increase in the size of the lamp. I do not see how the metal tubes which pass through the two holes in the glass plate *y* could be sealed in very well, except they were of platinum (which I do not understand they were), and even if they were of platinum, my impression is that owing to their great size they would crack the plate on cooling. Of course if the lamp had ever been intended to be sealed by fusing the glass together it would not by any possible stretch of imagination have been made as set forth in figure 5.

478 Q. Again calling your attention to figure 5 of the patent in suit, and also calling you- attention to the Sawyer-Man patent No. 205,144, to which reference is made in the patent in suit, and which explains how the metal tubes are to be closed by the metal caps screwed over their ends, please state whether or not in your opinion a lamp chamber could be closed in this way so as to maintain a vacuum which would be suitable for a practical incandescent lamp?

A. No, this is a ground joint seal. The caps as shown in figure

5 would have to contain some unctious substance, the same as described in their patents, to maintain a vacuum for an hour even.

479 Q. Even by using the unctious or other sealing substance, would the caps in your judgment be capable of maintaining a suitable vacuum?

A. I have testified several times that chambers in which it is proposed to maintain a vacuum, made of two parts ground together, with or without some cement or mobile substance, will not maintain a continuous vacuum, and is not a hermetical sealing which meets the requirements of the modern incandescent lamp. Such chambers will not hold a vacuum. Such lamps will not be useful, or commercially made with such chambers. I know of no such lamps which were ever commercial or which were ever introduced; 556 and I do not think there is any such lamp now being made, sold, or used, with chambers of this character, with the air exhausted therefrom. This answer will cover any of the chambers or devices shown in the patents of Sawyer and Man, 205,144 and 317,676.

480 Q. Please state approximately, if you know, when the complainant, The Consolidated Electric Light Company, began the business of incandescent electric lighting?

A. I am not very familiar with the various organizations through which the Consolidated Company was formed; but if I remember rightly they bought or consolidated with a company called the American Electric Light Company, whose technical department (that is to say, the making of lamps) was conducted by experts taken from my factory and laboratory; and if my memory serves me rightly it was these experiments which started the lamp factory of the Consolidated Company, and I think they went into the business for the sale of lamps about a year and a half or two years after we had started in the business.

Mr. Kerr objects to the last sentence of the answer as incompetent.

481 Q. What company do you refer to as starting in the lamp business a year and a half or two years after your company had started to make and sell lamps?

A. I refer to the Consolidated Company, which had acquired the American Company.

482 Q. Have you ever examined any of the lamps made by the Consolidated Company? If so, please state when, and also state the result of your examination with regard to the construction of the lamps?

Objected to by Mr. Kerr as incompetent and immaterial.

A. I have examined the lamps sold by the Consolidated Company, which lamps were known as Sawyer-Man lamps. They were almost precisely the same as our own lamps. The carbon filament 557 was made of bamboo, which fact I ascertained from a microscopic examination. The only difference in the carbon was that it was "flashed" by the deposition of carbon on the surface of the original filament. I think this examination took place about two years or two years and a half ago.

483 Q. How many lamps did you examine at that time?

A. About three.

484 Q. How were the lamp chambers of those lamps constructed?

A. The chamber was made entirely of glass, by the joints being fused, and the small platinum wire sealed in the glass, and passing into the chamber, just as is shown in my patent No. 223,898.

485 Q. What was the condition of the art of electric lighting when you commenced your experiments; and what generally was the advance made by you in such art—excluding any considerations as to the quality and production of suitable carbons. Please state this so that the court can understand the adjuncts necessary to a successful lamp in order to produce a complete system of electric lighting?

A. In 1878, when I took up actively the subject of electric lighting, no apparatus had been devised, so far as I know, that would in any measure fulfill the conditions which I thought would be necessary to make electric light suitable for the illumination of interiors. In that year was begun the introduction in Paris of the Jablochkoff candle, and a year or so later the introduction of the arc lamp was begun in this country. These electric lights were of large candle power, each unit being of several hundred candles, and I did not think them suitable for general interior illumination. The subdivision of the electric light into small units comparable with that of the ordinary gas jet was what I thought was required. The general scientific opinion was that this could not be done. Even after it had been announced in the public press in 1879, that it had been accomplished by me, the statement was discredited and was pronounced by many eminent scientific men, both in
558 this country and abroad, to be an impossibility. A committee was appointed by the English Parliament to examine into the general subject, and they called before them as witnesses nearly all of the prominent scientific men in England, all of whom, with the single exception of Mr. Tyndall, testified that, in their opinion, the subdivision of the electric light was an impossibility. Mr. Tyndall said he would hardly go as far as that—he would not say it was impossible, but he would not like to undertake the solution of the problem.

It is true that incandescent electric lamps had been proposed more than a quarter of a century previous to my taking the subject up, but no material advance had been made in their production, and the correct principle upon which to build them had not been, so far as I know, discovered. Not only had no incandescent lamp been made that was capable of practical use, but the conditions of use of a practical lamp had not been predetermined, nor had any comprehensive system been devised, whereby practical lamps of small unit candle power could be used to supplant gas as a general illuminant. It was not only necessary that the lamps should give light and the dynamos generate current, but the lamps must be adapted to the current of the dynamos, and the dynamos must be constructed to give the character of current required by the lamps, and likewise all parts of the system must be constructed with reference to all other parts, since, in one sense, all the parts form one machine, the connections between the parts being electrical instead of mechanical. Like any other machine, the failure of one part to co-operate properly with the other part disorganizes the whole and renders it inoperative for the purpose intended.

The problem then that I undertook to solve was stated generally, the production of the multifarious apparatus, methods and devices, each adapted for use with every other, and all forming a comprehensive system whereby electricity, properly controlled and directed, could be distributed over large areas through the streets of a city,
and supplied to houses in which it would feed incandescent
559 electric lamps of moderate candle power, which would be
entirely under the control of the householder, the whole to be on the same scale as the present system of gas distribution and affording the same character of convenience to the users.

The first thing necessary to be done was to adopt a fundamentally correct system of distributing the electric current and then to devise which could be worked practically on such a system—that would be practical and satisfactory both in a commercial and scientific sense. The essentials of a comprehensive system of electric illumination, similar to the general plan of illumination by gas, were a network of conductors all connected together, so that in a city area the lights could be fed with electricity from several directions, thus eliminating the disturbances to any particular section.

Second. To devise an electric lamp which would give about the same amount of light as the gas jet, which custom had proved was a suitable and useful unit, and which should possess the qualities necessitated by small investment, in the copper conductors. It was also necessary that each lamp should be independent of every other lamp, although on the same circuit. That the light should be produced sufficiently economically to commercially compete with gas. That the lamp should be durable, and capable of being handled by the public, and cheap to manufacture, and one that would remain incandescent and stable a great length of time.

Third. It was also necessary to devise means whereby the amount of light furnished a consumer could be accurately determined, as in the case of a gas meter—and that this should be done cheaply and reliably.

Fourth. I had also to devise a system of conductors capable of being placed underground or overhead, and which would allow of being tapped at intervals, speaking generally, about the width of each house facing the street—so that service wires could be run
from the main conductor into each house, as gas pipes run
560 from gas mains, and generally whatever was necessary to
such a comprehensive system of distribution as the system I had in view required. Where the conductors were to be placed underground, which I contemplated doing in large cities, it was necessary to devise a system of protective pipes for the copper con-

ductors, which would allow of their being tapped wherever required; also manholes, junction boxes, connections, and the various parap-ernalia of a complete system for underground general distribution.

Fifth. I had also to devise means of producing at all points, and on an extended area of distribution, a practically even pressure analogous to gas, so that all of the lights should give an equal light at all times and independent of the number that might be in use. I had also to devise means for regulating, at the point where the current was generated, the equality of the pressure of the current throughout the whole lighting area, also a means of indicating what the pressure was at the various points of the area.

Sixth. I had also to devise economical dynamo machines for the conversion of steam power into electricity, means for connecting, disconnecting, working and regulating the same: means for equalizing their loads; means for regulating the number of machines to be used to the demands on the station for electricity from the users of the light. The arranging of complete stations, with steam power and electric apparatus, and devices of all kinds to suit the varying conditions of buildings available for such stations in cities.

Seventh. I had also to devise devices which would prevent the current used from becoming excessive upon any conductors and causing fire or other injury, switches whereby the current could be turned on or off at such points as it was desirable that this should be done, lamp-holders, electric chandeliers and the like. I had also to devise means and methods for placing the wires that were to convey the current to the chandeliers in buildings.

561 I set out to found an entirely new industry and art. My system contemplated the generation of electric current on a very large scale, and its distribution throughout an extended area, and the division and subdivision of the current into small units converted into light at innumerable points in every possible direction from the point of its generation. Nothing of this character had ever been undertaken before, and the accomplishment of this result presented at almost every point problems of the utmost difficulty, the solution of which was not suggested by anything that had gone before in the art, but required a great amount of experiment and labor.

486 Q. What, in general, was the history of the commercial introduction of the Edison system of electric lighting?

A. I entered into relations with the Edison Electric Light Company in the fall of the year 1878, under an agreement by which I was to perfect the system I had in contemplation. I had at the time a large laboratory and a machine shop at Menlo Park, New Jersey. I immediately increased the working force in my laboratory and machine shop, employing mathematicians and scientists as well as the best mechanical skill, and I commenced experimenting on an extended scale, having at one time upwards of one hundred men engaged upon various branches of the experimental work. In December, 1879, I gave a public exhibition at Menlo Park of my system, lighting up the grounds and buildings with my carbon filament lamps, which I had then brought to what I considered commercial perfection.

By reason of the obstacles which are usually met with in an establishment of an entirely new art, the introduction of my apparatus proceeded slowly at first. The company did more or less business in the way of selling isolating plants for lighting single buildings, but it was not until the fall of 1882 that a complete central station was in operation. This plant was a great undertaking for an initial plant. Its conductors were designed to supply current to 16,000 lamps. They were laid underground in the streets in the lower part of New York city, and extended through all the streets
562 of district about one mile square, bounded on the east by the
East river, on the south by Wall street, on the west by Nassau street, and on the north by Spruce street, Ferry street, and Peck slip. The engines and dynamos for generating the current were located in a building on Pearl street. The first cost of this plant was in the neighborhood of $600,000. Since the erection of the first central station plant a large number have been installed by the Edison Light Company and its agents.

487 Q. What, if anything, did you do in the way of establishing factories for the manufacture of your electric lighting apparatus?

A. There were no established factories at the time which could undertake the manufacture of the apparatus. The necessity of establishing factories, together with the inventing and devising of the numerous tools and methods of manufacture, and the education of men in the manufacture of new character of apparatus, was a cause of great delay in the introduction of my system. The experimental work had been carried on in my laboratory and machine shop at Menlo Park until 1880, when I established works for making lamps. I had to establish these works, as it would have been impossible for me to have had the lamps made in any established factory, nor was there any skilled class of labor which could have made such lamps without my personal instruction or the instruction of my assistants. Shortly after the establishment of my lamp factory I caused the establishment of Bergmann & Co., for the manufacture of lamp sockets, meters, switches, safety catches, and the various small parts required in electric light plants, as well as chandeliers, brackets, and other forms of fixtures for supporting the lamps. These could not have been made in the general market for the reasons previously stated. Shortly afterward the Edison machine works was established for manufacturing dynamo machines. This factory I had to establish for the same reasons as above stated. I also formed the Electric Tube works, which
563 has since become amalgamated with the Edison machine
works for manufacturing underground conductors. These factories I put up largely at my own expense, investing all the moneys I had made from my previous inventions, and to-day I own a controlling interest in them. I established them because the business could not have been developed without them, and placed over each, as general superintendent, gentlemen who had been con-

nected with me in my laboratory, and who were familiar with the patented devices of my system.

488 Q. Did you or the Edison Electric Light Company have any trouble in finding skilled men to install these central station plants?

A. As I have said the art was an entirely new one. This made it necessary that men should be specially educated in it. There were no body of skilled artisans from which the company could draw. All the work had to be done at first under the direct supervision of myself and my laboratory assistants, who had acquired a knowledge of the inventions and apparatus used in my system during the course of my experimental work. In the installation of the first central station plant in New York city I was almost constantly present, giving my entire time to the work day and night. I had to give it careful and constant supervision. In illustration of what I say, I will state that I actually worked in trenches in the streets in the lower part of the city, in which the conductors were being laid, making many of the connections myself.

After the first station had been built the public were to form companies and install my system. The great difficulty was in getting men to do the work. There were not then, as now, electrical engineers who were familiar with my work and who could be employed for the actual construction of a central station. The art was new and men had to be educated and I had to educate them. I was compelled to form a construction department and personally undertake the construction and installation of central station plants in cases where my company had made contracts for the erection 564 of plants. I gave this construction department my personal attention, giving up my experimental work to a great degree. I gathered around me a body of men whom I instructed in the details of my system. In the shops I established training departments, so that the men I employed could become familiar with the apparatus that was to be used and generally familiar with all arrangements of the business, to the end that they might become able to superintend the installation of plants. I expended some $54,000 of my own money in educating men in my construction department and in my shops, so as to develop the company's business, for which I have never received the slightest return. Many of the persons whom I instructed, after they had acquired knowledge of my system, left my employ and used the knowledge they had acquired against my interest and the interests of my company.

Counsel for complainant objects to so much of the deposition of this witness as relates to the manufacture and sale of lamps subsequent to the date of the application for the patents in suit, or subsequent to the date when the witness or the Edison Electric Light Company had notice of the rights of Sawyer-Man, as incompetent and immaterial. Counsel also makes the same objection to the answers to questions 485, 486, 487 and 488. These objections are entered at this point in the examination by agreement of counsel, and are here made for the purpose of saving interruption and loss of time during the progress of the examination.

Cross-examination by Mr. KERR (without waiver of objection):

488 X Q. When was the Edison Electric Light Company formed?

A. I see by looking at a copy of the certificate of incorporation that the company was incorporated —— —, 1878.

565 489 X Q. How soon after the formation of the company did you begin your work on incandescent lamps, which you speak of as having resulted in the production of a successful lamp?

A. I was experimenting on devising a system of electric lighting before the company was formed, and continued these experiments right along until I had reached a successful lamp.

490 X Q. What facilities, as to men, money and apparatus, did you have in connection with your lamp-work at that time?

A. What time?

491 X Q. The time referred to in the last answer?

A. I said that I had experimented to devise a system of electric lighting before the Edison Electric Light Company was formed, but did not state any time.

492 X Q. My question referred particularly to your work after the formation of the company. I repeat the question with that understanding. What facilities as to men, money and apparatus, did you have in connection with your lamp-work at that time?

A. I had a laboratory at Menlo Park; I had sufficient money for all experimental purposes, but the facilities were gradually augmented after the formation of the company until I had all that was required.

493 X Q. My question also involved men?

A. I had all the men that I required.

494 X Q. Please name some of the men you had assisting you in those experiments?

A. Charles Batchelor, Francis R. Upton, Francis Jehl, John Kruesi, Martin Force, W. J. Hammer, Ludwig Boehm, Crosby and others.

495 X Q. Were you limited in any way as to expenditures, or the employment of men, or the purchase of apparatus, or any other thing that might be of advantage in your work?

A. No, not after the formation of the company.

496 X Q. Please give me the names of the persons who constituted the company?

A. The incorporators, as shown by the certificates, were—.

566 497 X Q. What relation did Mr. Lowrey have to the company during the year 1879?

A. He was a director, and, I believe, the counsel of the company.

498 X Q. What was the capital of the company?

A. I think the first capital was $300,000.

499 X Q. If it was subsequently increased, please state that fact, and also what, and as near as you can when, the increase was?

A. I remember that it was afterwards increased to, I think, $700,000, and then again to $1,500,000. I have no means of refreshing my recollection, and cannot give the dates when these increases took place. I did not pay much attention to that branch of the subject.

500 X Q. What was the par value of that stock?

A. $100.

501 X Q. Do you know what its market value in 1880, 1881 and 1882 was?

A. I considered the intrinsic value to be about $500 a share. The market value was very variable. I did not sell any of my own stock, and therefore cannot state the prices at which sales were made, except from hearsay.

502 X Q. Isn't it a fact that it went up to about $1,250 a share during that time?

A. My information was that it sold for that.

503 X Q. Who were the financial agents of the company during 1879 and up to 1883. I mean the bankers?

A. I don't remember who the bankers were. The firm of Drexel, Morgan & Co. were interested as stockholders, and one of the members of the firm was a director.

504 X Q. I wish you would just give his name?

A. Egisto P. Fabri. I don't think they were the bankers.

505 X Q. What variety of bamboo is it that you say you use in the manufacture of lamp carbons?

A. A variety which grows and is extensively cultivated in Japan for artistic purposes.

567 506 X Q. I wish that you would give the name of the variety, and from what part of Japan it comes, so that it may be identified?

A. I think the name of the quality which is the best is called Matake. It is, however, the same quality as is used in Japanese art work, having a very polished yellow surface. Flexible screens, lattice-like, put together with thread, and sold in Japanese art stores in New York, are made of the character of bamboo that we use.

507 X Q. Referring now to the patent in suit. Do I understand you that it would be impossible to make a lamp, such as is shown and described there, and fill it with nitrogen gas, that would be a practical lamp?

A. Yes, for commercial purposes.

508 X Q. What is necessary to fit a lamp for commercial purposes—I mean what qualities?

A. That it should be sufficiently economical, in the production of light, to permit of competition with gas, when an equivalent amount of light from an electric light can be sold for 50 per cent. more than the same amount of light by gas; it also must be cheap—that is to say, the lamp must be cheap to manufacture; simple, not liable to get out of order; the filament should last a considerable length of time; and generally have such characteristics as would permit the use of a moderate investment in the distributing system in streets and houses upon which it is to be worked. The use of nitrogen, at atmospheric pressure, would permit the use of the carbon conductor in a lamp longer than in a vacuum, as the tendency to leakage through the joints would not be so great. But, on the other hand, the employment of this means brings in a factor as disadvantageous, commercially speaking, almost as the shortened life of the conductor due to an unstable vacuum. As I have already testified, under these conditions of burning in nitrogen gas at atmospheric pressure, we would obtain only about one-eighth as much light from any incandescent conductor as would be obtained from the same in high *vacuo* with the same amount of electricity.

568 509 X Q. Could you take the patent in suit, make a lamp like it, fill it with nitrogen gas, and, by the application of a proper current, bring the carbon to incandescence?

A. Yes, sir.

510 X Q. Could you make such a lamp last for a day?

A. I don't think so.

511 X Q. Do you think it would be impossible?

A. It would depend upon the degree of incandescence. If brought up to the same degree of incandescence as the ordinary incandescent lamp now used, I do not think it would last a day.

512 X Q. What do you mean by the ordinary incandescence of a lamp?

A. I mean the regular incandescent lamp now sold throughout the country as under my patent 223,898.

513 X Q. What is the candle power?

A. A degree of incandescence of about 240 candles per electrical horse power.

514 X Q. Suppose such a lamp to be burned at 25-candle power, do you think you could make one which would last for a day?

A. Not at the specific incandescence of 240 candles per horse power.

515 X Q. I have called your attention to the lamp shown by the patent in suit. Please state whether you think it is impossible to make a lamp like that, having a burner composed of fibrous or textile carbon, which would burn, at the brilliance of an ordinary incandescent lamp of the present day, for a period of 24 hours?

A. I do not believe it could be made to do so.

516 X Q. I now show you a printed book entitled "In the United States Patent Office. Edison *vs.* Maxim *vs.* Swan. Interference. Electric lamps. Testimony in behalf of Edison." Please state whether you testified in that interference case, and whether your deposition appears on pages 1 to 13 and pages 164 to 252?

A. Yes, sir.

569 517 X Q. Do you know that this is the paper book containing the printed testimony on your behalf in that interference?

A. It appears to be. I have no doubt but what it is.

The examiner is requested to mark the paper book for identification as "Complainant's Exhibit Edison, Maxim and Swan Interference Record." The examiner does so.

The exhibit is objected to by counsel for the defendant as being incompetent and irrelevant, and as being only a part of a record.

Redirect examination by Mr. DYER:

518 Re-D. Q. In what sense, if at all, in your opinion, would the lamp described and illustrated in the patent in suit be practical when constructed with the general knowledge of the art as it existed at the date of the application, namely, January 9, 1880?

A. It would not be a practical lamp at the time of the filing of the application. Neither would it be a practical lamp if made according to the amended specification and the drawings; and I have testified that, if made according to the specifications and drawings, it is not a practical lamp now.

519 Re-D. Q. To what extent would such a lamp be capable of use if constructed with the general knowledge of the art as it existed at the date of the application?

A. No use.

520 Re-X. Q. Has the general knowledge of the state of the art materially increased since the date of the filing of the application of the patent in suit?

A. Yes, sir; the general appreciation of the problems inherent in the practical part of the art has been greatly acquired by experts since the application in question.

Recross-examination by Mr. KERR:

570 521 Re-X Q. State whether an incandescing conductor for an incandescent electric lamp, composed of carbonized fibrous or textile material, and of an arch or horseshoe shape, is a practical thing.

A. It depends on the nature of the material from which the incandescent conductor is made, and the conditions under which the same is worked.

522 Re-X Q. Suppose that material to be paper?

A. It depends on the kind of paper, the method of carbonizing, and the conditions under which it works.

523 Re-X Q. Those things all given, namely, a proper kind of paper, proper carbonization, and proper conditions under which it is worked, such a conductor would be a practical and operative thing, would it not?

A. It would be a relatively practical success as compared with bamboo; but in one sense, that is to say, for competing purposes, it could not compete with bamboo for the selling of light from lamps constructed as stated. The lamps, in their manufacture, would be under the disadvantage that not as many given lamps from a given lot can be obtained from the use of paper as from the use of a more perfect material such as bamboo, and the life of the lamps would not be so great as those containing bamboo.

524 Re-X Q. You did not know that fact on January 9, 1880, did you?

A. No, I did not. The paper lamp was the best one we had at that time when made in quantities, although I might have tried experiments on other material which showed in one or two cases better than paper. I don't remember now, as I have not read over my previous testimony, and it is so many years ago that I have a very indistinct recollection and would not be able to answer this question accurately without refreshing my memory by reading over testimony I have already given and looking at my original sketches.

525 Re-X Q. Was your first bamboo lamp as perfect as the lamp you now make?

A. No, not quite so perfect.

526 Re-X Q. There has been an advance then in that particular with yourself, has there not?

A. Yes, sir; we are enabled, by careful manipulation in
571 the various processess in the factory, to produce lamps which,
as a whole, are much better than we were able to make, producing the same number in 1880, although some of the 1880 lamps were far superior to some of the lamps now made from the same material.

527 Re-X Q. You are constantly improving the character of your lamps, are you not?

A. Yes, sir; constantly improving on the details of manufacture so as to ensure the production of a greater number of lamps in which defects are absent.

528 Re-X Q. You are also improving their efficiency, are you not?

A. The efficiency is improved by the perfecting of the details of manufacture.

529 Re-X Q. Isn't it a fact that the art of manufacturing incandescent lamps is constantly improving?

A. The art of manufacturing is constantly improving in the sense that in a lot of 100 lamps there will be a less number broken in the first hundred hours than in a lot of 100 made the year previous.

530 Re-X Q. And also that there will be a greater number of good lamps?

A. Yes, sir.

531 Re-X Q. Is the combination of an electric circuit, and an incandescing conductor of carbonized fibrous material included in and forming part of said circuit, and a transparent hermetically sealed chamber in which the conductor is enclosed, a practical and operative combination?

A If the incandescent conductor of textile or fibrous material is a good one and made from proper material and properly carbonized and properly exhausted, and the chamber is absolutely hermetically sealed by the fusion of the glass so that the whole of the chamber shall be made of glass through which the platinum wires are sealed, and the vacuum is high and stable, such a lamp would be, if included in an electric circuit, a commercial success.

532 Re-X Q. If you had made such a lamp and had found that the conductor was destroyed by reason of defective sealing of the chamber, what would you have done?
572 A. I would have done just as I did in my patent 223,898,

make the chamber entirely of glass by fusion—hermetically seal it in reality and not in name.

533 Re-X Q. In short, you would have made the sealing perfect, would you not?

A. Yes, sir.

534 Re-X Q. That would be the obvious thing to do, would it not?

A. Not obvious, no. It took me a long while to reach, by experimentation, the condition which caused me to appreciate that fact.

535 Re-X Q. My question supposed that you appreciated the fact that the sealing of the lamp was defective. Having appreciated that fact, was it not the obvious thing to do to make that sealing perfect?

A. I appreciated the fact that the method shown in the patent of the complainant was defective, but I did not appreciate the fact until I had experimentally determined that the only possible means whereby a continuously stable vacuum could be obtained was by the use of a chamber made entirely of glass; and when this became certain to my knowledge I applied for the patent No. 223,898.

536 Re-X Q. I didn't say anything about the complainant's patent. My question supposed a lamp having an electric circuit, an incandescent conductor of carbonized fibrous material included in and forming part of the circuit, and a transparent hermetically sealed chamber in which the conductor was enclosed, and the appreciation of the fact on your part that the sealing of such a lamp was defective, and I asked you whether it was not the obvious thing to do for you to make that sealing perfect. Now, was it not?

A. Your question implies that it was hermetically sealed. If it was hermetically sealed there would have been no use of fusion; but in point of fact such lamps as are implied by your question are not hermetically sealed. It was not obvious at the time—at least it was not to me—that by fusion of the glass such a chamber would maintain a stable vacuum. Such things are never obvious. 573 For instance, the telephone and the phonograph—two excessively simple things, performing great results—were not obvious to men skilled in the art, who knew all the conditions necessary to produce such instruments. In science those things which are the most simple and most conspicuous seem to be hidden the longest. Their very conspicuousness seems to hide them.

537 Re-X Q. We will omit the word "hermetically," and I call your attention to the fact that I said nothing about "fusion," and I ask you whether, given such a lamp, the sealing of which was defective, was it not the obvious thing to do to make that sealing perfect?

A. I don't know what would be obvious to other people. It was not obvious to me until I had reached that point, and when I did reach the point and got results I applied for a patent in which I claimed the conditions of an incandescing conductor in a chamber made wholly of glass, as claimed and shown in my patent 223,898.

538 Re-X Q. Please state whether an incandescing electric lamp, consisting of an illuminating chamber made wholly of glass, her-

metically sealed, and out of which all carbon-consuming gas has been exhausted or driven, an electric circuit conductor passing through the glass wall of such chamber, and hermetically sealed therein, an illuminating conductor in said circuit and forming a part thereof, within such chamber, consisting of carbon made from a fibrous or textile material having the form of an arch or loop, is a practicable and operative thing?

A. If the carbon is a good one, and the chamber is made entirely of glass, through which platinum wires, or wires having the same coefficient expansion as the glass, are sealed, and from which the air is exhausted, and if placed in an electric circuit, such lamp would be a practical lamp.

539 Re-X Q. Your bamboo carbon is a fibrous carbon, is it not?

A. Yes, sir.

574 540 Re-X Q. It has an arch or loop shape, has it not?

A. Yes, sir.

(Signed) THOMAS A. EDISON.

Sworn to before me—
[L. S.] WILLIAM FARNHAM,
Special Examiner and Notary Public.

MARCH 7*th*, 1889.

CHARLES BATCHELOR, being duly sworn, testifies as follows:

The same stipulation is entered into in regard to the testimony of the witness, Charles Batchelor, in the interference proceeding in the U. S. Patent Office, between Sawyer & Man and Thomas A. Edison, as appears of record in regard to the deposition of Thomas A. Edison; and the examiner is requested to copy said deposition as part of this examination, and the deposition is accordingly entered as follows:

The following is Mr. Batchelor's testimony in the interference case:

CHARLES BATCHELOR, a witness produced in behalf of Mr. Edison, testified on oath as follows, in answer to questions proposed to him by George W. Dyer, counsel for Edison:

1 Q. Please state your name, age, residence, and occupation?

A. Name, Charles Batchelor; age, 35; residence, Menlo Park, New Jersey; occupation, assistant to Mr. Edison.

2 Q. Please state how long you have been an assistant to Mr. Edison, and what your particular labors and duties have been in that capacity?

575 A. I have been assistant to Mr. Edison for nearly eleven years. My occupation has been entirely, during the last eight or nine years, the receiving of ideas and sketches, and afterwards carrying them out; making the necessary instruments myself, or with any help that I required. I have had general charge of all Mr. Edison's experiments during that time under himself.

3 Q. If you know of experiments of Mr. Edison's in 1876, in the carbonization of paper, please state about the same, somewhat in detail?

A. I remember some experiments in carbonization of paper in the summer or fall of 1876, in which paper carbon was made by him and myself for resistances, battery carbons, and other things that were to be sold by a company called the Novelty Company. I remember carbonizing strips of paper in pieces of gas tube, also sheets of paper in an old cast-iron box which we had laying around his laboratory. I do not remember what kinds of paper was used, with the exception that I remember carbonizing a number of sheets of tissue paper. The other papers were a variety of papers that were lying around the laboratory at the time. I also remember that we carbonized there paper called bristol-board, besides a number of different kinds of wood.

4 Q. How extensive and long-continued were these experiments in the carbonization of paper?

A. They were not very long-continued. I believe the experiments lasted not longer than a fortnight, as far as the Novelty Company was concerned. My impression is that I carbonized paper later than those experiments for our own use in the laboratory.

5 Q. Had you proceeded before the end of 1876 in the carbonization of paper, so far that nothing more was needed in the way of information with regard to the proper carbonization, *per se*, of paper?

A. The experiments of 1876, of which I speak, answered their purpose as far as I am aware, the papers being properly carbonized. I believe we required to learn no more on carbonization for that purpose.

6 Q. During the time mentioned had you put such carbonized paper in electrical circuits?

576 A. Yes, sir; as some strips were intended for resistances, we had measured their resistance to see what variation there was in the carbonizing. I do not remember what resistance the carbon strips were, as we had no particular size for them.

7 Q. State, if you please, the next experiments you remember of as made under Mr. Edison's direction with carbonized paper.

A. The next experiment that I remember was the use of carbonized paper in telephones. I have found a paper which refreshes my memory on that point, which is dated July 20th, 1877, and about that time we used carbonized paper in telephones for contact points and diaphragms. The next experiment with carbonized paper that I can remember is the cutting of strips of carbonized paper and putting them into the lamp on the table here, marked Edison's Exhibit First Incandescent Lamp. I believe the strips were cut from carbonized paper that had been carbonized by us in 1876, and I believe I put them in the lamp about August or September, 1877.

Question and answer objected to in so far as it relates to the lamp marked Edison's Exhibit First Incandescent Lamp, or in so far as it has any reference to electric lighting by incandescence with paper carbons, as going to prove that the invention was made and used previous to the time alleged in Mr. Edison's preliminary statement.

Papers referred to in the previous answer is put in evidence, and marked Edison's Exhibit No. 14.

Exhibit objected to as immaterial.

8 Q. When did Mr. Edison first begin to experiment in lighting by electricity, to the best of your knowledge, recollection or belief?

Objected to as calling for the mere belief of the witness, which is not evidence.

577 A. I know that Mr. Edison has frequently made experiments in electric lighting previous to the time I put the paper carbon in the lamp marked Edison's Exhibit First Incandescent Lamp, but I cannot tell just exactly what those experiments were. He had been experimenting for about a day on electric lighting previous to his telling me to put this paper carbon in the globe of this exhibit at that time. I find by a record book of Mr. Kruesi's, which is now in evidence, and marked Edison's Exhibit No. 12, which I believe to be true, that he did some work on an electric lamp in January, 1877. This, no doubt, was under my direction, but I have no memoranda to recall to my mind what the experiment was.

9 Q. What is the earliest experiment, to your knowledge, which Mr. Edison made with paper-carbon conductors in an incandescent electric lamp?

A. The earliest experiment that I remember is the one in which I put the paper carbons in the lamp marked Edison's Exhibit First Incandescent Lamp.

Answer objected to as intended to prove that the invention was made before the date stated in the preliminary statement.

10 Q. Please give in detail the history of the construction or fitting up of Edison's Exhibit First Incandescent Lamp, so far as you know about it?

Objected to on the ground that it is intended to prove that the invention was made previous to the date stated in the preliminary statement.

A. The instrument marked Edison's Exhibit First Incandescent Lamp, was originally a philosophical instrument, bought by Mr. Edison for his laboratory, and is called, I believe, a Gassiot tube or cascade, and was intended to show the discharge of electricity *in vacuo*. It had been in the laboratory, I believe, since 1875. It was made into an incandescent lamp by myself, at the request of Mr. Edison, in the summer or fall of 1877, he at that time wishing to try 578 some experiments on incandescent carbon for lighting purposes. I put on this instrument two binding posts, and also had made two clamps, which I put onto the ends of the rods inside the globe. At first Mr. Edison wanted a hard carbon piece put into the globe, but as I had great difficulty in making it small enough, and getting it in, he suggested that I should cut the carbon from carbonized paper, of which we had a quantity in the laboratory at the time. I did so, and succeeded in giving him a few of the carbons in the lamp. I do not believe the lamp has been used for any other experiments since that time.

11 Q. Please explain how you got the paper carbons into the lamp and held them in position there?

Same objection as before.

A. It was a very difficult and tedious process to put the carbon in there, but I did it by unscrewing the ball from the top of the rod, and also unscrewing the globe from the holder above the cock; also unscrewing the cock from the base; also unscrewing the packing cap. When these are all apart the top rod will drop out and the bottom rod can be left in the part having the cock. The carbon was now screwed to the clamp of the bottom rod whilst lying on the table. The other clamp was then screwed to the other end of the carbon, and all three together lifted and turned, so that the part having the cock would be topmost. The lamp was also turned upside down, and the rods and carbon carefully dropped through it. The top rod was then held until the packing and packing cap were put on, when the whole was screwed together again, and the ball replaced. The binding posts were put on the lamp to hold the connection wires from the battery.

12 Q. Please to state whether or not, after the carbon conductor was thus placed in position, the air was exhausted from the globe of the lamp; and if so, by what means.

Same objection as before.

579 A. After putting a carbon into the lamp, the lamp was placed on the plate of an ordinary air pump, and the bulb exhausted as well as we could do it with that pump. The current of electricity was then applied to the carbon, and heated the same for some short time.

13 Q. Was the carbon brought up to a point of incondescence in the lamp?

Same objection as before.

A. Yes; the lamp did give light for a short time in each case.

14 Q. Please to state, if you remember, how numerous those experiments were?

Same objection.

A. I cannot remember just the exact number I put in, but believe there were at least four.

15 Q. Do you remember from what kind of paper those paper carbons were made?

Same objection.

A. I cannot be sure what they were made from, as I did not make them at the time for the experiment. I remember I took a carbon sheet that was thin compared with others we had, but what kind of paper it was I do not know.

16 Q. Do you remember what was the size of the strips of carbon paper with which you experimented in that lamp?

Same objection.

A. I had no particular size given me by Mr. Edison, and I do not think I measured them, but should judge I made them three-quarters or an inch long and about a sixteenth wide. The thickness of the paper, I believe, was about seven or eight thousandths.

580 17 Q. Did you give this lamp to Mr. Edison to be filed by him as an exhibit with his testimony in this case?

Same objection.

A. No, sir; I may have been the means of calling his attention to the lamp, because I told him I was sure that he had tried incandescent carbon paper previous to the boron and silicon experiments.

18 Q. Who found the lamp previous to its being put in as an exhibit in this case?

Same objection.

A. I do not know who brought the lamp in here. The lamp has never been lost, for it has been lying around the laboratory, generally in full view, ever since the experiment of putting the carbon in it.

19 Q. Were there many other exhibits in the laboratory at the same time?

Objected to as immaterial.

A. There are and have been hundreds of such instruments in Edison's laboratory—relics of old experiments.

20 Q. How do you know that this Exhibit First Incandescent Lamp was made and experimented with, using paper-carbon conductors, at the time you have testified?

Objected to as going to show that the invention was made previous to the date given in the preliminary statement.

A. I can only approximate the date of the putting in of the paper carbon from a paper in evidence marked Edison's Exhibit No. 13, which is dated October 5th, 1877, witnessed by me on or about that date, and in which silicon is used between two electrodes for incandescent lighting, and I know that the experiment on in-
581 candescent paper carbon, in the lamp marked Edison's Exhibit First Incandescent Lamp, was at least from one to three months before that.

21 Q. Is that recollection further strengthened by inspection of Edison's Exhibits Nos. 4 and 5?

Same objection.

A. It is, for I remember from them that we hoped at that time to get better and more stable results than we had previously got from paper.

22 Q. Referring to these Exhibits 4 and 5, state whether or not your signature upon the same is in your own handwriting, and, if so, when was it made.

A. I recognize my signatures on both of these papers, and know that they were put on there by me, on or about the dates marked on the exhibits.

23 Q. After the experiments with paper-carbon conductors with Edison's Exhibit First Incandescent Lamp, what was the reason of making experiments with boron and silicon, and the other metals named in the Exhibits 4, 5, and 13?

Objected to as immaterial.

A. Mr. Edison hoped to get from them a more durable and unoxidizable substance than carbon for electric lighting.

24 Q. Referring again to Edison's Exhibit No. 13, please to explain what is shown and described in that exhibit?

Objected to as incompetent. That must appear by the exhibit itself.

A. Fig. 1, on Edison's Exhibit No. 13, shows three incandescent electric lamps, in which the light-giving substance is silicon, each placed around resistance in the line, so that only a portion of the current goes through the silicon, and the whole fed with electricity from a magneto machine.

582 The figure directly under this No. 1 shows three incandescent electric lamps, similar to the three in No. 1, but placed in multiple arc, each one with its own resistance.

The bottom figure on this exhibit shows the same three lamps, I presume, although the word "silicon" is not there, and these three lamps are all placed in series. In all three cases the electricity is furnished by a magneto machine.

25 Q. Please make a similar explanation of Edison's Exhibit No. 4.

A. In Edison's Exhibit No. 4, figure 1 shows four of such lamps in multiple arc, and figure 2 shows three of such lamps in series, and an explanation is here made to show that other substances could be used besides silicon, as Mr. Edison has remarked on it that he has tried a number of other things, and suggests the better method of working either boron or silicon. He also suggests on this, mixtures of non-conductors and semi-conductors, in order to get a greater resistance when using low-resistance materials.

26 Q. After the experiments described by you with Edison's Exhibit First Incandescent Lamp, what were Mr. Edison's next experiments with carbonized paper for electric lamps?

A. The next experiments that I remember in carbonizing paper for electric lamps were a series of experiments he had me make in order to get a good and light carbon for a lamp which was to be worked on a partial incandescence. I made a great many carbons about August and September, 1878, a great many of which were made from paper. Some of these carbons, especially the smaller ones, were raised to incandescence in an exhausted bell jar of an air pump about that time. I believe I worked altogether, about that time, equal to about two months' ordinary daily working.

Answer objected to upon the ground that it related to experiments made and carbonized paper burnt for electric lighting previous to the date alleged by Mr. Edison in his preliminary statement.

583 27 Q. What were the size and the form of the paper-carbon conductors used in these last-named experiments?

A. The thin ones were generally short—from two to three inches; the thick ones were sometimes as long as six inches; I believe I made as many as from fifty to seventy-five of the paper carbons, which ranged in diameter from three-sixteenths of an inch down to considerably below a thirty-second of an inch. It was difficult to get the small ones very long. The best method I found of making these carbons was to coat tissue paper, or very thin paper, with a mixture of tar and lamp-black, and then roll them up on a flat plate very tightly.

28 Q. Have you any recollection of applying these paper carbons to a lamp such as shown in Mr. Edison's patent No. 224,329—if so, at about what time was that?

A. I do not remember a lamp similar to that shown in the patent referred to being made, except similar in principle. I made a lamp the same in principle as these, which I have found a portion of, in which one of these paper carbons was placed directly over six platinum points and guided in its descent by an upright arm, having a projection on it, with a hole through which the carbon could slip. I believe this lamp was used with three points and six points. The lamp was both an incandescent and an arc lamp—a slight arc forming between the points and the carbon. I cannot exactly tell the date of this lamp. I believe it was previous to Mr. Upton's coming with us in the laboratory, which I think was in November, 1878. I produce a portion of this lamp, showing the base, and the six springs and holders screwed thereon, but the platina points have been taken out.

Portion of the lamp placed in testimony and marked Edison's Exhibit No. 15.

Answer and exhibit objected to as immaterial, and as referring to a lamp that is not an incandescent lamp, in the sense that 584 that expression is used in the application for the patent in interference, but is an incandescent lamp in which the illuminating carbon or electrode is being continually consumed.

29 Q. Was this lamp, Edison's Exhibit No. 15, put in electric circuit and the paper carbon heated to incandescence?

A. Yes, sir.

30 Q. In this lamp, just referred to, was provision made to keep a constant electric continuity?

A. Yes, sir; the fact that the carbon conductor stood directly above the platinum or iridium points and was free to fall by gravity, kept it always in contact with the points.

31 Q. Were other experiments made at about this time by Mr. Edison, or under his direction, in connection with incandescent electric lights?

A. Yes, sir; at that time Mr. Edison was almost entirely occupied with incandescent electric lights. Mr. Edison about this time commmenced the improvement of apparatus for getting a good vacuum. He was also experimenting at the time for the best dynamo-electric machine that could possibly be got. He was also endeavoring to get a lamp of high resistance from metals, such as platinum, nickel, iron and alloys of platinum-iridium. These experiments on the perfection of vacuum apparatus extended far into 1879.

32 Q. During that time also, namely, the latter portion of 1878 were not experiments going on on incandescent paper-carbon conductors, *in vacuo?*

A. I have mentioned that we made experiments in August or September, wherein we placed paper carbons, made by myself, in a vacuum, and raised them to incandescence by the electric current in the bell receiver of the pump. To the best of my recollection, after these experiments were tried, Mr. Edison's attention was turned more particularly to the getting of this lamp of high resistance, which he required, from metals instead of carbon; this he succeeded in doing to a great state of perfection; but in doing so he
585 had been able to get an apparatus for making a vacuum which was far superior to anything we had had before; and it occurred to him that, with such a vacuum, carbon, however small, should be able to stand without oxidizing, which it had always done before.

33 Q. Please examine Exhibit Edison's Commercial Incandescent Electric Lamp, and state when lamps of that description were first made by Mr. Edison?

A. The lamp marked Edison's Commercial Incandescent Electric Lamp is one of a number of lamps made in October or November, 1879, and lamps of this description were first made about the middle of October, 1879.

34 Q. What kind of a lamp is this exhibit you have just testified about?

A. It is composed of a hermetically sealed globe, wholly of glass, through which two platinum wires project on the inside, and to which is clamped a carbon conductor made of paper carbonized. This globe is exhausted of air.

35 Q. When did Mr. Edison first produce an incandescent electric lamp with a carbonized paper conductor, in all respects complete and able to compete successfully with illuminating gas for light-giving purposes?

A. I believe about the middle of October, 1879, when he produced lamps similar to this lamp marked Edison's Commercial Incandescent Electric Lamp?

36 Q. At the date named, what progress had been made in gen-

erators, apparatus for producing vacuum, regulating apparatus, a system for lighting districts, and other matters and things essential for a commercial light for general use in cities and towns?

A. At this time everything was ready, to the best of my belief, and was only waiting for the perfection of the lamp to make the whole system a success, as directly we got the lamp we, in the shortest possible time, exhibited just such a system to the public, that being previous to Christmas day, 1879.

37 Q. Please to give a summary in a connected way, mentioning dates, as far as possible, of the progress of the invention of incandescent conductors for electric lights made of carbonized paper, from the beginning up to the completion of the commercial lamp? 586

Question objected to in so far as it may be intended to bring out anything appertaining to the electric lighting by incandescence with the experiments on carbonized paper previous to the date of the invention alleged in the preliminary statement of Mr. Edison in this interference.

A. The history of electric lighting by incandescence with paper carbon by Mr. Edison, as far as I know it, is as follows: In the summer of 1877 he used strips of paper carbonized as an incandescent conductor *in vacuo*, and the lamp in which they were used is now in evidence and marked Exhibit Edison's First Incandescent Lamp. I should have said here that I remember Edison, within a day or two previous to this lamp being made, using carbonized paper as an incandescent conductor between two electrodes of a battery, but in the open air. The next experiment, or series of experiments, that I call to mind are the ones which I have before spoken of as being made in August or September, 1878. At this time my whole time and attention began to be devoted to development of his system of incandescent electric lighting. These paper carbons were made by coating thin papers with lamp-black and tar, and rolling up tightly into a rod, drying and carbonizing the same in a suitable furnace. Some of these paper carbons were put in between the two electrodes in an electric circuit, and raised to incandescence in a vacuum. At this time carbons made of paper were not the only things that we tried as incandescent conductors in a vacuum. We made many experiments with hard carbons, wood carbons, and some metals, such as platinum, nickel and iron. It had early been decided by Mr. Edison that the requisite material for his incandescent lamp should have a great resistance combined with the least possible surface, and I remember 587 well that at this time and previous we used to expect that we should be able to get a substance for an incandescent conductor that would give us at least 500 ohms resistance. The result of this latter series of experiments *in vacuo* had shown us that in order to get a high resistance lamp from carbon in any form, it would have to be cut in an exceedingly fine filament. The paper carbons which we tried were larger than we should have to use if we wanted a higher resistance. With the vacuum we then got, and which

we considered at that time to be good, the carbons lasted at the most from 10 to 15 minutes in a state of incandescence. The experiments on platinum led us to hope that it might be easier to get a high resistance from that metal than from carbon. From the date of the finishing of these experiments, which, I believe, was towards the latter end of October, '78, Mr. Edison turned his attention to lamps in which the incandescing conductors were formed of metals and alloys of metals. During the last part of the year '78 and up to October, 1879, I made, at Mr. Edison's request, a very large number of lamps having platinum and platinum-irid*ui*m composing the incandescent conductor. A great many of these lamps had their conductors coated with insulating material, in order to be able to wind them up close and get them into as small a space as possible in order to offer the least radiating surface. Mr. Edison very frequently sat down at my table and worked for hours helping me on these experiments. Our conversation frequently was directed to getting the highest resistance in the least possible space. I remember once or twice during these conversations, early in 1879, he remarked how easy it would be to get this resistance if carbon was only stable. During the time that I was experimenting on these lamps he had been busy experimenting to perfect the different apparatus composing his electric lighting system as a whole. I had also worked on these matters, but as our lamp was an exceedingly difficult job, the majority of my time, both night and day, with the exception of a week or two in which I devoted some time
588 to telephones, was spent on the lamp. He had succeeded in making a more perfect dynamo machine. In testing the lamps with platinum conductors he had been continually improving the apparatus for exhausting the globes. In October, 1879, when he had got a very perfect vacuum for his lamps, he suggested the use again of carbonized paper as a conductor, and accordingly he had me cut a fine filament of paper, which we carbonized and put in a globe. This filament, I believe, was cut straight from paper and bent round previous to putting in the carbonizing chamber. I do not remember what we did with this lamp afterwards; but within a day or so of that I cut a loop from paper similar in shape to the one now in Edison's commercial incandescent electric lamp. At the same time that these were being tried, I also made lamps of loops of carbonized thread, carbonized flax, fine filaments of lamp-black and tar rolled up and baked, and, also, threads which had been treated with lamp-black and tar previous to carbonization. All these things were used about the same time as incandescent conductors in electric lamps, the most satisfactory at the time being the carbonized paper loop, which I had cut by hand. We immediately after this made a steel mould in which these loops could be cut quickly, and after a few experiments in the carbonization of them, in order to get their resistance as near as possible alike after carbonization, we made a number of these filaments and used them at an exhibition in Mr. Edison's house, about the 2d or 3d of December, 1879. When the first lamp was made which had a fine filamentary carbonized-paper conductor from which the light was

given, which was about October 22d, 1879, then, I believe, we had a system of electric lighting that was complete and could compete with gas, and we proceeded as expeditiously as possible to exhibit it as such.

38 Q. Did you start a record of the life of the early lamps put in position at Menlo park, and, if so, is Edison's Exhibit No. 3 a transcript of the first fifteen pages of that record?

589 A. I started a record about January 2d, but at that time a number of the lamps had been burning on exhibition for some time, and I remember, on looking at Book 67, that as I did not know the exact time at which these lamps were put up, I allowed as near as possible for the time they had burnt. This is shown on page 1, where lamp 142 is recorded by me on January 2d, 1880, and after marking its resistance I remarked that it has burned at least 200 hours. I have compared the exhibit referred to with the book and see no variation.

39 Q. Please examine Note Book No. 74. State whether you commenced said record and had it continued under your charge. State whether or not Edison's Exhibit No. 11 is a correct transcript from said note book.

A. I have examined Book 74, and I find it is a continuation of the record of lamps commenced by me on January 2d, 1880, and was continued under my direction through Book 74. The exhibit No. 11, as far as I can see, is a correct copy of the pages mentioned in the exhibit.

40 Q. Please state whether or not such records state the facts correctly?

A. They do. I was always very particular to have this attended to in a proper manner. It was the duty of Mr. Herrick to enter in these books their time, as they burnt, daily, and I believe that he did so. I was also very particular to have him mark down in the book the cause of their ceasing to burn; and if at any time he was not present when a lamp ceased to burn, it was generally made a note of by any one in the laboratory present, and put on Mr. Herrick's desk, so that he could go, take out the lamp and examine it, noting its defects.

41 Q. Have you read the testimony of Sawyer & Man in this interference, and if so, have you carbonized paper in the various modes described by them?

A. I have read the testimony and have made some samples of of carbonized blotting paper in the same manner that is described in their testimony.

42 Q. Please produce such specimens, describing what each one is.

590 A. I here produce specimens of ordinary blotting paper carbonized, which were carbonized in a square iron box filled with powdered charcoal. This carbonization was done in an ordinary fire.

Specimens referred to put in evidence and marked Edison's Exhibit No. 16.

I also produce a piece of carbonized blotting paper, the paper having been pressed before carbonization, as stated in answer to question 22 in Albon Man's testimony.

Said specimen is put in evidence and marked Edison's Exhibit No. 17.

I also produce a specimen—two sheets of ordinary blotting paper cemented and pressed together, as also stated in answer to question 22 of Albon Man's examination-in-chief.

Specimen put in evidence and marked Edison's Exhibit No. 18.

I also produce a specimen of several sheets of blotting paper cemented together without pressure and carbonized, which may be meant in answer 22 in Albon Man's examination-in chief. All these specimens were carbonized in an iron box, packed in powdered charcoal and heated in an ordinary fire.

Specimen referred to put in evidence and marked Edison's Exhibit No. 19.

I also produce a number of sheets of blotting paper in which two or more are cemented together and carbonized, the cement being different in this case from the former ones.

Specimen put in evidence and marked Edison's Exhibit No. 20.

591 43 Q. Have you also carbonized paper in the manner described in your testimony as having been done by Mr. Edison and under his direction, in the earlier experiments?

A. I have carbonized also some samples of tissue paper similar to the experiments on carbonization of paper that I have testified to as being in 1876, and here produce the same.

Carbons put in evidence and marked Edison's Exhibit No. 21.

I have also carbonized some samples of strips of bristol-board, which I also remember are like the ones carbonized in gas-pipe tubes in the experiments of 1876.

Samples put in evidence and marked Edison's Exhibit No. 22.

44 Q. Where a paper-carbon conductor has been recarbonized and treated with the electrical current in a hydrocarbon bath, as testified to by Albon Man in answer to 67th cross-question, if such a conductor is heated to incandescence in an electric lamp, what part of the conductor produces the light?

A. As the light from an incandescent conductor is all given off at its surface, and as the experiments which my experience has tried have shown that the treatment of an incandescent conductor in a hydrocarbon bath deposits carbon from the hydrocarbon on its surface and in the interstices, I believe that all the light would be radiated from the deposited carbon.

Counsel for Edison rests his examination of this witness here, and offers him for cross-examination.

Cross-examination by Amos Broadnax, Esq., counsel for Sawyer & Man:

45 X Q. The papers you say you carbonized in pieces of
592 gas tube in the summer of 1876; please to state in detail just
how you carbonized the paper in the gas tubes?

A. A piece of tube was taken, such as is used for gas pipes. To the *the* best of my recollection from five to six inches long and having about three quarters to an inch hole in it. A thread was cut on each end of this, and a screw-cap fitted on each end. One end of this tube was completely closed by the cap being fitted tight on it. The other screwed on and off easily. The strips of paper that were carbonized in this tube were cut into lengths, and put lengthwise in the tube, in which some powdered charcoal had been placed and the tube was then packed full of powdered charcoal. In screwing the cap on to this we generally put a little moist clay on the thread to make it air tight. There was more than one tube made for this purpose. I remember one smaller than this. I cannot give the exact size of the smaller one, but believe it was a piece of three-eighths pipe.

46 X Q. How many pieces of your piping did you have fitted in that way for carbonizing paper?

A. I can only call to mind at present the two mentioned.

47 X Q. What kinds of paper did you carbonize in these tubes?

A. Principally stiff papers, such as bristol-board. We also carbonized other kinds of papers, but I do not know that they were carbonized in these tubes.

48 X Q How much paper did you carbonize in these tubes?

A. I cannot say how much paper was carbonized in these tubes, as all the work that I did on this carbonizing was generally done at night. Mr. Edison and Mr. Adams being there in the daytime, also carbonized, I presume, with the same tubes.

49 X Q. How did you heat the tubes?

A. We put them into a common fire and heated them red hot,
and allowed them to cool again before taking the carbons out.

593 50 X Q. How long did you keep them red hot before tak-
ing them out of the fire?

A. I cannot say just how long; sometimes two or three hours. In some of my experiments I took them out of the fire red hot, and covered them up with ashes, so that they would take a long time to cool off.

51 X Q. These paper carbons that were made in the gas tubes, how long were they, how wide, and how thick after being carbonized?

A. I do not remember that we cut them any particular size. The ones that I carbonized were generally about three and a half to four inches long, about three-eighths of an inch wide, and the thickness of ordinary bristol-board. I do not believe that I ever measured this bristol-board for thickness, but believe it was about the thickness of an ordinary visiting card. This was the size, as near as I can recollect, when they were put in.

52 X Q. How many pieces of paper did you put in at one time?

A. I put no specified number each time, but I believe I sometimes had as many as six in the large one.

53 X Q. What were these paper carbons used for?

A. As far as I was concerned, they were specimens of carbonizing. Mr. Edison and Adams, I believe, tested them for resistance and used them as such. I do not remember making any instrument myself in which these were used as resistances.

54 X Q. Did you see Mr. Edison use them as resistances in any instrument, and if so, what instrument?

A. I had seen Mr. Edison testing their resistance with a Bradley galvanometer. Previous to this I had made for Mr. Edison resistances of powdered carbon; also resistances of plumbago on wood. At the time of these carbonizing experiments the majority of my time was taken up in New York, and the experimenting that I did on this was at night.

55 X Q. I asked you if you had seen Mr. Edison use any of the carbons carbonized in the gas tube as resistances in any instrument, and if so, what instrument? 594

A. I simply saw him measure one or two of these carbons, and in those cases they were resistances in an instrument when being measured.

56 X Q. Well, what instrument were they used in?

A. The Bradley galvanometer.

57 X Q. Did you see them used in any other machine; if so, what?

A. I do not remember seeing him use them as special resistances for other experiments, but know that they were carbonized with a view towards getting carbons for resistances, as I believe that was one of the things we proposed to give to the Novelty Company.

58 X Q. Was any practical use made of these carbons, and if so, what; I am referring to the carbons made in the gas tubes all the time.

A. I do not remember that there was any practical use made of these special carbons, as the experiments were never carried far enough to make an instrument from them suitable for the Novelty Company to sell.

59 X Q. Did you undertake these experiments in carbonizing paper in the gas tubes upon the request of Mr. Edison?

A. I did, although I was not working at them all my time. I believe Mr. Adams carbonized and carried on the experiments more than I did.

60 X Q. But you initiated the experiments, as I understand you?

A. No, sir. Mr. Edison commenced the experiments and we simply helped to carry them out. If I remember right, the stoppage of the Novelty Company for want of funds stopped these experiments for them.

61 X Q. When you undertook these experiments or commenced to assist Mr. Edison in making them, did he explain to you his object in carbonizing paper?

A. I believe I remember that in conversation with myself and

Adams on the things that should be given to the Novelty Company, when he mentioned the different articles to be made from carbon he then said that we could get any resistance we wanted
595 from paper carbonized. We had been using previous to that resistances for cable-work which had been made of carbon, but which did not keep their resistances well, as they were made from powdered carbon packed in tubes. A cheap and high resistance carbon was a desideratum for cable experiments, if it could be made constant. This, I believe, was Mr. Edison's idea when he proposed to have the Novelty Company sell resistances which were made of carbonized paper.

62 X Q. These paper carbons which you say you made with a gas tube, were any of them considered commercially salable for the purposes you have mentioned?

A. As the experiments were never carried to such an extent that we had a standard instrument made of these carbonized paper strips, I do not consider that they were a commercially salable article.

63 X Q. Can you produce any of the carbonized paper made by you in the gas tubes in the experiments about which you have testified?

A. I cannot; to my knowledge, for a year or so after these carbonizing experiments, I believe, there were some of these strips carbonized in gas tubes lying around the laboratory, but I cannot say whether there are any there now.

64 X Q. Have you, upon your examination-in-chief, produced any specimens of carbonized paper made in a gas tube similar to those about which you have testified?

A. I have produced and put in evidence strips of carbon paper which have been carbonized in substan*stan*tially the same manner as those described as being carbonized in a gas tube. These strips, however, were carbonized in a small iron box with the cover luted on, and not screwed on as in the tube experiments. This was heated in a boiler fire. This method is substantially the same as the gas-tube experiments.

65 X Q. Which one of the exhibits contains the carbons referred to in your last answer?

A. That marked Edison's Exhibit No. 22.

596 66 X Q. What kind of papers are these carbons made of—Exhibit 22?

A. These paper carbons are made from what is known as bristol-board.

67 X Q. And they were made in an iron box, and not in a section of gas tube, as I understand you?

A. Yes, as I had not a section of the gas tube. A section of the gas tube would probably have made me a more perfect carbon, as the screwing of the cover on is less likely to allow air into the chamber than the mere luting of it up.

68 X Q. How big was the box in which you made these carbons, Exhibit 22?

A. The box was somewhere about five inches long, about two inches wide, but about four inches deep. The box was filled to within an inch of the top with powdered charcoal previous to my putting these card-board strips in. I used this box simply because I had it. If I had had to make a box, I should have preferred the gas tube, in order to make the experiment the same as in 1876.

69 X Q. How many paper strips did you put into the box when you made this Exhibit 22?

A. I did not count the number of paper carbons in the exhibit, but I think they are all there that I put in, in the form of paper.

70 X Q. Then these were all made at once as I understand you?

A. Yes.

71 X Q. After you had the strips of paper put in the box on the pulverized carbon, did you cover the strips with pulverized carbon also?

A. Yes, sir; pressing down the carbon, so as to get in as much as possible and as tight as possible.

72 X Q. Did the lid of the box screw down on it, or how was it fastened on?

A. The box lid had a projection on its under surface that extended into the box about an eighth of an inch. We took moistened clay and plastered all around the projection, and then pressed it to its place carefully. The moistened clay filled the crevice all around the box. It was not screwed or otherwise fastened down. 597

73 X Q. Was the lid of the box held simply by the clay?

A. The lid of the box does not depend on the clay to be held, as we kept it in one position, and it stayed there by its own weight.

74 X Q. Then, as I understand you, the only pressure there was upon the powdered charcoal and the strips of paper in the box was that due to the weight of the lid of the box?

A. Yes.

75 X Q. In making these carbons, Exhibit 22, was it your intention to show just the quality of paper carbon you made in the gas tubes in the summer of 1876?

A. My intention was to show paper carbons made in a similar manner, and with the same material, as those we made in the summer of 1876, in the gas tube.

76 X Q. Why didn't you make them in exactly the same way that you did in 1876?

A. I should have done so if I had had time.

77 X Q. When did you make these, Exhibit 22?

A. Early this morning; between half past twelve and three o'clock.

78 X Q. For the purpose of this examination?

A. Yes, sir.

79 X Q. How do these carbons, Exhibit 22, compare in quality with those you made in the gas tube in the summer of 1876?

A. I can only tell from their appearance. As near as I can recollect, they are very similar in appearance.

80 X Q. Were those you made in the gas tube as entirely unbroken as these are?

A. As far as I can remember, they were as unbroken as these.

81 X Q. Now, that we have got through with the carbons made in the gas tube, and the carbons of Exhibit 22, I call your attention to the sheets of paper carbon you made in an old cast-iron box that was laying around the laboratory in 1876. Please to give
598 the several dimensions of that box, as near as you can recollect them?

A. As near as I can recollect, the size of the box named was about five inches in diameter, and about two inches deep; the box was circular; there was no regular cover to this box, but we used a piece of sheet iron.

82 X Q. How large were the sheets of paper that you carbonized in that box, and what kind of paper was it?

A. I remember only two kinds of paper that I ever carbonized in that box myself, and they were tissue paper and card-board. I believe many other kinds were carbonized, but do not remember doing it myself. The size of the sheets I should judge was not more than about three inches by two or thereabouts.

83 X Q. What you believe is not evidence. Please to confine your answers to what you know and what you remember, and state, if you please, how you charged the box, and how much paper you put in in each charge, and how often you charged it?

A. It is impossible for me to remember at this late date without anything to refresh my memory, exactly how many times I charged the box, or how many papers I put in each box, or in what way I charged each box. I can only say that the experiments I tried for Mr. Edison with this particular box were those in which he required me to get a flat paper carbon after carbonization. The box sometimes had the bottom covered with powdered charcoal, and then a paper sheet. Afterward another layer of powdered charcoal, and then another paper sheet. This was continued for a number of sheets in some experiments. In other experiments fewer sheets were put in, and a weight of iron placed on the top to keep them straight.

I tried a number of devices, and finally succeeded in bringing out flat carbons by putting a heavy weight on top of the successive layers of card-board and powdered charcoal.

84 X Q. Having the box thus charged, and forced down
599 by a weight, in what kind of furnace did you heat it?

A. Sometimes it was heated in a stove; at other times in a small boiler furnace.

85 X Q. Were the carbons thus made straight flat sheets, or were they more or less crooked?

A. The carbons in some of the experiments were exceedingly crooked. The problem was, with me, how to make them come out straight. I succeeded in this by putting heavy weights on them, and leaving the weights on until they were cold.

86 X Q. And then were the carbon sheets whole, or were they more or less fractured?

A. There was no difficulty, that I remember, with the breaking of the carbons. Sometimes some would be broken in taking them out.

87 X Q. What proportion of all the carbons which you made in this box were straight and perfect?

A. Only a small proportion of the carbons that I made myself in this box were straight and unbroken, but when I left off experimenting with that box I could bring out almost all the papers I put in as straight and perfect carbons.

88 X Q. And was this perfection of the carbons, referred to by you, in your last answer, due, in your opinion, to a sufficient weight upon them, and to uniform heating and cooling of them?

A. When I spoke of the perfection of the carbon in that last answer, I meant its perfection of form and shape, unbroken. There was no effort at uniformity on my part at that time to get uniform heating other than from an ordinary fire, but I frequently endeavored to get uniformity of cooling by covering it over with the ashes of the grate.

89 X Q. These sheets of paper carbon that you at last succeeded in getting straight and whole, of what kind of paper were they made?

A. I believe, principally, of ordinary card-board.

90 X Q. Card-board is of various thickness. State about how thick the card-board was that you used to make these carbons, as near as you can recollect.

600 A. About the thickness of an ordinary visiting card.

91 X Q. What use did Mr. Edison make of these sheets of carbon you made in this box in 1876?

A. I do not remember any use that they were put to; as well as I can remember the flatness of the carbons was requisite for making carbons for batteries, and in order to make the generality of battery carbons we should have to have larger molds and larger sheets; the experiments, I remember, resulted merely in getting flat sheets of carbon from paper.

92 X Q. Can you produce any specimens of the carbons made in this box in 1876?

A. I cannot; I have looked in Edison's laboratory for some specimens of these paper carbons, but although I can find plenty of carbonized paper, I could not bring any here that I could swear was carbonized by us in 1876.

93 X Q. Have you produced here to-day any specimens of carbonized paper intended to show the quality of the carbonized paper you made in that box in 1876, other than these contained in Exhibit 22?

A. Yes, sir; I have put in evidence here some carbonized tissue sheets which are marked Edison's Exhibit 21, which are substantially similar to some tissue sheets that I carbonized in the iron box in 1876.

94 X Q. Are these carbons of Exhibit 21 carbonized in the same box that the carbons of Exhibit 22 were carbonized in, and in the same way and at the same time?

A. They were carbonized in the same box, but not at the same time; they were carbonized in the same manner, between eleven o'clock the night of July 7th and three o'clock the morning of July 8th, 1881.

95 X Q. Are these carbons of Exhibit 21 suitable carbons out of which to make illuminating conductors for Mr. Edison's incandescent electric lamp?

A. No, sir.

96 X Q. The same question as to the carbons of Exhibit 22?

A. I cannot say, as I have not tried them.

97 X Q. What is your opinion about it?

601 A. My opinion is that the carbons in Exhibit 22, if used as incandescent conductors in an electric lamp, would answer that purpose; as the carbonizing we do now for Edison's electric lamps is no different in principle from the way in which we carbonized the strips in 1876.

98 X Q. What time in the year 1876 did you commence these experiments of carbonizing paper, about which you have been testifying?

A. I cannot give the exact date, as I have no memoranda to refresh my memory; the particular year, 1876, I remember, as during that year I spent a great part of my time in New York selling and perfecting the manufacture of Edison's electric pen; it was about the time of the organization of the Novelty Company.

99 X Q. At the time these experiments were made what reference did they have to electric lighting?

A. I know of none.

100 X Q. Referring now to the exhibit marked Edison's First Incandescent Lamp, please to state whether the lamp is now in the same condition it was when you made the experiment in it about which you have testified?

A. As far as I can see, it is in the same condition as when I put the paper carbons in for Mr. Edison.

101 X Q. These experiments, as I understand you, with this lamp, were undertaken by you at the request of Mr. Edison in the latter part of the summer or the early part of the fall of 1877?

A. Yes, sir.

102 X Q. When Mr. Edison requested you to undertake these experiments, what did he say to you?

A. As near as I can recollect his words were: "Batch., put me a piece of carbon in this," and I believe he brought the globe to me at the time.

103 X Q. Is that all he said to you upon the subject of the experiment at the time—did he say nothing about the object of the experiment?

A. At that particular time that was all that I remember; but when I had finished the instrument, and was making a thin
602 carbon to put in, and he saw the difficulty I had to get it thin enough, he suggested to me to cut the carbon from some of the carbonized paper that was lying around. I do not remember that he said anything to me at that time about the object of the experiment. It was quite apparent to me what he wanted to do.

104 X Q. When did he first say anything to you about the object of the experiment?

A. I cannot call to mind the first time he spoke of the object of this experiment.

105 X Q. State the first time you recollect of his speaking to you about it, and state what he said?

A. I cannot give any particular time when he spoke of the object of this experiment. At the time this experiment was made my time was not wholly devoted to experimenting on electric lighting, and the experiment only occupied my mind for a short time, as I had to make it for him. It was a frequent occurrence for me to break off experimenting on one thing to make an instrument to illustrate some idea of Mr. Edison's.

106 X Q. After you succeeded in getting the carbon in this lamp, to what degree of luminosity did you succeed in raising it?

A. I cannot tell the exact degree. I remember Mr. Edison and Adams made the experiment with it, and I remember that they all came to incandescence before oxidizing or bursting.

107 X Q. How long were they maintained in a state of incandescence before they were destroyed?

A. I cannot say, but they lasted a very short time.

108 X Q. Well, about how long?

A. None of them, I believe, lasted more than from ten to fifteen minutes.

109 X Q. Did you see these experiments yourself?

A. I was present and saw them, but did not direct the experiments, Mr. Edison doing that himself, as my mind was not on that. I was simply curious to see the result and did see it.

110 X Q. Then you can tell me whether the carbon was raised
to a red heat, to a yellowish heat, or to a white heat. Give
603 me, as near as you can, the degree of luminosity or color of
the carbon that was obtained in those experiments?

A. In those experiments the carbons were raised through the red and yellow to a white heat, and generally before bursting gave a very brilliant light. The degree of luminosity I cannot say.

111 X Q. How many carbons were put in this experimental lamp?

A. I cannot say the exact number, but am sure there were more than two. I could not swear to there being more than six or seven.

112 X Q. All that was put in, as I understand you, you put in?

A. Yes, sir; as far as I know.

113 X Q. How large were the carbons—give their several dimensions, as near as you can recollect?

A. I cannot give their dimensions exactly, but I remember the first one was the widest. Their lengths, as near as I remember, were about alike, and their thickness. I do not believe that any of these carbons were more than an inch long or less than $\frac{3}{4}$ of an inch. Their width was not more than $\frac{1}{4}$ of an inch nor less than $\frac{1}{32}$ of an inch, and their thickness, as near as I can judge, without anything to refresh my memory, would be in the neighborhood of from seven to ten-thousandths of an inch. As I did not carbonize these especially for the purpose, but cut them from already carbonized sheets, this measurement is as near as I can get.

114 X Q. What degree of vacuum did you obtain in the glass chamber or globe of this lamp in which you illuminated a carbon?

A. That I cannot tell; but I know that the vacuum pump, on the platen of which this was exhausted, will not, under any circumstances, give a state of exhaustion which I should call a good vacuum now. At that time I believe they pumped until they could see no diminution in the column of mercury, and then stopped.

115 X Q. When Mr. Edison saw the carbons illuminated
604 in this experimental lamp, and saw them go out, or destroyed
by the current, as you have stated, what did he say?

A. I cannot remember what he said, with the exception that he wanted another one in, and I proceeded immediately to put one in. My attention was taken with this, and I cannot remember what he said at the time, or whether he said anything further than expressing a wish to have another one put in.

116 X Q. After he saw the last one burn and go out, what did he say?

A. I cannot remember at this time that he said anything in particular.

117 X Q. Didn't make any remarks about the experiments at all?

A. I cannot remember that he made any at all at that time.

118 X Q. Why did he undertake the experiments?

A. Because his mind was running on experimenting with electric light as one of the after things of the telephone, for many months during our experimenting with that telephone, and before my time was devoted entirely to the light.

119 X Q. What did he undertake to prove by these particular experiments?

A. He did not undertake to prove anything to me about them. I knew from these experiments that he had me try what his object was to do, they needed no explanation.

120 X Q. How did you know what his object was?

A. I knew that he thought some on electric lighting. I saw him for a day or two working at a table near my table experimenting with a battery and pieces of material in between the electrodes, and I knew, without being told, that he was experimenting in electric lighting. Paper carbons were part of the same series of experiments, and he gave them to me because I was more used to doing work of that kind than he was, or, at least, I suppose so. My principal time, and almost all my energy at that time, was on telephones.

121 X Q. Then, as I understand you, you ascertained what Mr.
Edison's object was in making the experiments with this
605 exhibit, Edison's First Incandescent Lamp, by what you
saw him do, and not by what you heard him say?

A. Yes, sir; by what I saw him do, and what he had me do.

122 X Q. Now, what did you see him do, and what did he have you do, that showed you the object of his experiments?

A. As I said before, I saw him experimenting on electric lighting. He had me put paper carbons in the lamps marked Edison's First Incandescent Lamp, and I saw from that, that in this case, he wanted to make an incandescent electric lamp, in which the incandescent material was carbonized paper *in vacuo.*

123 X Q. And that, as I understand you, is all that you saw him do and all that you done, that led you to that conclusion?

A. Yes, sir; that is all that was needed to lead me to that conclusion. I afterwards saw him raise these carbons to incandescence in the vacuum, proving to me that such was the case.

124 X Q. When did you see him raise the carbons to incandescence in the vacuum afterwards; was it at the time of these experiments or afterward?

A. Immediately on my giving him the lamp with each paper carbon fixed in place.

125 X Q. Then, from the facts and circumstances which you have related, you inferred, as I understand you, that Mr. Edison's object was to make an incandescent lamp, in which the illuminating conductor should be of carbonized paper?

A. Yes, sir.

126 X Q. How well did Mr. Edison accomplish this object at that time?

A. The lamp was complete, and gave light for a short time. It was not a commercial success. As a lamp for a few minutes, it was a success.

127 X Q. If that was Mr. Edison's object in making those experiments, why did he tell you first to put hard carbon in the lamp, and then when he saw how much trouble it was to get in the
606 hard carbon, direct you to put in strips of paper carbon?

A. I do not know why he told me to put in the paper carbon, except that I know he did so.

128 X Q. Now, in putting this carbon in this lamp, I understand you to say that you screwed the glass globe off of the pedestal, in which the cock is placed below the globe?

A. Yes, sir.

129 X Q. That you screwed the ball off of the top of the stem?

A. Yes, sir.

130 X Q. And the gland off of the stuffing box?

A. Yes, sir.

131 X Q. And took the packing out of the stuffing box?

A. Yes.

132 X Q. And made the clamps on the end of the rod that forms the conductor in the chamber of the lamp?

A. Yes, sir.

133 X Q. That you took the piece of carbon and fastened it in the clamps?

A. Yes.

134 X Q. That you then screwed the lower end of the conductor

in the top of the pedestal in which the cock is placed under the globe of the lamp?

A. I either screwed it in there or fastened it in tightly.

135 X Q. You then passed the whole conductor up through the bottom of the globe, the upper end of the conductor passing up through the stuffing box, the globe being turned right upside down?

A. Yes.

136 X Q. You then, while the globe of the lamp was in an inverted position, screwed the pedestal in which the cock is placed in the bottom of the globe?

A. Yes.

137 X Q. Then put the packing in and screwed in the gland?

A. Yes, sir.

607 138 X Q. Now, after you had got the carbon in the lamp, and the lamp together in that way, how did you exhaust the air out of the globe?

A. This was done by an ordinary air pump. The base of this lamp, being true, was placed right over the exhausting hole of the platen, and the air drawn out of the lamp. This, I believe, was done by Adams.

139 X Q. How could the air be drawn out of the globe of the lamp unless there was an open passage between the air pump and the globe of the lamp?

A. You will find that there is such a passage in the inside of the lamp, I believe, where the screw is driven in.

140 X Q. On an examination of the lamp I do not find any such passage. Please to point it out.

A. You will find there are two small grooves, one on each side of the rod of brass, through which, if the grease was cleaned out of the lamp, you would be able to suck air.

141 X Q. When were these experiments with the Exhibit Edison's First Incandescent Lamp concluded?

A. They only lasted a few days altogether with this particular lamp, in the end of the summer or beginning of the fall of 1877.

142 X Q. Did you experiment with any other lamps at that time?

A. I do not recall to mind making any more lamps for Mr. Edison about that time.

143 X Q. I read to you your answer in examination-in-chief to question 26.

Counsel reads question and answer.

—. Were all the carbons that were then illuminated—I mean at the time referred to in your answer, which I have just read—illuminated in the bell receiver of the air pump, or did you then have at that time, in the fall of 1878, a lamp made having a glass chamber from which the air was exhausted, and into which you put these carbons to illuminate them?

608 A. As far as I remember, they were all illuminated in one of the bell jars belonging to the pump.

144 X Q. What was the shape of these carbons?

A. They were as near as we could get them to short, straight sticks.

145 X Q. Did you experiment with other carbons besides paper carbons at the same time?

A. Yes, sir; during the same series of experiments.

146 X Q. How long did that series of experiments last, and when was it concluded, as near as you can recollect?

A. I cannot say just what time I gave over experimenting myself on these; probably about the end of September, 1878.

147 X Q. After you concluded your experiments in the fall of 1878 with the carbonized paper in the bell jar of the air pump, when did you next use carbonized paper for illuminating in an electric lamp?

A. Shortly after the experiments referred to Mr. Edison used some of these carbons in the electric lamp, Exhibit No. 15.

148 X Q. Was that a sealed lamp in which the carbons burnt *in vacuo* or in an inert gas?

A. No, sir; the carbons burnt in the atmosphere.

149 X Q. When did you next use carbonized paper for illuminating in a sealed electric lamp, out of which the air had been exhausted, after you had completed your experiments in the fall of 1878—I mean the experiments in the bell jar of the air pump?

A. About the middle of October, 1879, within a day or so of the time that the first of the style of lamp of which Edison's Exhibit Commercial Incandescent Lamp is one, was made.

150 X Q. In that case, as I understand you, the carbon was substantially of the form of that shown in the Exhibit Edison's Commercial Incandescent Electric Lamp, and the lamp was made for the purpose of burning an incandescent conductor of carbonized paper or something substantially the same as carbonized paper?

A. It was substantially the same with this exception—that,
609 I remember, the first loop that was cut was cut straight and
bent round when put into the carbonizing chamber. The lamp was made for the purpose of a lamp. With the exception that I have mentioned, the lamp was similar to this exhibit.

151 X Q. When did you first cut the paper of the form substantially shown in the Exhibit Edison's Commercial Incandescent Lamp, before carbonizing?

A. I believe I cut them during October, 1879. My impression is, between the 20th and 25th. I think I could find the record somewhere amongst our books, to that effect.

152 X Q. Then, as I understand you, the first sealed incandescent electric lamp or lamps that Mr. Edison made, or caused to be made, as a lamp, in which he used carbonized paper for the illuminating conductor, was made in October, 1879?

A. With the exception of the Exhibit Edison's First Incandescent Lamp, and the experiments I have mentioned in the bell jar of an air pump, the lamp made in October, 1879, was the first lamp which answers the conditions of your question.

153 X Q. Referring now to Exhibit No. 16, please to describe ex-

actly how you carbonized that paper, and what kind of blotting paper you used.

A. The Exhibit 16 is ordinary blotting paper similar to that which I now put in the box with Exhibit 16 and mark in ink with my initials. These sheets were carbonized in the same box that I have spoken of as being one in which Exhibits 21 and 22 were made. The paper was put in the box, tightly packed with powdered charcoal between each sheet. They were made to show what kind of carbon ordinary blotting paper makes when carbonized substantially the same as is spoken of in Mr. Man's testimony.

154 X Q. How did you fasten the lid down on the box in this case, the same as in the other case?

A. I did not fasten the lid down by wire, as spoken of in one of Mr. Man's statements, as the lid of my box has a projection going inside the box.

610 155 X Q. Was there any pressure upon the paper during the operation of the carbonization?

A. None except the weight of the lid.

156 X Q. Was the full weight of the lid upon the paper?

A. No, sir; the lid rested on the tightly packed powdered carbon. The papers were some distance from the surface.

157 X Q. Did you saturate the paper with any carbonaceous material, put it in a dydraulic press and press it hard, before carbonizing?

A. I did not saturate this exhibit with anything, nor did I press it. I, however, pressed a piece of the blotting paper under a powerful screw-press and carbonized that. I did not, however, saturate this with anything. I have produced this and it is here, marked Edison's Exhibit No. 17. I made these to show the kind of carbon that blotting paper made, whether pressed or in its ordinary state.

158 X Q. What experience, if any, have you had in treating paper carbons electrically, in the presence of hydrocarbon gas?

Question objected to as being new matter, not brought out upon examination-in-chief.

A. I have had considerable experience in treating carbonized paper used as an incandescent conductor in hydrocarbon vapor in connection with the paper carbon loops of Edison's electric lamp.

159 X Q. What effect does such treatment have upon the paper-carbon burner?

A. It deposits carbon from the hydrocarbon on the surface of the incandescent conductor.

160 X Q. Doesn't it fill up the interstices and consolidate the carbon—making it finer and more compact?

A. It probably does fill up the little interstices on the surface, but I do not think it makes the paper carbon any more compact. It adds to that by coating on the surface. I have frequently
611 broken these conductors that have been treated in the vapor of the hydrocarbon, and, under a powerful microscope, have found that the fracture of the paper carbon showed no greater den-

sity, and the deposited carbon sticking to it in the shape of small needles stuck endwise on it.

161 X Q. In the presence of what kind of hydrocarbon gas did you treat the carbon; how high did you raise its temperature of luminosity?

A. In our experiments we have generally used the vapor gasoline, benzine and such vapors. The carbons were raised to different temperatures, but were always raised to brilliant incandescence when we were depositing this carbon.

162 X Q. Under what pressure of the gas did you treat the carbon?

A. I do not know what pressure we had. The chambers that I had made for the experiments in the experiments I speak of always had a small outlet, so that the vapor could escape, and we made it while the experiment was going on. We did not create an artificial pressure for the purpose of treating carbon under pressure. If there was any pressure at all it was an incidental pressure, while we were making the gas.

163 X Q. How large were the carbons you treated?

A. Some of the carbons were the same as the one in Exhibit Edison's Commercial Incandescent Electric Lamp. The other carbons were about the same size, but made from different fibres.

Redirect examination by GEORGE W. DYER, counsel for Edison:

164 Q. Do you wish to explain your testimony in regard to first putting carbons into the lamp, Exhibit Edison's First Incandescent Lamp—if so, please make your explanation?

A. Yes; in my direct testimony I testified that Edison wanted a hard carbon put in that lamp, so that it reads as if he requested that it should be specially hard carbon. I could not swear 612 that he especially wanted a hard carbon, but that he told me, as I have afterwards stated, to put a carbon in the lamp, and I proceeded at that time to put a hard carbon in, supposing that was what he wanted.

165 Q. Referring to your answer in cross-examination about the Exhibit First Incandescent Lamp, state, if you remember, how long before the experiments with the lamp was the lamp made, as a lamp?

Question objected to, and all testimony appertaining to the alleged lamp—Edison's first incandescent lamp—as tending to prove that the invention was made before the date alleged in the preliminary statement; because the question assumes that the so-called lamp was ever made for a lamp.

A. The lamp was used as a lamp within a day of its being made as a lamp.

166 Q. At the time of these experiments with this exhibit, do you wish to be understood that the only conversation Mr. Edison had with you in regard to electric lighting by incandescence was the direction to put a carbon in that lamp?

A. Previous to that time and after that time, Mr. Edison had frequently spoken of electric lighting for domestic purposes as a big field for experiment when we had the telephone and some other things off our hands. He frequently tried experiments himself whilst we were working on these other things. He knew that I was conversant with the experiments and the end they tended towards, and therefore his order to me, to put the carbon in, that needed no further explanation from him as to what he proposed to do.

613 The witness, CHARLES BATCHELOR, being further interrogated, as a portion of his direct examination, by WALTER K. GRIFFIN, Esq., counsel for defendant, testifies as follows:

167 Q. What is your name, age, residence and occupation?

A. Charles Batchelor; 43 years of age; I reside in New York city; I am assistant to Thomas A. Edison; as such my duties have been for the last nineteen years the carrying out in a practical manner the ideas of Mr. Edison generally in his laboratory with a large force of men, at other times building and designing especial machinery for the various businesses that his discoveries and inventions have created. At present I am commencing the manufacture of his phonographs part of my time, the rest of my time superintending a large number of his experiments in the laboratory.

168 Q. I hand you a book and ask you to state what the same is?

Book handed witness.

A. The book referred to is vol. 52 of a series of books in which records of experiments were kept at the time we were in the Menlo Park laboratory, and refers principally to experiments that I carried on for Mr. Edison in the latter part of 1879. It is especially a book that was always kept on my personal work-table. Whilst I had general charge of the place I still did a very large amount of personal experimenting. I wrote in almost all the books that were around the shop, but this one in particular is almost entirely in my own handwriting.

169 Q. Did you have the book in your possession or know of its whereabouts at the time of your deposition in the interference?

A. I believe not. The book was mislaid at the time of this interference suit and I was rather surprised to see it brought here again. The reason we always gave for the losing of some of our

614 books was the fact that they contained records of our experiments very largely on telephones, and many of such books were put or used in interference cases. I do not think that there are many telephone experiments in that book, but we could not find it at the time.

170 Q. With the aid of the book please state your recollection of the experiments in electric lighting made by Mr. Edison or by yourself under his direction so far as the same are referred to in the book, having special reference to such experiments as involved the use of carbons for the purposes of illumination?

A. The first part of the book relates particularly to that part of

a line of experiments where Mr. Edison required a very high resistance conductor to be used in an incandescent lamp and in which the incandescent part should occupy a small space. It was particularly necessary for these experiments that the incandescent conductor should have a high resistance, and those experiments relate to metal conductors. The rest or two-thirds of the book about consists in experiments for incandescent conductors to be used in lamps made from carbons carbonized from very many different substances and formed into many different shapes. They refer to lamps made from carbons carbonized from tarry matters, threads of different kinds, papers of many kinds and many other materials. My recollection of these is that there were many of them that were very excellent lamps, and I find some of them of which there were large numbers used at the same time. Those lamps which involved the use of carbon were generally very good lamps; my part of the work there was generally to make the incandescent conductor, place it in its position and give directions to the glass-blower to put it in its place, after which it was generally put on the pump by one of our assistants, after which I got a statement of its value as a lamp. The latter part of the book consists mainly of lamps with incandescent conductors of carbonized paper and of these lamps there were a great many made, as many as seven or eight hundred of them being used in Menlo Park at one time. In regard to the carbon experiments I find
615 that we made incandescent conductors October 7th, 1879—
carbon spirals. These were made from paper tarred, rubbed with tar and lamp-black and rolled into the shape of a thread. They were then wound in a spiral form on a special device for that purpose, carbonized, and afterwards put into lamps. These were also made of powdered electric-light carbon, which was made into a pasty mass, then rolled up in the form of a thread, carbonized and placed in lamps. On page 92 I find an incandescent conductor made from paper cut in the form of a flat ring, carbonized, and a small piece of the carbon cut out so as to leave two ends to the imperfect ring. These ends were fastened to the leading wires of the lamp so as to put it into the lamp. I next find experiments showing the best way to work and carbonize these lamps. Next I find that we made carbons for incandescent conductors of cotton thread which we bent into shape and carbonized, after which we attached the ends to similar conductors to be placed in lamps. At the same time we made lamps having carbonized conductors from vulcanized fibre, threads rubbed with tarred lamp-black, soft paper, fish line, fine threads plaited together in strands, soft paper saturated with tar, tar and lamp-black mixed with a proportion of lime, different kinds of thread, card-boards, cotton soaked in boiling tar. Immediately following this there is a record of some of the lamps above mentioned. Shortly after this I carbonized a great many materials, such as vulcanized fibre, celluloid, box-wood, cocoanut hair and shell, drawing papers of different grades, spruce shavings, hickory shavings, bay-wood shavings and cedar shavings, rosewood fish lines, maple shavings, tissue paper, string cotton, lampwick, punk,

cork and bagging flax. Immediately following is the record of
lamps made from some of the before-mentioned pieces, with
remarks in many cases of how they lasted or how they were
carbonized and how or why they ceased to burn. Then fol-
low some of the different methods of how they were fastened
to the platinum wires, in order to secure their good con-
nection at the point of contact. Then follow experiments
616 in methods of carbonizing card-board for conductors. On page
145 I find a sketch which is about the actual size of carbon
conductors, of which there were a large number made, which shows
the size of the paper cut from card-board and its size after carbonization. I find also designs for tools for cutting such paper carbons. Then follow a series of numbers of lamps that were made from this model, with occasional remarks of their being made from different materials. Lamps made from these are shown in design attached to the fixtures which were designed at that time for receiving them. Pages 171 to 179 inclusive contain records of lamp carbons made from different kinds of paper, most of which had impurities in the paper. These are immediately followed by designs of tools that were made to cut such papers. Pages 185 to 211 contain records of lamps made from carbonized card-boards with records of some of the facts connected with them, and in some cases deductions drawn from the experiments. Pages 219 to 223 are a record of about fifty lamps showing their condition before putting in the lamp as regards their resistance and the same condition after they were put in the lamp. Pages 225 and 227 relate to methods of carbonization of the paper for lamps with remarks that were made at the time. Page 229 relates to lamps made about this time of carbons made from paper cut in circular form. Pages 233 to 237 relate to methods of carbonization and some deductions therefrom. The rest of the book contains methods of carbonization and records of some of the lamps that had been made from paper carbons. The results of the experiments in this book are to the effect that Mr. Edison produced lamps having the requisite conditions that he had been long looking and working for, viz: a high-resistance incandescent conductor entirely enclosed in a single piece of glass from which the air had been exhausted to a very high degree. It does not by any means give a list of all the experiments, but only a very few.

617 The book above referred to is offered in evidence to be marked "Defendant's Exhibit Batchelor Note Book No. 52, March 7, 1889."

171 Q. You stated something in your last answer as to obtaining a high vacuum in the lamps. By what means did Mr. Edison progress towards obtaining this vacuum?

A. At the time that these experiments were made we had already got what we conceived as a high vacuum. Some of the previous experiments had been made in a vacuum, such as could be got from a common air pump. These had extended back for a considerable time, and all incandescent burners which we had raised to give light in such a vacuum had never been satisfactory to Mr. Edison, as the materials of which the burner was made were liable to oxidation in a more or less degree as the vacuum was good or bad. At the time of these experiments Mr. Edison had made lamps which were entirely made of one piece of glass, and by a long series of experiments he had been able to make mercury pumps which would exhaust the air very thoroughly; in fact, equal to anything that is similarly found in the pumps that are used now for manufacturing lamps.

172 Q. How does carbon compare with metals such as platinum or iridium so far as this liability to oxidation is concerned?

A. Carbon compares very poorly in this regard with the finer metals where the carbon is in the open air or even in a poor vacuum. This was our experience in former experiments where we had but a poor vacuum. A lamp made from platinum, some of which are shown in the first part of that book, would last much longer than a lamp made under the same conditions from carbon. In my testimony given in the interference case in 1881 between Sawyer & Man and Edison, already in this case, I testified to having put incandescent conductors in a lamp in October or September, 1877. From these experiments I remember that Mr. Edison about that time had frequently put a current through platinum and platinum-iridium, lighting them to incandescence. He had experimented with 618 small pieces of carbon in the same manner, but they had lasted such a short time that he asked me to put him a piece of carbon in the lamp and exhaust the air from the lamp so that he could raise it to incandescence in a vacuum. This I did, but owing to the vacuum being imperfect they did not last long at the brilliant incandescence that he wished to run them. In the open air this same carbon would not have lasted at all.

173 Q. So long as the vacuum is poor is there any substantial difference in the life of the carbons due to a different nature of the carbon: that is to say, would a filament of gas carbon or of paper carbon or of bamboo carbon have any material difference of life in a poor vacuum?

A. I think a poor vacuum would be fatal to all as a long-life lamp.

174 Q. How long did Mr. Edison continue in the commercial sale or manufacture of paper-carbon lamps, to the best of your present recollection?

A. I think, to the best of my present recollection, the paper carbons were discontinued in the early part of 1880.

175 Q. After that time what proportion of the lamps manufactured were made of paper?

A. I cannot say at present, but I know a very small proportion.

176 Q. At the time of the decision in interference, January 20, 1882, by the examiner of interferences, J. B. Church, were any paper lamps being manufactured and sold by Mr. Edison or the Edison Company, commercially?

A. There may have been a few paper lamps made for experiment, but the lamps sold to the public were entirely made from other material, bamboo fibre. I may say here that at all times, then and since then, Mr. Edison has been continually making lamps of different materials, but the standard manufacture of lamps at that time, as now, has been and is bamboo fibre.

619 177 Q. What were the practical reasons, if any, which resulted in the commercial abandonment of paper carbon?

A. Mr. Edison found that he could get better carbons for his purpose from a particular part of the bamboo plant than he could get from paper.

178 Q. What was the trouble, if any, with the paper carbon in its commercial use in lamps?

A. The trouble with the paper carbon, from a commercial point of view, was its average life. This in some of the paper carbons was great; in others it was quite small, owing to defects in the paper, causing small arcs at those points and shortening their life. Their average length of life would not compare at all, however careful we were to cut and carbonize them, with the average life of bamboo fibre when properly selected.

179 Q. What was the nature of the trouble caused by the formation of internal arcs in the paper carbons?

A. In the lamps made from carbonized paper, wherever there was a slight defect in the paper, at this point the continuity of the lamp carbon would be lessened as far as the carbon is concerned, owing to the imperfection in the paper being due to some other substance. This would increase the resistance of the carbon at that point to such an extent that it would amount almost to an arc, and we generally saw it whilst the lamp was burning, especially if we only lighted it to a dark red, in the form of a brighter spot at that point than on any other part of the filament. Paper carbons are also defective for lamps by reason of their blackening the globes, owing to the carbon being deposited from the filament on the glass. In Exhibit Batchelor, Book 52, my records frequently state that the lamps broke at a certain place or were "busted" on the pumps. These we frequently examined under the microscope, and many of them we thought were due to imperfections in the paper. In cutting the paper we always took great care to select those portions of the paper that did not show any defect to the naked eye; but it
was very frequently the case that the defect might be inside
620 the paper, causing the point of high resistance and destruction of the lamp all the same.

180 Q. Do you know of any lamps on the market having carbons of paper?

A. No, sir.

181 Q. So far as your knowledge extends, is the use of paper as a carbon for an incandescent electric lamp of any recognized value at the present day?

A. The use of paper carbon in a lamp for an incandescent conductor is so much poorer than bamboo that I believe that there are no manufacturers or sellers of it in the world to-day.

182 Q. Was there anything in the use of paper carbon as such that suggested to Mr. Edison or yourself the use of bamboo fibre or the particular quality of bamboo fibre that you finally adopted?

A. There was nothing in paper carbon that was essentially better than anything else carbonized to make a carbon from, except that it was an easy and cheap method of being able to manufacture. It was by no means such a carbon as we have now, which by nature is almost perfectly solid, much smaller and perfectly uniform, which the imperfections of paper never would allow us to get.

183 Q. What experiments has Mr. Edison made from time to time as to the suitable material for use in incandescent lamps?

A. Mr. Edison's experiments have been very extensive. I have made lamps for him from almost every conceivable fibre, from almost all the woods, for some of which I have designed expensive machinery before making them. Mr. Edison's experiments on the grasses and bamboos have been very extensive. He has sent a number of men to different parts of the world, at great expense, who would continually send him large batches of different fibres and different woods which we would select from and make lamps. He has spent a great deal of money in this direction. As I remember now, he has at the present time one man who has been down
in the Cauca valley, in the United States of Colombia, for
621 about a year. He has sent out at two different times men
to Buenos Ayres. He has had a man in Mexico; he has sent two different men to Florida and Cuba; he has sent a man to India and Burmah; he has sent a man for 2,000 miles up the Amazon at one time, and at another time sent two men together for about 2,500 miles up the Amazon, one of them returning and the other one crossing over to the other side of the continent, and he is the man who is now in the Cauca valley. And this has been done at an enormous expense, as his books will show. These men have all sent back large lots of samples of various woods which have been put through tests sufficient to find their availability for incandescent lamps. I should mention also a man that he sent to Japan, China, and the Malay island.

184 Q. Have you experimented with exogenous woods, and, if so, what have you found to be their value in actual use in an incandescent lamp such as you manufacture or have manufactured since the beginning of your business?

A. The use of such woods is very poor for an incandescent lamp. To get a perfect carbon from such woods is almost impossible, owing to the fact that there are cross-fibres running around the wood which you are obliged to cut in cutting lengthwise with the grain. Wherever such a fibre is cut it leaves a bad place in the carbon, owing to the fact that that fibre is partially hollow and lessens the cross-section of your fibre at that point; and in such woods you have a fault similar to what I mentioned in the paper carbon which would cause arcs, but very much more so than in the paper carbon. I consider them practically useless.

185 Q. Do you know of any manufacturer who sells lamps having the carbons made of any of the exogenous woods?

A. No, sir; I believe they are not employed by any manufacturer.

186 Q. To your knowledge, have they been employed by any manufacturer?

A. No, sir.

622 187 Q. How many exogenous woods has Mr. Edison, to your knowledge, experimented upon?

A. I could not say exactly, but a great many; I should judge forty or fifty. I made at one time a special machine for him to cut these woods out, and I know we tried a great many of them before giving the thing up, as it was rather an expensive experiment.

188 Q. Were these experiments with exogenous woods on one or two lamps, or on how many?

A. I should judge as many as forty or fifty of them, using different kinds of wood.

189 Q Exclusive of bamboo, are you aware of any wood of any description now being used commercially in the manufacture of incandescent lamps?

A. No, sir.

190 Q. Out of the stem of a bamboo, how much have you found practically and commercially available for the manufacture of carbon filaments?

A. There is a very small portion of the bamboo that is practically available for the purpose of making a commercial incandescent lamp. This is the most solid part of the wood, right next to the silicious cuticle, and although the thickness of the shell in some cases is as much as an inch, we can only use a few thousandths of it next to the scale. I would also say that of all the many kinds of bamboo that there are in existence there are only a very few that we can make such carbons from, and these could be very soon spoiled for our purpose previous to their getting to us if they were not of a certain growth and seasoned in a proper manner.

191 Q. Have you found by experiment that bamboo has to be cut in any special manner in order to form suitable filaments?

A. We had to design, for making the fibres from bamboo filaments, special machinery to cut that part out of the bamboo that was good for our use; afterwards to take the scale off of it, and then to cut the fibre lengthwise in such a manner as never to split or cut through a single fibre on the outside. The necessity of this was discovered by Mr. Edison when we found that the finest 623 bamboo that we can get is only made up of a number of single fibres very close together, and if we should cut one of them across it would materially lessen the availability of that particular piece of bamboo for use in an incandescent lamp. This we tried to avoid, as after it has been carbonized it has cost considerable money, and all that money would be thrown away if we should find out afterwards, when it was in the lamp, that it had been spoiled in cutting. These things, and many other peculiarities of manufacture necessary to a successful carbon, even from bamboo, we had to find out by a long series of experiments.

192 Q. What do you mean by your answer in regard to the necessity of proper seasoning of the bamboo?

A. In the early part of these experiments we had, along with samples of bamboo, also samples of the same bamboo that were of different growths as regards age and also the different lengths of time that they had been seasoned, and it was found that the filaments which came from the same bamboo were not as good when of some age or of some particular method or time of seasoning as others, and experiment told us which were the best. After knowing this we gave our orders for our fine strips of a certain age and a certain seasoning, and that is done, I believe, to the present day.

193 Q. How many endogenous woods and grasses has Mr. Edison experimented upon, to your best recollection?

A. Several thousand.

194 Q. Out of these several thousand how many were practically available, so far as their electrical qualities were concerned, for a filament for an incandescent lamp?

A. There are very few indeed that I could call available for an incandescent lamp. Some of them, although pretty fair, are too difficult to manufacture. Others, while pretty fair for pretty short lengths, cannot be got out for long lengths. I should say that the bamboo, and one or two others, are about all that can be used, that we know of, commercially. Some of the fibres are so loose 624 and have so little carbonizable matter between them that when carbonized they will split apart. Others are so coarse-grained, or the cell wall so small in proportion to the size of the fibre, that it is practically impossible to make lamps from them. We had to find out all these things by experiment. The wood would look all right to the eye to cut filaments from, but something would be there, so that, when carbonized, we got an entirely different result from what we expected, the cause of this being, in many cases, undiscoverable, but arising, probably, from some peculiar chemical constituent in the wood.

195 Q. Was any substance known or described generally in the art, on January 9, 1880, as "carbonized paper cover with powdered plumbago"?

A. No, sir; I know of none; I never heard of it.

196 Q. Is it practically possible, in any ordinary sense, to cut out a filament of carbon, such as used in the Edison lamps, from carbonized paper?

A. It is practically impossible. The carbon cut from carbonized paper from such extreme thinness as would be required for a filament similar to the Edison incandescent lamp filament to-day, or at any time, would be an exceedingly difficult mechanical operation. Its liability to fracture during the operation of cutting would be so great that I doubt very much whether I myself, who am very expert at anything of that kind, would be able to cut more than one in a hundred, and I should not consider it could possibly be anything like as regular and uniform mechanically, not to say electrically, as our present fibre.

197 Q. Are you, and were you, on January 9, 1880, acquainted with the general state of the art in relation to electric lighting, and, in particular, to incandescent electric lighting?

A. Yes, sir.

198 Q. In view of the general state of the art at that date (January 9, 1880), would a direction to use wood carbon or charcoal as an incandescent arc or burner in a lamp be of any value as a guide or index to the selection of a suitable arc or burner, or have
625 any value as an aid to the manufacture of a suitable arc or conductor?

A. No, sir; not at all.

199 Q. Is there any quality known to you in wood carbon, as such, which in any way adapts it, as compared with other carbons, for use in an incandescent lamp?

A. No, sir. Out of all the woods that we have tried, we had to find out a peculiar property that is only applicable to a very few of the very many woods that we tried. If wood carbon had been suggested to us it would have given us no clue at all, in the state of the art at that time, to the existence of these qualities that Mr. Edison had to find out with so much experimenting.

200 Q. Similarly I ask you whether, in view of the general state of the art at that date (January 9, 1880) a direction to use an arc or burner for an incandescent lamp, of wood charcoal, would have been of any value or assistance as a guide or aid in the manufacture or selection of a proper arc or burner for an incandescent lamp?

A. Such a suggestion would have been no use at all, as the natural meaning of such a suggestion at that time would have been the use of an exogenous wood, such as willow charcoal, or charcoal made of boxwood or other such woods. Mr. Edison and myself, by reason of our private experiments, had probably gone much further than the general state of the art at that date, and even with our knowledge from our experiments such a direction would have been of no value, for, as already testified to by me, we have never succeeded in making an incandescent lamp, having an exogenous wood as the arc or burner, which could by any stretch of language be called a commercial lamp.

201 Q. In view of the general state of the art at the same date, would a direction to make an incandescing arc of carbonized fibrous material have been of any value as an aid or guide to the manufacture or construction of a proper incandescing arc or burner for for an electric lamp at that date?

626 A. No, sir; for the reason, as I said before, that it was only by tedious experiment we found those particular qualities in certain materials that proved to be of value. The term "fibrous" would apply not only to vegetable matter, but to animal matter, and, if used in the broadest sense, would cover almost the entire kingdom of organic substance, and out of this enormous mass of material it would be impossible to select a suitable incandescing arc or burner, except by such experiments as Mr. Edison actually conducted, in which the peculiar qualities adapting a substance to incandescing lighting might be determined. The fibrous quality of many materials is the very quality which actually destroys their value for incandescent lighting, owing to their sinuosity and the fact that the fibrous nature differentiates one portion of the material from the other, causing a difference of electrical resistance between

one portion of the material and the other, and so a tendency to disruption. This is the case with nearly all grasses and with nearly every wood or woody material that we have experimented upon. I do not mean to say that all these materials would be absolutely useless—that is to say that they could not be rendered incandescent—but that in any ordinary sense, considering the fact that they are to be used in a lamp for practical use to give light, they are of no commercial value.

202 Q. How did you ascertain the fact that in certain woods the fibres were so arranged or of such a character or nature as to be injurious electrically to the life of an incandescent burner?

A. By the use of the microscope, either before the lamp was made or after the lamp had proved bad. We were led to the use of the microscope after our experiments had continued some time.

203 Q. In view of the general state of the art at the same date (January 9, 1880), what value, if any, would there have been to you in the mention, in a specification, that the inventors had tried carbonized paper covered with powdered plumbago for use as an incandescent arc or burner for an electric lamp?

A. Absolutely none. I do not see for what reason they
627 should cover the carbonized paper with plumbago. If they
already had carbon it could do it no good to cover it with plumbago. If they wanted a greater surface, or a greater amount of carbon, they could have taken a little thicker paper and got the same result. As I have already testified, paper already carbonized I had put in a lamp for Mr. Edison previous to this time, and it would have been of no service to me, in the making of a better lamp, to have told me to put plumbago onto it.

NEW YORK, *March 8th*, 1889.

Met pursuant to adjournment.

Present: Amos Broadnax, Esq., for complainant; Walter K. Griffin, Esq., for defendant.

CHARLES BATCHELOR, being further examined by MR. GRIFFIN, testified as follows:

204 Q. Please examine the patent in suit, with the specification and drawings, and state whether to your knowledge lamps of the construction shown in said patent, are now, or at any time to your knowledge have been used practically and commercially, or offered for sale in the market?

Objected to as incompetent and immaterial.

A. I know of no lamp, such as is shown in this patent, having been offered for sale in the market; I have no knowledge of any such lamps having been used commercially in incandescent lighting.

Answer objected to as irresponsive.

205 Q. Have you any knowledge of the use of such lamps practically for other electric lighting than incandescent?

Objected to as incompetent and immaterial.

A. I have not.

628 206 Q. Examining the said specification and drawings and further examining the specification and drawings of letters patent No. 205,144, to Sawyer and Man, referred to in the patent in issue, please state whether you find there shown a lamp chamber wholly of glass?

Objected to as incompetent and immaterial.

A. I do not.

207 Q. Why do you consider that the lamp chamber shown in the patent in suit (No. 205,144, to which I referred you), is not wholly of glass?

Objected to as incompetent and immaterial.

A. Because the lamp chamber A is placed on the glass disc B having a slight coating of fir balsam, or some cement between them; also at another place, L, on the glass plate B, the patent says that he uses some cement and tinfoil between the glass stopper and the plate B. If the chamber was entirely of glass there would be no other materials forming any part of the walls of that chamber.

208 Q. Fir balsam is Canada balsam, is it not?

Objected to as incompetent and immaterial.

A. That is what is generally supposed.

209 Q. Assuming the lamp shown in the patent in suit, letters patent 205,144, to be lit, and in actual operation, what would be the effect of the heating of the lamp upon the fir balsam or other cement used to connect the base with the globe of the lamp?

Objected to as incompetent and immaterial.

A. It would tend to soften the same.

210 Q. How is Canada fir or Canada balsam affected by heat?

Objected to as incompetent and immaterial.

629 A. Canada fir or Canada balsam is made more fluid by heating.

211 Q. Assuming the lamp shown in or referred to in the patent in suit to be filled with a gas, as for example, nitrogen, what would be the effect of rendering the lamp incandescent, upon the cement joint between the base and the globe of the lamp?

Objected to as incompetent and immaterial.

A. The heat produced by the incandescence of the lamp would in my opinion expand the gas, thus putting a greater pressure on the inside of the gas than on the outside. This heat continued would soften the Canada balsam, and there would be a tendency of the rarified gas to get out at the most imperfect part of the joint. The reverse would be the case after the lamp was extinguished, except that in that case the atmosphere would tend to get in.

212 Q. In your opinion, would the expansion and contraction of the glass base and the bell of the lamp be uniform or vary, and what effect, if any, would such contractions and expansions have upon the cement used to connect the base and the bell, and upon the clamps fastening the base?

Objected to as incompetent and immaterial.

A. I do not think that the difference of expansion in the glasses would make very much difference in the lamp; but the continual heating and cooling of the interior of the lamp would tend to make a bad joint at their point of contact.

213 Q. Have you had any practical experience and knowledge of the art of fusing glass for the purposes of incandescent lamps?

Objected to as incompetent and immaterial.

A. Yes, sir. I have superintended the making of most of the
processes that are used in the Edison lamp factory for this
630 purpose. I have also built and ran for some three years a
large lamp factory in France, and my knowledge on this
subject, although not an expert glass-blower, is considerable.

214 Q. In your opinion is it practically possible to fuse together a glass disc or plate, and the flanges of a glass globe, such as is shown in figure 5 of the patent in suit?

Objected to as incompetent and immaterial.

A. It is practically impossible to fuse the two pieces of glass shown in No. 317,676, without damage to the globe.

215 Q. What is the reason of this?

Objected to as incompetent and immaterial.

A. The reason of this is that the thin glass fusing, the globe will cool off so much quicker than the large portion, that when the whole is cold some parts of the glass will be under tension. In nine cases out of ten it would crack almost immediately after it was cooled; and if not then, a very short time afterwards.

216 Q. Referring you again to figure 5 of the patent in suit, and to letters patent 205,144, mentioned in said patent, and to the explanation in the specifications of these two patents of how the metal tubes are closed by metal caps, state whether or not in your opinion it is practical to close such a lamp chamber so as to maintain such a vacuum as is suitable for a practical incandescent lamp?

Objected to as incompetent and immaterial.

A. I do not think that the method shown in either of these patents are suitable for closing a lamp chamber for a practical commercial incandescent lamp. I do not see that in either case they
could get anything more than a vacuum similar to what could be
got in an ordinary common air pump. They certainly could
631 not exhaust it to such an extent as in any commercial in-
candescent lamp that is at present on the market.

217 Q. In your opinion, and from your experience, would it be

possible to maintain any efficient vacuum in a lamp such as is shown in the patent in issue, if the glass disc were ground so as to fit smoothly against the flanges of the glass bell, and clamped however tightly, without any connecting cement?

Objected to as incompetent and immaterial.

A. In my opinion it would be impossible to keep such a vacuum under the conditions under which an incandescent lamp has to work.

219 Q. Referring you again to the lamp shown and described in the patent in suit, would there be any advantage in the use of a fibrous or textile carbon, or a carbon made from fibrous or textile material, as compared with the use of hard carbons?

Objected to as incompetent and immaterial.

A. I do not see any advantage to be gained, except that it might be easier mechanically to work it.

220 Q. Is there, or was there, in view of the state of the art on January 9th, 1880, any difficulty in making artificial carbon pencils, such for example, as the Carré pencils, of the dimensions similar to or identical with the dimensions of the carbon burner shown in the patent in suit?

Objected to as incompetent and immaterial.

A. I believe there was no difficulty in making such; but the particular carbons here do not seem to me to be round.

221 Q. Is, or was there any material difficulty in manufacturing artificial carbons of such material as the Carré pencils are composed of, of the size and shape shown in the patent in suit? 632

Objected to as incompetent and immaterial.

A. The Carré carbons are generally made round, but the plastic material when in such a state could very easily be squirted through a die having a rectangular section, and previous to their being baked, small portions of these could be taken and bent into the form of an arch, and placed into a lamp similar to that in the patent in issue.

222 Q. Can you tell from the drawings of the patent in suit the nature of the electrical system (exclusive of the lamp) in which the lamp shown is intended to be used?

Objected to as incompetent and immaterial.

A. If the patent- had ever intended to work more than one of these lamps from a machine commercially, he certainly must have intended to work them in series. He certainly could not expect to distribute light over a section of a city with such a lamp as that in multiple arc, which is the generally recognized method of doing so.

243 Q. Where lamps in series are used, is it an advantage or disadvantage to have the resistance of the incandescing conductor high?

Objected to as incompetent and immaterial.

A. It should be as low as possible.

224 Q. How does the resistance of incandescent conductors, say of paper carbon, compare with similar conductors of gas-retort carbon?

Objected to as incompetent and immaterial.

633 A. To the best of my knowledge carbons made from paper carbonized would have considerable more resistance than would what we call hard carbon, when both have the same cross-section and length, even when the carbonization is the most perfect.

225 Q. Returning to the subject of the carbonization of materials for incandescent conductors, state what precautions or conditions you found necessary in practice in order to manufacture paper carbons of suitable character for incandescent conductors?

Objected to as incompetent and immaterial.

A. There are ma-y conditions to be attended to in order to produce paper carbon for an incandescent conductor of a lamp that will be good commercially. I believe in our exhibit yesterday (Book No. 52, which was put in evidence) many of these conditions are enumerated; but briefly I will give my recollection of some of them. It is very necessary that the carbon should be straight after carbonization. It is also necessary that its shrinkage should be uniform all through. It is necessary that its uniformity should be so great that their electrical resistances are about alike. It is very necessary that you should take a certain amount of time in making such carbonization, as, if it is done too quickly, all those hydrocarbons which become gaseous below about 700 or 800, will be driven off, and tends to rupture whatever is left in getting out; wheteas they ought to be left in to produce better carbon by their own interlocking of the remaining particles. A carbon made by carbonizing paper in a furnace that is already very hot, and in which the carbon is brought in a few minutes to a white heat, would be practically useless, and its resistance would be very much greater than if it was brought up to a certain heat very slow, and only to a white heat after it had been hot for some time.

226 Q. Were all forms of paper suitable for the manufacture of incandescent conductors?

Objected to as incompetent and immaterial.

634 A. No, sir; there are very many forms of paper that are quite unsuitable. Most forms of card-boards are heavily loaded with oxides of one metal or other—I presume to give them a better finish or to weigh heavier; and these are very unsuitable.

227 Q. Is blotting paper suitable for use as an incandescent conductor when carbonized?

Objected to as incompetent and immaterial.

A. I should not consider it at all suitable.

228 Q. In the carbonizing of paper carbon, what was the effect, if there was any, of unequally heating the different parts of the filament during carbonization?

Objected to as incompetent and immaterial.

A. The effect would be that some parts of the carbon filament would have more resistance than others. This would be detrimental to the lamp, as it would give "spots" in the filament that would be brighter than others, and consequently shorten its life.

229 Q. In the carbonizing of paper, did you find it necessary to use any means to preserve the tension or strain of the fibres composing the paper?

Objected to as incompetent and immaterial.

A. Yes. As I have already stated, it was necessary to bring them out straight and uniform. In order to do this, we had determined, by experiment, that it was necessary to put a weight on each carbon, or a given weight for a total number of carbons, whilst they were in the mould, and heating up in the furnace. Our method of carbonization to accomplish this result generally was to place some sheets of thin paper that we did not want to use as carbon, on top of which we placed paper intended for a filament; after which, a few more sheets of paper, and then another filament; and so on for quite a number of carbons intended for filaments. At other
635 times, we had a single weight for a single filament. These were our practical and cheapest methods of getting the desired result.

230 Q. Do you find any statement in the patent in suit, or in the original specification filed January 9, 1880, which, as the art stood at the date of said original application, was, or would have been a sufficient description to enable a proper paper to be selected for an incandescent electrical conductor without experiment?

Objected to as incompetent and immaterial.

A. I do not. I find no description of preparing paper carbons, except that where it is said that they are confined in retorts, in powdered carbon. In fact, the patent, and the specification in question, leave it entirely to the skill of the man who is going to make the lamps, to find out which is the best method. Certainly, long before the application of January 9, 1880, we had discarded in our own experiments, and for carbonizing for commercial lamps, the only method that I see here described.

231 Q. My previous question was intended to refer not to the method of carbonization, but to the selection of a proper paper before carbonization. Do you find, either in the patent in suit or in the original specification, any direction which, in view of the general state of the art at the date of the application of January 9th, 1880, was sufficient to enable one conversant with the art to select a proper paper for an incandescent electrical conductor, without experiment?

Objected to as incompetent and immaterial.

A. I do not.

232 Q. As a matter of actual fact, how did Mr. Edison and yourself arrive at the selection of a paper which could be used as an incandescent conductor?

Objected to as incompetent and immaterial.

A. By long-continued experiments, made with a very large number of different kinds of paper.

636 233 Q. Do you find, in the original specification of the patent in suit filed January 9, 1880, any description of how the paper intended to be used is to be carbonized?

Objected to as incompetent and immaterial.

A. I do not.

234 Q. Is there anything in the original specification which indicates to your mind that the paper was intended to be shaped or cut into form before carbonization?

Objected to as incompetent and immaterial; and also that the original specification is itself the best evidence.

A. There is not. There is nothing in this original specification that I can see that would tend to show me that any of these substances that were used were shaped in the form before carbonization.

236 Q What, at the date of the application of January 9th, 1880, was understood in the art by the term "carbonized paper"?

Objected to as incompetent and immaterial.

A. The term "carbonized paper" previous to the date of the application of January 9th, 1880, by us at any rate, was applied to paper that had been put into a closed chamber with powdered carbon, and raised to a red heat in the furnace or fire.

236 Q. Did the term "carbonized paper" at that date mean, in view of the general state of the art, paper already carbonized, or paper to be carbonized?

Objected to as incompetent and immaterial.

A. Paper already carbonized.

237 Q. You have mentioned various conditions of carbonized paper essential to the manufacture of a paper incandescent conductor. How, as matter of fact, did Mr. Edison and your-
637 self ascertain these necessary conditions of carbonization?

Objected to as incompetent and immaterial.

A. By a large number of experiments previous to this time. I know of no literature on the subject that was given out at that time, from which we could gain any information more than what was already generally known.

238 Q. In the original specification is there, in your opinion, in view of the general state of the art at its date, any sufficient descrip-

tion to enable one skilled generally in the art to properly carbonize a paper conductor for an incandescent lamp?

Objected to as incompetent and immaterial.

A. The original specification gives no information that would indicate to a man skilled in the art how he should carbonize a piece of paper in order to make a proper carbon for an incandescent lamp.

239 Q. In using woods for incandescent conductors for electric lamps, what would be the effect of cutting the conductor, and especially of cutting a filamentary conductor across the grain of the wood?

Objected to as incompetent and immaterial.

A. I think it would be entirely impracticable to do such a thing.

240 Q. What would be the effect of similarly cutting a conductor at an angle to the grain?

Objected to as incompetent and immaterial.

A. A similar effect would be caused in this case, but not to so great an extent.

241 Q. What practical effect would this cutting at an angle to the grain have upon the life of such a filament as has been and is used in the Edison lamp?

Objected to as incompetent and immaterial.

638 A. The practical effect of cutting across the grain of the filament used in the Edison lamps would be to very materially lessen their life.

242 Q. In carbonizing bamboo for the filaments in the Edison lamps, has it been found necessary to use special means of carbonization, or has it been possible to use the general means known in the art on January 9th, 1880?

Objected to as incompetent and immaterial.

A. There is nothing that was generally known in the art of carbonizing on January 9th, 1880, that is being used to-day in a commercial Edison lamp.

243 Q. Had Mr. Edison *or* yourself, prior to January 9th, 1880, made any special experiments as to the carbonization of paper by methods not generally known in the art?

Objected to as incompetent and immaterial.

A. Yes. I believe that our methods of carbonization for the purpose of incandescent conductors for electric lights were known only to ourselves.

Cross-examination by Mr. BROADNAX:

244 X Q. Referring now to "Defendant's Exhibits Batchelor's Note Book No. 52:" Was this book referred to in your examination in the interference case—I mean in the interference case

between Sawyer and Man, on the one side, and Thomas A. Edison on the other?

A. I do not think it was referred to during my testimony in that case.

245 X Q. How recently have you read your deposition in that case?

A. Within the last few days.

246 X Q. And you do not find in that examination any reference to this book, as I understand you?

A. No. I may say that I have just cursorily glanced
639 over it again, and I find no reference to it in my testimony.

247 X Q. In whose handwriting is this book?

A. Almost entirely in my own.

248 X Q. You stated, in answer to question 168 of this deposition, that the book "refers principally to experiments that I carried on for Mr. Edison, in the latter part of 1879." From what period in 1879 does the book refer to experiments carried on by you for Mr. Edison?

A. From July 31st, 1879, to the end of the year. I find the date here, January 2d, 1880.

249 X Q. If there is any part of it which is not in your handwriting, please designate such parts.

A. The following parts are not in my handwriting: Page 1, the initials T. A. E. are in the handwriting of Thomas A. Edison. The next page is all in my handwriting except the initials T. A. E. in Edison's writing. Page 5, the first 13 lines are in Edison's writing; the remaining four are in my handwriting. The date and my name are in my handwriting at the top, and the initials T. A. E. are in Edison's writing. Page 7 is entirely in my own handwriting except the initials T. A. E. Page 9 is entirely in my handwriting except the initials T. A. E. in Edison's. Page 11, all the writing on this page is in the handwriting of Thomas A. Edison. The drawings on this page I believe were made by myself; 13 is entirely in my handwriting except the initials T. A. E. in Mr. Edison's handwriting; 15, drawings and writing entirely mine, except the initials T. A. E. in Edison's handwriting; 17, sketch and writing entirely in my handwriting; the initials T. A. E. in Edison's. Page 19, the handwriting is entirely mine except the initials T. A. E. in Edison's handwriting. Page 21, handwriting entirely mine except the initials T. A. E. in Edison's. Page 23, handwriting entirely mine except T. A. E. in Edison's. Page 25, handwriting entirely mine except initials T. A. E. in Edison's. Page 27, handwriting and sketch entirely mine. Page 29, handwriting entirely mine
except the initials T. A. E. in Edison's. Page 31, hand-
640 writing entirely Edison's except my name in my own hand-
writing; 33, sketch and handwriting entirely mine after initials T. A. E. in Edison's; 35, handwriting entirely mine except initials T. A. E. in Edison's; 37, handwriting entirely mine except initials T. A. E. in Edison's handwriting; 39, handwriting entirely mine except the initials T. A. E. in Edison's; 41, handwriting entirely mine except initials T. A. E. in Edison's; 43, handwriting

and sketch entirely mine except initials T. A. E. in Edison's; 45, entirely my own handwriting except initials T. A. E. in Edison's; 47, entirely mine except initials T. A. E. in Edison's; 49, entirely in my handwriting except initials T. A. E. in Edison's; 51, entirely in my handwriting except initials T. A. E. in Edison's; 53, entirely in my handwriting except initials T. A. E. in Edison's; 57, sketches and writing entirely in my handwriting except initials T. A. E. in Edison's; 58, writing entirely mine except initials T. A. E. in Edison's; 61, writing and sketches entirely mine except the initials T. A. E. in Edison's; 63, writing entirely mine except initials T. A. E. in Edison's; 65, writing entirely mine except initials T. A. E. in Edison's; 67, writing entirely mine except initials T. A. E. in Edison's; 69, writing entirely mine except initials T. A. E. in Edison's; 70, the figures entirely in my handwriting; 71, entirely in my handwriting except initials T. A. E in Edison's; 73, writing and sketch entirely in my handwriting except initials T. A. E. in Edison's. There is a faint initial J. A. R.; this, however, I do not know the meaning of; 74, the writing, what there is of it, is Edison's; 75, sketches and figures in Edison's handwriting; 76, sketches—I do not know the writing; 77, writing entirely mine; 79, writing entirely mine; 81, writing entirely mine; 83, writing entirely mine; 84, the figures almost all my own, but of no consequence; 85, writing entirely mine. One or two of the sketches mine. The rest of the sketches—the ones relating to carbon spirals are Edison's; 87, the writing entirely mine; 89, the writing entirely mine; 91, writing and sketch entirely mine; 92, writing and sketch entirely Edison's; 93, writing and sketches entirely mine; 95, 641 writing entirely mine; 97, writing entirely mine; 99, writing entirely mine; 101, writing and sketches entirely mine; 103, writing entirely mine; 105, writing and sketches entirely mine; 107, writing entirely mine; 111, writing entirely mine; 113, sketches entirely Edison's; 115, writing entirely mine; 117, writing entirely mine except the letters "D. N. C., March 23, 1883;" 119, entirely my handwriting; 121, entirely my handwriting; 122, entirely in my handwriting; 125, entirely in my own handwriting; 127, sketches and writing entirely mine; 129, sketches and writing entirely mine; 131, sketches and writing entirely mine except "D. N. C., March 23, 1883;" 132, figures in my own handwriting; 133, sketches and writing entirely mine except "D. N. C., March 23, 1883;" 135, sketches and writing entirely mine except the writing "D. N. C., March 23, 1883;" 137, writing entirely mine; 139, writing entirely mine except the signature of A. P. Poinier.

250 X Q. Who is he?

A. He was a young man who was experimenting with us at that time. He was one of my assistant carbonizers.

Page 141, sketch and writing entirely mine except the signature of Poinier; 143, sketch and writing entirely mine except the signature of Poinier; 145, sketches and writing entirely mine; 146, disconnected words, I do not know in whose writing; 147, sketches and writing entirely mine; 149, writing entirely mine; 151, writing entirely mine except the signature of Poinier; 153, writing entirely

mine; 155, signature and writing entirely mine; 157, sketches and
writing entirely mine; 158, the writing entirely Edison's except a
few figures of mine; 159, writing and figures are Edison's, a few in
some one else's hand that I do not know; it is the item "365 x 13;"
161, writing entirely Edison's; 163, writing entirely mine; 164, sketch
all mine; 165, writing entirely Poinier's; 166 and 167 are two sketches.
I am not sure who made them nor what they represent; 168, figures
entirely by Edison, relating to electric light stations; 169, entirely
642 my own handwriting except the addition of 38,000 to 10,000
in figures in Edison's handwriting, and the letters "D. N. C.,
March 23d, 1883;" 171, entirely in my handwriting; pages 173,
175, 177, 178, and 179 are entirely in my handwriting; 181, entirely
in Poinier's writing; 183, sketches and writing entirely my own
except Poinier's signature in his handwriting, T. A. E. in Edison's
writing, and J. Seymour in Seymour's handwriting; Seymour was
also an assistant; 185, entirely in my handwriting; 187, entirely in
my handwriting; 188, numerous sketches made by Mr. Edison; 189,
entirely in my handwriting; 191, sketches and writing entirely
mine; 192, figures—I am not quite sure of them; they do not, however, denote anything that I know of; 193, sketches with no signature, I am not sure whether they are Edison's or my own; 195,
entirely in my own handwriting; 197, unfinished sketch, I am not
sure whether in my hand or not; 198, sketches and writing in
Edison's handwriting; 199, the sketch I do not know; 200 and
201, immaterial sketches, no signature, and I do not know who
they were made by; 203, I believe is in Sawyer's writing, the first
part of it has been written backward, so I am not quite sure; I
recognize the latter part; 205, entirely in my own handwriting
207, sketches and writing entirely mine except Poinier's signature, in his own; 209, entirely mine except Poinier's signature, in
his own handwriting, 211, entirely in my own handwriting.
Pages 212, 213, 214 and 215, sketches, with a few figures—all
in Edison's handwriting; 219, entirely in my own handwriting,
220, sketch made by me; 221, entirely in my own handwriting;
223, entirely in my own handwriting; 225, entirely in my own
handwriting; 226, figures in my own handwriting; 227, entirely
in my own handwriting; 229, entirely in my own handwriting;
230, sketches—I do not know whose they are; 231, entirely in my
own handwriting; 232, figures in Edison's handwriting; *232, figures in Edison's handwriting;* 233, entirely in my own handwriting;
234, rough sketches; I am not sure who made them; 235 entirely
in my own handwriting; 237, entirely in my handwriting;
643 239, sketch and writing entirely mine; 241, entirely in my
own handwriting; 242, entirely in my handwriting; 244,
sketches very much like Edison's; I am not quite sure; 245,
entirely in my own handwriting; 247, sketches and handwriting mine; 248, figures all in Edison's writing; 249, figures, all
of them Edison's; 250 and 251, figures, all of them Edison's;
253, sketch and writing entirely mine; 254, figures, Edison's;
255, my handwriting; 256, a few figures that I am not sure of;
all the handwriting is of Edison's; 257, entirely in my own

handwriting; 258, sketch I believe is Edison's; 261, sketch, looks like mine; 262, all my handwriting; 263, all in my handwriting; 264, sketches and writing mine; 266, sketch and writing mine, except the word "these." 267, writing purposely made indistinct. I do not know who wrote this. It does not relate to anything in regard to paper carbon. 268, sketches; I do not know whose; 270 and 271, sketches; I do not know who made them; 272, sketch and writing entirely mine, except the word "pump" and "30 inch" in Edison's handwriting; 273, sketch I am not sure of; the figures are Edison's; 274, sketch and handwriting mine; also some figures of Edison's near the bottom; 275, a few figures of mine; with handwriting and figures of Edison; 276, sketch and writing entirely mine; 278, sketch and writing entirely mine, with few figures of Edison's on the bottom; 279, writing and figures on top part of page mine; figures on bottom part of page Edison's; 280, sketches at bottom I am not sure of. That is all.

251 X Q. The writing and figures on the several pages of this book—are they in lead pencil or in ink?

A. Some of them are in lead pencil and some in ink.

252 X Q. Please to designate the pages that have the figures and writing in ink?

Objected to by counsel for defendant, because the book being already in evidence, it is sufficiently apparent upon the face which entries are made in pencil and which in ink; and unless some 644 special object is made to appear, the cross-examination is trivial and immaterial; if any object material to this inquiry is stated, no objection will be made.

Counsel for complainant states that it appears that great deal of the writing is in lead pencil, and being so is easily effaced or changed; and he wishes it therefore to appear on the record, so that in case of the book being lost or mislaid, or any question arising as to its contents, it may be determined by the facts on the record.

A. All the pages are numbered in ink. The pages in which the subject-matter appears partly or wholly in ink are as follows: 73, 105, 107, 117, 119, 121, 123, 125, 127, 129, 137, 139, 141, 143, 145, 146, 147, 149, 151, 153, 165, 171, 173, 175, 177, 178, 179, 181, 183, 185, 187, 189, 191, 195, 203, 205, 207, 209, 211, 219, 221, 223, 225, 227, 231, 239, 245, 247, 253, 255 and 263. And that is all.

253 X Q. Why are the pages of this book that are in your handwriting signed by Mr. Edison with his initials?

A. Because Mr. Edison had given me the original instructions to make these experiments, and was keeping watch over them all the time. He would frequently sit down with me and help me for hours. Whenever he saw me entering anything in the book he would generally put his signature to it.

254 X Q. Do you wish to be understood as saying that the facts noted in this book, whether they are in your handwriting, or in Mr. Edison's handwriting, or in the handwriting of any of your assistants, were noted as of the acts and doings of Mr. Edison himself, the same as if Mr. Edison had made them himself?

A. Yes, sir; the general instructions for all experiments came from him.

255 X Q. And, as I understand you, the facts in this book are a record of the experiments either made by Mr. Edison himself, in his own proper person, or by you and your assistants, for Mr. Edison, of inventions made by Mr. Edison. Is that correct?

645 A. They were records of experiments made by Mr. Edison and myself, and my assistants, all of which tended towards carrying out the instructions of Mr. Edison in regard to incandescent lighting.

256 X Q. And were the experiments noted in that book made at the time that the experiments were noted?

A. In regard to my own signature, it was always placed there on the date that I had finished the experiment, as far as my part of it was concerned. Mr. Edison's signature, wherever it appears, was placed on at the same date as mine, where it appears with mine. Our general rule with all our assistants was to sign the experiments at the time they were making them.

257 X Q. Are the dates of the several entries given in the book?

A. I do not understand that.

258 X Q. Is the dates under which the notes were made on the book given in the book?

A. Generally, through the book.

259 X Q. And are the facts noted in the book true?

A. As far as I know they are. Where I have made deductions from experiments they are made from the best knowledge that I had at the time.

260 X Q. What I want to know is whether the book is a true record of the facts noted, as you understood them, at the time that the notes were made.

A. They are a true record of facts at the time that they were made. They are not by any means the only record, as that book is only one of a large number of books that were used on the same general line of experimenting, but in different parts of the establishment. I will illustrate that by saying that you find very few records in that book of the difficulties or troubles attending the mounting of those particular carbons into their glass globes. This part of the work would be recorded in a book that was kept in the glass-blowers' establishment. Similarly, not all details of carbonization can be found here; only such as were useful for my purpose to guide me in making another lamp at that particular bench; 646 also, the behavior of such lamps on the pumps. You will find only a few of the deductions that could have been made, and have been made in other books, recorded in that book.

The last part of the answer is objected to by counsel for complainant as voluntary and irresponsive.

261 X Q. How long was it after your examination in the interference case before you found this book?

A. I never found it. The first time I saw it since I went to

Europe in 1881 is last Sunday, when it was brought to the laboratory for me to see whether I recognized it.

262 X Q. At what time in 1881 did you go to Europe?

A. I went somewhere about February, 1881, the first time.

263 X Q. How long before that did you see this book?

A. I do not remember particularly seeing that book any more than any other of our large number of experiment books after the date of the last record in it. It is very probable that I used it frequently for reference, at the time we were working, on the subject.

364 X Q. In your answer to question 170 you state that "the latter part of the book consists mainly of lamps with incandescent conductors of carbonized paper, and of these lamps there were a great many made, as many as seven or eight hundred of them being used in Menlo Park at one time." Were these lamps, made of paper carbon, as stated by you, good, practical lamps?

A. They were very good, practical lamps in the then state of the art.

265 X Q. But not so good as the lamp of to-day, as I understand you?

A. They were not so good as the lamp of to-day.

266 X Q. You also state in the same answer, referring to carbons,
"These were also made of powdered electric light carbon,
647 which was made into a pasty mass, then rolled up in the
form of a thread, carbonized and placed in lamps." Did you
consider these lamps also good, practical lamps in the then state of
the art?

A. In the then state of the art we did not consider them so good a lamp as we wanted.

267 X Q. That does not answer my question. Please to answer it categorically, whether the lamps were considered good, practical lamps in the then state of the art?

A. They were better lamps than had been made before. They were not sufficiently practical to put out as a commercial lamp.

268 X Q. You also state in the same answer as follows, in regard to carbon experiments: "I find that we made these incandescent conductors October 7th, 1879, carbon spirals. These were made from paper tarred—rubbed with tar and lamp-black and rolled into the shape of a thread. They were then wound in a spiral form on a special device for that purpose, carbonized, and afterwards put into lamps." How did lamps fitted with these kinds of carbon perform? Were they as good as the lamps made of plain paper?

A. They were about the same as the lamps made of plain paper previous to this time.

269 X Q. Referring now to these paper carbons of plain paper, of tarred paper, and of the pasty material referred to by you, how did they compare with the incandescent electric lamps of the present day?

A. They cannot compare at all.

270 X Q. They were very much inferior, as I understand you?

A. They were very much inferior, and they were much more difficult to make.

271 X Q. In the same answer you say, "At the same time we made lamps having carbonized conductors from vulcanized fibre." What do you mean by " vulcanized fibre "?

A. Vulcanized fibre is a material well known in the market, and
used by electrical men as an insulator where they do not re-
648 quire such high insulation as rubber. It is practically made
by only one or two concerns, in Wilmington, Delaware. It
is, I think, paper that has been partly parchmentized by treating with chlorate of zinc, and pressure, and is generally a hard, compact mass.

272 X Q. In the same answer you say that you also made carbonized conductors for your lamps from "threads" rubbed with tarred lamp-black, soft paper, fish line, fine threads plaited together in strands, soft papers saturated with tar, tar and lamp-black mixed with a proportion of lime, different kinds of threads, cardboards, cotton soaked in boiling tar." How did these lamps perform. Were they then considered by you as good, practical lamps?

A. They were not considered by us as commercial lamps in any sense. They were simply lamps made in a long line of experiments that we had to do for Mr. Edison.

273 X Q. I do not ask you about commercial lamps. I ask you about practical lamps?

A. My only idea at this date of the practical value of a lamp is its commercial value. A lamp, however, good, is not commercial unless it can be used generally by the public, as we use our lamps to-day.

274 X Q. That is what you mean then, if I understand you, when you say a " practical lamp," or when you speak of a lamp as being a "practical lamp," in connection with your last answer?

A. Some of the above lamps may have been practical lamps if they had been followed, but in the light of to-day I should not consider them, as they burned then, practical lamps.

275 X Q. Did you ever follow up the making of any of these lamps by actual experiments to ascertain whether they could be made good practical lamps, using the word " practical " as you have defined it?

A. Mr. Edison, I believe, has made many experiments on just such materials as these, and some of these are dated far into the time when he had a much better, and a commercial lamp. My experi-
ments did not carry me further on some of these than just suf-
649 ficient to show what is now shown in this book. You will
notice that the thread lamps are carried quite extensively;
but after a really commercial lamp was ready for the market I gave very little attention personally to making experiments on the old substances that we had proved by experiments were not so good as we had got at a later date.

276 X Q. You also state in the same answer that: "Shortly after this I carbonized a great many materials, such as vulcanized fibre, celluloid, boxwood, cocoanut hair and shell, drawing papers of

different grades." How did the lamps made with paper carbons perform? Were they considered good practical lamps?

A. Many of the paper carbons that are spoken of in this book made good lamps at the time. As long as we had nothing better we considered that these lamps were good. That we had not got what was the desideratum for electric lighting is shown by the fact that we discontinued such paper lamps very shortly afterwards in favor of other material.

277 X Q. What material did you adopt as a substitute for the carbons made of paper?

A. The material that we adopted as a substitute was bamboo fibre.

278 X Q. How did the carbons made from drawing paper compare with carbons made from other paper?

A. It depended entirely on the kind of paper that we used. You will find in the book that I have shown you a record of anything that occurred to me at the time; and very many of the card-boards that were carbonized proved to be heavily loaded. The best paper-carbon loop that we could make would be from absolutely pure paper, and cut perfectly even.

279 X Q. As I understand from your answer, the best papers for making carbons for incandescent electric lamps would be paper of pure cellulose as near as you could get it. Is that correct?

A. Paper with the greatest amount of carbonizable matter in it.

280 X Q. That would be pure cellulose, would it not?

650 A. Of course there is no paper to be found that is pure cellulose, but the paper which has the greatest percentage of cellulose in it.

281 X Q. As matter of fact, what kind of an incandescing conductor did the drawing paper make, including all the different varieties of drawing paper used by you? Did it make a good practical lamp?

A. I cannot give you the results of that experiment at present. I do not find it in the book.

282 X Q. Which of the papers used by you made the best carbon?

A. The best paper carbon, as I now remember it, was got from thin bristol-board of a very pure quality. The tests shown on pages 171 to 179 are tests for papers and card-boards for ash; and some of them are so badly loaded that we could not use them at all. The ones that were not loaded at all were generally the better carbons in the lamp.

283 X Q. At that time did you succeed in making carbons from the paper mentioned by you, that you then considered good practical carbons?

A. At this time we had made lamps with paper carbons for their incandescent conductors, which we considered at that time as the best lamps that we had so far got. Time alone proved that there were many far superior, which we got shortly afterwards.

284 X Q. You do not answer my question, which I now repeat: Please state whether at that time you made carbons from the paper

mentioned by you, that you then considered good practical carbons. I am referring, of course, to that time.

A. We considered them more practical than any carbons that we had then made; but that did not deter us from continuing to look for something far superior.

Adjourned to March 9th, 1889, at 10 a. m.

651 NEW YORK, *March 9th*, 1889.

Met pursuant to adjournment.

Present: Amos Broadnax, Esq., for complainant; Walker K. Griffin, Esq., for defendant.

CHARLES BATCHELOR, being further cross-examined by Mr. BROADNAX, testified as follows:

285 X Q. Do you mean that you had a carbon made of paper that was a fairly good carbon, but did not quite satisfy you, and you therefore continued to look for something better, and persevered until you got it?

A. Yes.

286 X Q. Of what material, in your opinion, can you make the best illuminating conductor for an incandescent electric lamp? I do not, of course, inquire about anything that you or Mr. Edison may have done that is not known to the public?

A. The best conductor for a commercial incandescent lamp that has been tried commercially is, in my opinion, the bamboo fibre.

287 X Q. And that is a fibrous carbon, so called, is it not?

A. That is a carbon made from fibrous material.

288 X Q. And in the course of practice and experiments growing out of the invention of the paper carbon, as I gather from your testimony?

A. No, sir. Paper carbon was only one of many substances in that long chain of experiments to get the desired result.

289 X Q. Which was the first fibrous material out of which you made an illuminating conductor for an incandescent electric lamp?

A. I cannot say which was the first fibrous material that I took to make a carbon for an incandescent lamp, whether of thread or tissue paper. I did not consider the lamp that I made for Mr. Edison in 1877 as made especially by me from fibrous material.

The last part of the answer is objected to by Mr. Broadnax as irresponsive.

652 290 X Q. Whatever the fibrous material was of which you made the first incandescent conductor for an electric lamp, as I understand you, you continued from that time on to experiment with different kinds of fibrous material for making illuminating conductors until you settled down on the bamboo carbon?

A. We continued to experiment on fibrous material, but we did not cease to experiment on the other material, as the book will show.

291 X Q. But you adopted the bamboo as yielding the best results, as I understand you?

A. We finally adopted the bamboo as being the best adapted, as known at the time, to the requirements of Mr. Edison.

292 X Q. Was it the discovery that an illuminating conductor for an incandescing electric lamp could be made of fibrous material that l*ead* you to the long series of experiments of which you have testified, to ascertain which of the fibrous materials would make the best conductor?

A. I do not so take it. The bamboo fibre we found after long search had those qualities which were wanted in greater perfection than any other kind of carbon that we had tried before.

293 X Q. If the discovery that a good illuminating conductor could be made of some fibrous material had not been made, was there anything else that could have led you to make the long series of experiments to ascertain out of which of the fibrous materials the best carbon could be made?

A. I do not think that fibrous material, as fibrous material, gave Mr. Edison much clue to what he was working for. I remember lamps made of lamp-black and tar (that was rolled out very thin), that have worked infinitely superior to hundreds of fibrous lamps that were made.

294 X Q. You have testified that Mr. Edison, and you as his assistant, have made a long series of experiments to get a better illuminating conductor of fibrous material. Now, if the discovery that an illuminating conductor could be made of paper, or
653 similar fibrous material, had not been made, what could have led you to make this long series of experiments?

A. Whether we had ever used a carbon made from paper or not, I think we should naturally have got on to the vegetable growths, because there are so many thousands of different forms, all of which carbons could be made from, and each one of which had its own peculiarity; and from so many thousands of them it was almost a sure thing that we could find some that were good. On the other hand, it is the most likely place to find good carbons in great diversity. The other sources of carbons are rather limited.

The answer is objected to by Mr. Broadnax as irresponsive.

295 X Q. Is it not true as matter of fact that your investigation in these different kinds of vegetable fibres was entered upon after you had discovered that you could make a good illuminating conductor for an incandescent electric lamp from paper, or some similar fibre?

A. It is true that we got good results from bamboo fibre, after having the knowledge that incandescent lamps could be made with paper carbon; but it does not follow that the paper carbon was a means of our commencing those experiments. I put carbons made from paper into a lamp for Mr. Edison almost two years before, and he did not immediately tell me to make him some bamboo lamps from that. It was only to my mind after a long series of experiments that he found that bamboo had that particular quality that he wanted.

The answer is objected to by Mr. Broadnax as irresponsive.

296 X Q. At the time that you discovered that a good illuminating conductor could be made of paper, did you not think that you had made a discovery of great value?

654 A. We thought that we had made a discovery of value; the fact that we abandoned it later shows that we had found something much better.

297 X Q. At the time you discovered that you could make a good illuminating conductor of fibrous material did you not think (you and Mr. Edison) that you had made a discovery of great value?

A. At the time we were making incandescent conductors from paper we believed that we had something much more valuable than it proved.

298 X Q. (Last question repeated.)

A. We thought we had made a discovery of value.

299 X Q. But not of great value, as I understand you.

A. I do not know what Mr. Edison thought about it. I thought it of value; how valuable I did not know.

300 X Q. Did you think it was worth following up until you had proved its value?

A. We thought it worth while to, and did follow it up, and proved it of no commercial value.

301 X Q. Do you mean that you proved that an incandescent conductor made of fibrous material possessed no value?

A. No; I mean that we proved to our own satisfaction that paper was not anything like so good a material to make carbon for incandescent conductors as other things.

302 X Q. You will please to observe that my question does not refer to paper at all as a specific form of fibrous or textile material. The question refers only to fibrous material. With this explanation, my question is repeated (297 X Q. read): "At the time you discovered that you could make a good illuminating conductor of fibrous material, did you not think (you and Mr. Edison) that you had made a discovery of great value?"

A. At the first time that we had made an incandescent conductor of fibrous material, we thought that that discovery had considerable value. I do not know that we attached any of that value to the fact of its being fibrous material. As I have testified before, in answer to question 37 of my direct examination, my under-
655 standing of what Mr. Edison wanted was that the requisite material for his incandescent lamp must have great resistance combined with the least possible surface; and that we were expected to get a substance for an incandescent conductor that would give at least five hundred ohms resistance. I also testified in the same answer that our conversations about that time were frequently directed to getting the highest resistance in the least possible space; and, as I remember it now, I do not believe that the

fibrous nature of the carbon entered into the question at all. In fact our experiments show that we had equally as good carbons, at the time of their being made, from non-fibrous material, as from any other.

Mr. Broadnax objects to, and gives notice of motion to strike out as irresponsive, all of the answer commencing with the words "As I have testified before in answer to question 37."

303 X Q. Do you mean to swear that the discovery that illuminating conductors for an incandescent electric light could be made of fibrous material, was not a discovery of great value?

A. As far as my knowledge is in regard to conductors for incandescent lamps, I am sure that their fibrous nature as such was not the great discovery in electric lamps. I would illustrate this by the fact that very many, in fact the greatest proportion of carbons for incandescent lamps I have made from woods where the fibrous material was absolutely worthless.

Mr. Broadnax objects to the answer commencing with the words, "I would illustrate this by the fact," and gave notice of motion to strike out.

304 X Q. You have testified that at the time that the paper carbons were first made by you, you had made incandescent conductors of other material that were equally as good or better than the carbons made of paper. Were those carbons made of any of the materials you have mentioned in your examination here?

656 A. I said, at that time, yes, sir.

305 X Q. Which of them?

A. I do not remember at this time that a paper carbon was thought any better than some of the ones that I have mentioned, as follows: vulcanized fibre; threads rubbed with tarred lamp-black; soft paper; fish line; fine thread plaited together in strands; soft paper saturated with tar; tar and lamp-black mixed with a portion of lime; different kinds of thread; card-boards; cotton soaked in boiling tar.

306 X Q. All those you have enumerated are fibrous carbons, excepting the tar and the lamp-black carbon. Did you find that carbon as good as those made of fibrous material in whole or in part?

A. To the best of my recollection those carbons were as good as the others made at that time.

307 X Q. How many of them did you make?

A. There were only a few of them made at that time.

308 X Q. Did you ever put out any lamps with such carbons?

A. I do not think so. I presume you mean by "putting out" giving them to the public to use, or selling them to the public to use.

309 X Q. Why did you discontinue the making of such carbons?

A. I do not think that I can say that we have ever discontinued the making of carbons of lamp-black and tar.

310 X Q. How many such carbons have you made in the past two years?

A. I have made none myself during the last two years.

311 X Q. How many have you made the last five years?

A. I made some carbons, I think, in 1883—at my factory in Paris, of such materials to be used to illustrate lamps made on that principle, in a lawsuit or interference suit, in London.

312 X Q. You made them by way of experiments?

657 A. I made them to show that they were practical lamps.

313 X Q. Commercially practical?

A. Not commercially practical in the sense of our present lamp, but that they would give light, and burn for a considerable time.

314 X Q. How many of them did you make?

A. I think about a dozen of them.

315 X Q. You made them to use as exhibits in a lawsuit in London, as I understand you?

A. I do not know whether they were used as exhibits, but I made them at the request of either the Edison Light Company of London or of their lawyers.

315 X Q. Are all of the Edison lamps now put upon the market fitted with illuminating conductors made of fibrous carbons?

A. All of the Edison lamps made by the Edison Company are fitted with conductors made from carbonized vegetable substances.

317 X Q. Are they cut into form before carbonization?

A. I do not think so. My understanding of them is that they are cut to a shape, then bent into their form and then carbonized.

318 X Q. You mean by your last answer that the illuminating conductors are made to the desired form and size before they are carbonized?

A. They are made to the desired form and to a certain size; after they are carbonized they are smaller.

319 X Q. You have testified that since the discovery of the fact that a good carbon conductor could be made of vegetable fibrous material you have spent a great deal of time and effort to ascertain of what fibrous material you could obtain the most satisfactory illuminating conductor. How much time and effort have you spent to ascertain whether an equally good illuminating conductor could be made of materials non-fibrous?

A. In proportion to the variety of conditions of carbon that you can make from vegetable substances to those substances from which you can procure suitable carbons for making incandescent
658 conductors that are not vegetable, I should say that a very large amount of time has been spent in trying to procure a carbon from non-vegetable substances. As we can make carbon from almost all vegetable substances, and as our other sources of carbon in proportion are very much limited, it follows that a great deal more time has been spent in total on those carbons than on those from non-vegetable substances.

320 X Q. What success did you meet with in your efforts to make satisfactory carbons from non-vegetable substances?

A. As experiments they were successful.

321 X Q. Were they so successful as to warrant you in putting any lamps on the market provided with such carbons?

A. I do not remember that we have ever put such lamps on the market.

322 X Q. If you have made any lamps with such carbons since your first use of paper carbons, state if you recollect how many you have made?

A. I have answered this before in the lamps that I mentioned that I made in Paris.

323 X Q. Did you ever make any in this country?

A. None except the ones that were made and spoken of in my exhibit book No. 52.

324 X Q. What do you mean by the "bell" of the lamp?

A. If it is in an answer relating to the sketch of the Sawyer-Man lamp, I mean the bell jar or enclosing globe of the lamp.

325 X Q. Is it your opinion that it is impracticable to fuse a glass disc and the bottom of the enclosing globe or lighting chamber of the Sawyer-Man lamp?

A. It is impracticable to fuse the glass disc onto the bottom of the enclosing globe of such a lamp as is shown in the Sawyer-Man patent. I do not say that it is impossible to do so, but, as I testified before, the unequal contraction in the cooling of such a globe after fusion, would be very detrimental; and a very large percentage of them would crack at the point where the glass is smaller in section than the large plate.

659 326 X Q. I do not say anything in my question about the thickness of the glass disc to be fused on the bottom of the lamp.

A. I presume that you referred to the lamp that I have testified about, and of which there was a drawing here at the time, in the specification.

327 X Q. Assuming the glass disc to be of equal thickness with the globe of the lamp?

A. I think that it is then a difficult operation, compared with the ordinary method of sealing the parts of the lamp together.

328 X Q. Is it your opinion that it would be practically impossible?

A. I do not say that it is practically impossible, but a good commercial lamp would never be made that way, as the state of the art at present gives us much better means.

329 X Q. At the time that the application for the patent in suit was made, was there any novelty in making the enclosing chamber of the lamp of glass, and then fusing the two parts together?

A. At the time of this application (which is January 9th, 1880), the process for use in an incandescent lamp was novel, and only used to my knowledge by Mr. Edison.

330 X Q. Was there any novelty in making such a lamp in the summer or fall of 1878?

A. I do not know. I do not remember any such lamp being made in 1878, by anybody.

331 X Q. Do you not know that the chamber or enclosing globe

of an incandescent electric lamp had been made wholly of one piece of glass, having their electrodes passing through holes in the bottom of such lamps?

Objected to as incompetent on cross-examination, not being based on anything in the direct.

A. At what time?
332 X Q. In 1878.
A. I do not know of any such lamp having been made in 1878.
660 333 X Q. Did you read the deposition of Mr. Sharp, for the defendant, in this case?

Same objection as X Q. 331.

A. I did not.
334 X Q. Is it your understanding that the incandescing conductors claimed by the patent in suit are limited to their use in the particular lamp, or form of lamp, described in or referred to by the patent in suit.

Same objection as to the last question; and also as immaterial.

A. I have no particular understanding or opinion in the matter as regards its being confined to anything. I find that, although expressed differently, it is practically the same thing as the lamp made by me for Mr. Edison in 1877.

The last sentence of the answer is objected to as irresponsive.

335 X Q. Was it not old, in 1878, to make glass bulbs of the same form substantially of the bulbs or enclosing chamber of the Edison lamp?

Objected to as improper on cross-examination, not being based on any fact or circumstance brought out on the direct.

A. I do not remember to have seen any globe of that particular shape. I think that those globes were especially made for us, and they have been known as the Edison patent, almost always.
336 X Q. Was it not old, in 1878, to seal the leading-in wires for an electric circuit in the walls of a glass-enclosing bulb or chamber.

661 Objected to for reasons last stated; and also that it does not appear that the witness is qualified to speak of the state of the art in the particular respects requested of him by counsel for complainant.

A. It was not old in 1878 to use an enclosing globe having wires sealed into the glass, which wires were coated together by an incandescent conductor.
337 X Q. (Last question repeated.)
A. If you refer to such specific instruments as Geysler tubes, they were known in 1878.
338 X Q. I do not refer to any particular specifical instrument,

but simply want to know whether it was old in 1878 to seal an electrical conductor in the walls of a glass-enclosing chamber?

Same objection as to X Q. 336.

A. I think it was old. I have seen such instruments.

339 X Q. Have you ever read the specification of Mr. Edison, making part of the application which was involved in the interference with Sawyer and Man, and as to which you gave your testimony?

A. I have given testimony on it, I presume. I have read it, but I do not recall it to my mind. I would probably know it if I saw it.

340 X Q. Do you mean by your last answer that you do not recollect of having read that specification?

A. I do not recollect to have read that particular specification at present. If I have testified on it I believe I have read it; but I do not now recall it to mind. (Said specification is handed to the witness.) I have now read the specification referred to.

341 X Q. Is this the first you have read it?

A. I do not think so. I believe I have read that before.

342 X Q. In answer to question 237: "You have mentioned various conditions of carbonized paper essential to the manufacture of a paper incandescent conductor. How, as matter of fact, did Mr. Edison and yourself ascertain these necessary conditions of
662 carbonization?" you answered: "By a large number of experiments previous to this time; I know of no literature on the subject that was given out at that time from which we could gain any information more than what was already more generally known;" do you mean, or did you mean at the time that the notes were made in the book?

A. Yes; at the time that the notes were made in the book.

Redirect examination by Mr. GRIFFIN:

343 Q. Is it within your general knowledge whether or not commercial lamps are commonly on sale, in which the incandescent conductors are made of non-fibrous material; if so, please state what materials you know are commonly understood to be used by manufacturers or vendors of incandescent lamps in this country?

Objected to as incompetent and immaterial.

A. It is commonly understood that the U. S. Electric Lighting Company make a lamp of tamadine. This I believe to be a non-fibrous material. I believe also in England I have read of their using lamps from a substance which is non-fibrous, and which is squirted through a die into a liquid, which precipitates it. My impression is that these lamps were on the market. Outside of these I do not remember any others.

344 Q. Mr. Broadnax in his cross-examination spoke of Mr. Edison's discovery that conductors of fibrous carbon could be used in incandescent lamps; at the time that Mr. Edison was using paper carbon, did he attach any importance to the fibrous nature of paper,

or discuss with you in — way any advantages due to its fibrous quality?

Objected to as incompetent and immaterial.

A. I do not think he attached much importance to its fibrous quality. His conversations with me at the time were always
663 in regard to finding a material or substance from which we could get a carbon that would be practical, of extreme smallness of cross-section, with length which would naturally give high resistance. As I understood, whether we got it from one thing or another was immaterial, so long as those conditions were there.

345 Q. What is the common and ordinary source of carbon; is it from vegetable or inorganic matter that it is more generally obtained?

Objected to as incompetent and immaterial.

A. The great source of carbon, in the ordinary expression of the term, is vegetable or has vegetable origin.

346 Q. So far as your experience has gone, has the fibrous quality, so far as the same may exist in vegetable structures, been of any value as such in the construction of electrical conductors for incandescent lamps?

Objected to as incompetent and immaterial.

A. The value that we have found after long experiments in carbons made from vegetable substances, I believe is more in the fact of their having small filamentary cells packed very closely together than in anything else. It took us a very long time to find out those peculiar vegetable fibres that would give us perfect continuity, and the most even and dense structure.

347 Q. Have you found in your experiments that the presence of the fibrous quality in the woods or vegetable substance used by you, was any indication as to the electrical value of the resultant carbon, when used as a conductor in an incandescent lamp?

Objected to as incompetent and immaterial.

A. No, sir. If we could produce a method of making a carbon whereby the solid part would be perfectly dense, and still
664 longitudinally it would be cellular, this would be much better than the carbon we now produce from bamboo fibre.

348 Q. As a matter of fact, in all exog/nous woods that you have experimented upon, as testified to by you upon direct examination, has the fibrous quality of the woods, so far as it may have existed, been of any value in the formation of a carbon conductor?

Objected to as incompetent and immaterial.

A. In the formation of a carbon conductor from such woods, the fibrous nature of it is absolutely detrimental. In fact it makes them worthless.

349 Q. Whatever the real reason may be as to the peculiar merits possessed by bamboo as a material for incandescent electrical con-

ductors, as matter of fact do the same merits exist in all vegetable fibrous material?

Objected to as incompetent and immaterial.

A. No, sir; and in all materials that are manufactured, such as paper, thread, ropes, and such, they do not exist at all.

350 Q. You spoke of Mr. Edison's search for a material having a high resistance and small surface. Did this search begin before or after the use of paper carbon in incandescent lamps?

Objected to as incompetent and immaterial.

A. It began, as far as I know, long before—when he first discovered that it was possible to subdivide the light by that method.

351 Q. In such vacuums as you had the means of creating in the earlier stages of Mr. Edison's experiments, was it possible to prevent any form of carbon from oxidization?

Objected to as incompetent and immaterial.

665 A. Previous to the time when Mr. Edison made lamps having glass globes hermetically sealed (in the sense that we to-day know them to be hermetically sealed), nothing would last when used as an incandescent conductor, for any length of time, compared with the life of lamps now, in such vacuums as we could get then.

Adjourned to Monday, March 11th, 1889, at 11 a. m.

CHARLES BATCHELOR.

Sworn to before me,
[L. S.]

WILLIAM T. FARNHAM,
Special Examiner and Notary Public.

NEW YORK, *March* 11*th*, 1889.

Met pursuant to adjournment.

Present: Amos Broadnax, Esq., for complainant; Walter K. Griffin, Esq., and Grosvenor P. Lowrey, Esq., for the defendant.

HENRY E. VINEING, a witness for the defendant, being duly sworn, testified as follows:

Direct examination by Mr. GRIFFIN:

1 Q. What is your name, age, residence and occupation?

A. Henry E. Vineing; age, 32; residence, No. 842 Franklin street, Philadelphia; occupation, mechanical and electrical engineer.

2 Q. What experience have you had generally in the subject-matter of electric lighting, and in electrical matters generally?

A. I am conversant upon all the subjects pertaining to the electric-light business, covering all the different uses to which electricity is put. My experience dates back as far as 1876. At that time I was employed in England by different parties, and doing work appertaining to laying ocean cables, torpedoes for the British government, and experimenting and assisting in the erection of electric light plants generally for the Siemens Brothers. 666

3 Q. Have you been in the employ at any time of the Consolidated Electric Light Company; if so, please state when and for how long?

A. In the year 1883 (I think that is the correct year; as far as I can remember 1883 is the date; but by referring to the Consolidated Company you can get the exact dates), I was employed by the Consolidated Electric Light Company. I think about the middle of that year I entered their employ. I was engaged to make incandescent lamps for that company, and carbons in the same way.

4 Q. Where was the factory or workshops of the company at the time you were employed by them?

A. The factory was at the corner of Front and Adams streets, Brooklyn.

5 Q. By what company had you been employed prior to your employment by the Consolidated Company?

A. By the Brush Company, in Elizabeth street, New York.

6 Q. At the beginning of your employment with the Consolidated Company, what was the nature of your duties or work for them?

Objected to as incompetent and immaterial.

A. I was engaged by the manager of the Consolidated Company, Mr. William Main, at that time. I called there to get a position, and stated my previous experience in incandescent work with the Lane-Fox people of London; and Mr. Main seemed very anxious to tell me that the company would probably be very anxious to get my services. Next day I was engaged to take charge of their carbon department, and to introduce all the latest or better facilities for making lamps than what they already had, and also to experiment on carbons.

667 7 Q. What kind of carbons was the Consolidated Company using at that time in its lamps?

Objected to as incompetent and immaterial.

A. They were using at that time bamboo carbon, or carbon made from bamboo.

8 Q. What kind of material did you work or experiment upon in making carbons for lamps for them?

Objected to as incompetent and immaterial.

A. I worked on basswood, the same as they use in bass brooms; French whisk, or broom whisk, which they use in whisks for brushing clothes; manilla fibre; Tampica; cotton thread; linen thread; fish lines—hemp fish line, and also sea-grass fish line; and fibre from the willow.

9 Q. How many lamps in all did you make of these various materials?

Objected to as incompetent and immaterial.

A. About two hundred or two hundred and fifty, I should say. I cannot be certain of that number, but it is about that number. It is so long a time ago now that I am uncertain of the number.

10 Q. How long did these experiments continue?

Objected to as incompetent and immaterial.

A. From the time that I entered their employment until some two or three months afterwards.

11 Q. Who directed you to make these experiments with the various materials you have mentioned?

Objected to as incompetent and immaterial.

A. The directions came from the office, through Mr. Main.

668 12 Q. What was the amount of success arrived at by the use of any of these materials which you have mentioned?

Objected to as incompetent and immaterial.

A. In a number of lamps that we made—that I made and experimented on—I found from the use of them that we could not get a lamp that would last any appreciable length of time, that is, a number of lamps out of them. That is, the material they were made of was not satisfactory for the making of a large number of lamps.

13 Q. Were the carbons uniform in quality, or in their life in the lamp?

Objected to as incompetent and immaterial.

A. No; not at all. They varied considerably on account of the almost impossibility of getting the carbons made from whisk and broom of an even diameter all the way up the carbon. It was impossible to get the number of lamps which would be exactly the same, because amongst a bunch of broom of a thousand fibres you would probably get twenty per cent. somewhere near the size you wanted; but even those would not be the same. There would be a difference of diameter which would make a difference in the lamps.

14 Q. Out of the carbons made from the same material, was the duration of the carbon in actual use uniform or different?

Objected to as incompetent and immaterial.

A. The duration of the carbons of about the same or nearly the same gauge, were within ten per cent. of the same duration, provided they were all pumped out at the same time, and had the same treatment, and made out of the same batch.

15 Q. What was the degree of success with the willow carbons, or willow fibres that you have mentioned?

Objected to as incompetent and immaterial.

669 A. That was a very short experiment that we tried. We found in a very short time that it was practically impossible to make carbons at all from that on account of the fibre being so coarse in the willow, and it being so easily broken; we could not cut it down fine enough to make a carbon of it.

16 Q. At the conclusion of your experiments for the manufacture

of these lamps of the various materials you have mentioned, what material was adopted, if any, by the company for the manufacture of their carbons for incandescent lamps?

Objected to as incompetent and immaterial.

A. They decided to go on using bamboo to make their carbons of.

17 Q. What part of the bamboo did they use?

Objected to as incompetent and immaterial.

A. They used the dense part of the bamboo structure underneath the outside surface of the cane.

18 Q. Were you, during the time of these experiments, familiar with the Edison bamboo film?

Objected to as incompetent and immaterial.

A. No, sir.

19 Q. After the adoption of the bamboo by the Consolidated Company did they, to your knowledge, use any other material for the carbon for their incandescent lamps?

Objected to as incompetent and immaterial.

A. Yes. Some time after that I received orders from the office through Mr. Main (I believe from Mr. Garden) to make a number of lamps from paper, to make some experimental lamps out of different grades of paper, which I did.

20 Q. What kind of paper did you experiment upon?

Objected to as incompetent and immaterial.

670 A. I used linen paper, common writing paper, paper made from straw, and bristol-board. I obtained these papers and got them cut at the place in Beekman street of W. E. Spangel & Sons, cut to the size that I required or that I wanted to make carbons of.

21 Q. About how many lamps with paper carbon did you make?

Objected to as incompetent and immaterial.

A. I should say nearly one hundred—about one hundred—somewhere around that number.

22 Q. Did you find any difference in the practical effect of using different papers, or were all the papers the same?

Objected to as incompetent and immaterial.

A. Yes. I found that certain grades of paper were of no good as carbons because they were uneven in their texture, and I found that in carbonizing them, in using these papers, on account of the uneven formation of the paper pulp that the thin places would burn out in carbonization; and when they came out of the oven the parts that did not show perforations by being burned out when I put them in the treating apparatus, these parts that were thin would become of greater heat and take a heavier coating of hydrocarbon gas.

23 Q. Do I understand that the Consolidated Company treated their carbons?

Objected to as incompetent and immaterial.

A. The Consolidated Company treated their carbons at that time by the hydrocarbon process.

24 Q. Describe the process used by them for treating their carbon?

Objected to as incompetent and immaterial.

A. At that time we had a bottle with three necks in it, in which were inserted rubber bungs. The gas passed in from the
671 mains (previously having been passed through the purifying
apparatus to take the heavier hydrocarbon away from the gas), and it was passed up through the bottle and allowed to burn out through the outside bung, through a tube which was lit. The rubber bung in the centre hole had two metallic rods placed in it that carried the gas to the carbon, which was fixed on one end of this rod and immersed in the gas in the bottle. The rods that protruded through this bung was connected with wires on the outside for the purpose of allowing connection being made by flexible connections, so as to pass the current through the carbons.

25 Q. What was the practical result of the test of the one hundred or so paper-carbon lamps that you made for the company?

Objected to as incompetent and immaterial.

A. The result was that they found, or they decided, that the sufficiency of the paper carbons so made rendered them useless for practical use, the efficiency of them being very low, and not only that, but it was very hard to get paper of even texture, and of the number of carbons that were made a very large percentage of them were of no good at *at* all.

26 Q. What was the commercial practical value, in your opinion, from your experience of the various woody matters and fibrous matters mentioned by you, from which you constructed carbons for lamps other than the bamboo carbon?

Objected to as incompetent and immaterial.

A. The commercial value of the lamp was *nil*, for the reason that there was no regularity. We could not possibly make them in irregular grades without a great loss. Consequently the cost of a lamp, if you did get a good one (which you would probably get—one out of a good many that you made), would render the cost of
the lamp so high that it would not be practical to make it.

672 27 Q. I ask you to look at the patent in suit, to W. E. Sawyer and Albon Man, and to the drawing figure 5 of the specification. Did you, while you were with the Consolidated Company, make use of any lamps having a glass disc and a glass chamber with flanges, as shown in that figure?

Objected to as incompetent and immaterial.

A. Yes; to the best of my recollection there were two of those lamps—one to a certainty—that I experimented on, trying to make the carbon burn; it was a pencil carbon, an ordinary electric light carbon, of small diameter. I fixed a lamp similar to this, with a pencil carbon in it, pumped it out, and made it substantially the same as this, and sealed it with different kinds of wax. Mr. Main experimented, and made up different kinds of wax to seal this with. I sealed them, and treated them, but never managed to get any of them to burn for any length of time.

28 Q. How long, to your best recollection, did carbons burn in such a lamp?

Objected to as incompetent and immaterial.

A. Half an hour at the outside.

29 Q. What became of it then?

Objected to as incompetent and immaterial.

A. Several times when we tried that experiment the globes burst.

30 Q. Did you use any cement between the disc and the glass chamber?

Objected to as incompetent and immaterial.

A. Between the disc and the glass chamber they used balsam. Some balsam that they had in the factory at the time was used, or it was procured for that purpose, I believe, by Mr. Main.

673 31 Q. Was there anything additional to the balsam used to affix or attach the disc to the glass chamber?

Objected to as incompetent and immaterial.

A. Not with that lamp that I experimented with.

32 Q. Did you see any lamp at the Consolidated Company having a glass disc and chamber and flange, as shown in figure 5 of the patent in suit?

Objected to as incompetent and immaterial.

A. Yes; I saw some lamps made with a shade—a shade on the lamp similar in size to this; the conductors to the carbon were on a frame; and the outside metal frame was made double; and the glass shade went into this wall which is made between the metal, and is filled in with cement. The metal base was double, and the glass shade fitted into it; and then the space was filled up with cement.

33 Q. Did you find it possible to preserve a vacuum in such lamps?

Objected to as incompetent and immaterial.

A. Not for any length of time.

34 Q. When did you leave the Consolidated Company, or its employment?

Objected to as incompetent and immaterial.

A. I think about ten or twelve months after my engagement with them. I am not certain about that, but it is about that time. All the papers that I had about that time were burned up in a fire that occurred at the place I was employed after leaving there; and I have no dates that I can fall back upon to give you the exact period when I left them: but that is about the time that I was with them altogether.

35 Q. Did you subsequently return to the employment of the Consolidated Company?

Objected to as incompetent and immaterial.

674 A. Yes: I subsequently returned to their employment on my leaving the employment of Messrs. Remington & Son; I think about some time in 1885.

36 Q. What was your employment, or what were your duties at Messrs. Remington & Sons?

Objected to as incompetent and immaterial.

A. I engaged with Messrs. Remington & Sons to start an incandescent lamp factory. I did so, and put out two plants; but the Edison people commenced a lawsuit against the Remington people for infringing their patent, and stopped them.

37 Q. What kind of carbon did you use at the Remington's?

Objected to as incompetent and immaterial.

A. Bamboo.

38 Q. After you had returned to the Consolidated Company, what kind of a carbon were they using for their filaments for incandescent lamps?

Objected to as incompetent and immaterial.

A. Bamboo.

39 Q. How did the lamps compare in their general feature with the lamps of the Edison Company?

Objected to as incompetent and immaterial.

A. The difference between that lamp and the Edison lamp was that instead of the connection between the carbon (the platinum wire), instead of being electroplated, the connection was a connection with cement—carbon cement.

40 Q. What was the original shape of the globes or glass chambers used by the Consolidated Company when you first went there?

Objected to as incompetent and immaterial.

675 A. They were tubes about an inch and a quarter in diameter.

41 Q. How long?

Objected to as incompetent and immaterial.

A. I should say about five or six inches.

42 Q. What shape did they subsequently adopt?

Objected to as incompetent and immaterial.

A. An egg-shaped globe.

43 Q. How did that shape compare with the shape of the Edison Company lamp?

Objected to as incompetent and immaterial.

A. The globes that they used first, after using the tubular globes, were made in a mould. They were of uniform shape—egg-shaped, with a straight neck.

44 Q. How did the shape of them compare with the shape of the Edison Company lamp?

Objected to as incompetent and immaterial.

A. They were globe-shaped. The Edison Company lamp tapered off down; that is, the Edison Company's globes was blown from the end of a blow-pipe, in the factory, and naturally had a gradual taper off down to the end of it; whereas the globes they used practically answered the same purpose, but were made in a mould; and the bottom of the egg shape was elongated to a straight neck, so as to allow the easy sealing in of the inside supporting bulb that they then used.

45 Q. What experience if any had you had in England prior to your employment with the Consolidated Company here, in the making of carbons for incandescent lamps?

Objected to as incompetent and immaterial.

A. I was engaged in the Lane-Fox factory, in London, in
676 the treating-room of that establishment. There I went
through the experiments with the different fibres and woods;
and also with cotton.

46 Q. What success, if any, did you have with ordinary woods?

Objected to as incompetent and immaterial.

A. None whatever. The experiments with those were of very short duration, on account of not being able to arrive at any practical carbon.

47 Q. What was the trouble?

Objected to as incompetent and immaterial.

A. It was impossible to cut the wood down so fine as we wanted it; and not only that, but it was very coarse; and after it was carbonized, it was very porous and uneven and very easy to break, and brittle on account of the cross-fibres in the different woods.

48 Q. Who composed the Lane-Fox Company?

Objected to as incompetent and immaterial.

A. It was the Anglo-American Brush Company—an incorporation; and this was the Lane-Fox department. They were making incandescent lamps under the Lane-Fox patents.

49 Q. How many lamps were they making at Lane, Fox & Co.?

Objected to as incompetent and immaterial.

A. At the time of my employment with them they were averaging some days one hundred, some days two hundred or two hundred and fifty; the average was about one hundred and fifty to two hundred per day.

50 Q. Did the Anglo-American Brush Company carry on incandescent lighting commercially at that time in England?

Objected to as incompetent and immaterial.

677 A. At that time I was not conversant with any permanent installation that they had; but a short time afterwards I left the testing-room, and went and made an installation in the new houses of parliament at Vienna, for that company; and they made an installation also at the Crystal Palace electrical exhibition.

51 Q. Who was the Mr. Lane-Fox of whom you have spoken; and what was his relation to the incandescent lighting subject?

Objected to as incompetent and immaterial.

A. He was the inventor of the Lane-Fox lamp.

52 Q. Was that a lamp similar in form to the lamp at present used by the Consolidated Company, and by Mr. Edison?

Objected to as incompetent and immaterial.

A. It was similar to this effect, that it was a carbonized film, burning in a vacuum, for the purpose of incandescent lighting. The details of construction were somewhat different.

53 Q. At the time that you worked for the Consolidated Company did you receive specific directions as to the kind of carbons you were to use, or what were your directions as to your experiments on carbons for incandescent lamps?

Objected to as incompetent and immaterial, and also as leading.

A. After my experiments, after the first two or three months, when they had found out the value of these different materials, which I had tried, I was told to go on making, to continue making lamps with bamboo carbons in them; carbon made from bamboo.

54 Q. I mean, at the beginning of the service, and before you had made the experiments, what were your directions then, if any?

Objected to as incompetent and immaterial.

678 A. To make lamps of these different materials that I had made them out of when in Lane-Fox employ, and if possible to make a good lamp.

55 Q. Did you succeed in making a "good lamp," to use your own expression, out of any of these materials, except bamboo?

Objected to as incompetent and immaterial.

A. Yes; I succeeded in making a good lamp, but not a practical commercial lamp. I would make one good lamp probably out of fifty or sixty; but it was not at all certain what percentage of good lamps, out of the number I made, would be. Necessarily it could not be called practically a good lamp, on account of there not being any regular percentage of them good.

56 Q. What do you mean by a "commercial lamp," to use your own phrase?

Objected to as incompetent and immaterial.

A. By a commercial lamp I mean a lamp made of a material whereby the life of such lamp is of such duration, and the percentage of lamps made from that material are of such a life as to warrant their being sold at a regular standard rate.

57 Q. Supposing that out of one hundred lamps actually made, twenty of them were good for practical use, and the rest were not good. Would you call that type of lamp a commercial lamp?

Objected to as incompetent and immaterial.

A. I should not call it a commercial lamp, because nothing can be called commercial unless the percentage from the manufacturing is fifty or over.

58 Q. What proportion of the lamps that you made from different materials, other than bamboo, that you have mentioned, were good lamps as regards the duration of the carbon, in any ordinary meaning of the term?

Objected to as incompetent, immaterial and as already answered. Question withdrawn.

679 59 Q. Did you have any conversation with any of the managers of the Consolidated Company as to the adoption by them of the features of the Edison Company's lamps?

Objected to as incompetent and immaterial.

A. Yes. Several times I had spoken both to Mr. Main, Mr. Richardson and Mr. Garden, about the feasibility of adopting another mode of sealing in the bottom of the lamp, on account of being such a great loss from the mode they were then using of sealing in the inside part of the lamp. I asked them a good many times if they would not adopt the same way that Edison did, of supporting the bulb, because there was less loss in that way of doing it, and it was a quicker method.

60 Q. What was their answer?

Objected to as incompetent and immaterial.

A. They said that they preferred to go on in the way they were going on account of not making a lamp too near like Edison's.

61 Q. Finally, what did they do in this respect?

Objected to as incompetent and immaterial.

A. As I said before, they changed from the tubular-shape lamp to the globe, and at the time I left them, the first time, I believe the glass-blower there got up another mode of sealing in; and when I returned to them the second time they were using this new way of sealing in.

62 Q. Was there any substantial difference between that method and the lamp of the Edison Company, except in detail?

Objected to as incompetent and immaterial.

A. The ultimate result arrived at is exactly the same, but the details are not the same.

680 63 Q. What do you mean by saying that the ultimate result was the same?

Objected to as incompetent and immaterial.

A. A glass support for the platinum wires to the carbon to seal in the bottom of the lamp. In Edison's case he used a bulb with a long piece of glass protruding inside of the bulb of the lamp and sealed at the top of this projection; but the Sawyer-Man people have the seal in solid glass, and they inserted in this solid glass the wires that were sealed into it in the bottom of the bulb, so that the projections inside the Sawyer-Man lamp are solid until near the top, while Edison's go a long way in and are hollow.

64 Q. Then, as I understand you, the only difference was in the shape of the glass supporting the wires?

Objected to as incompetent and immaterial.

A. Yes; that is the difference.

65 Q. Did you ever have any conversation with any of the managers of the Consolidated Company as to adopting bamboo carbon, such as is used in the Edison Company lamp?

Objected to as incompetent and immaterial.

A. When I had gone through these experiments that I have already told you about, in my first two or three months' engagement, they decided to make carbon from bamboo fibre; and I received instructions through Mr. Main to go on making lamps, using bamboo fibre for the carbons.

66 Q. After this adoption of bamboo did the company use any other fibre, to your knowledge?

Objected to as incompetent and immaterial.

A. Yes; as I answered before in one of the questions, some time after that I had orders to make some lamps of paper—that is, to make carbons from paper.

681 67 Q. With the exception of the paper carbon, as to which you have already testified, were there any lamps to your knowledge manufactured by the Consolidated Company with any other material than bamboo?

Objected to as incompetent and immaterial.

A. Not that I am aware of.

68 Q. What experience, if any, have you had in glass-blowing,

either personally or as superintendent of the manufacturing of incandescent lamps for electric lighting?

Objected to as incompetent and immaterial.

A. I have been in direct charge of glass-blowers, of two glass-blowers in the Lane-Fox factory, and also I have been in charge of glass-blowers in factories I have been in since then; and I can also make a lamp from beginning to end, seal the glass, and do the whole thing.

69 Q. Please look at the drawing figure 5 in the patent in suit, and state whether in your opinion, and from your experience, it is practically possible to fuse together a glass disc, and the flanges of the glass chamber, as shown in that drawing in the patent?

Objected to as incompetent and immaterial.

A. Is that glass disc supposed to be flat all the time; is that what you mean?

70 Q. I mean a flat disc and chamber, as shown in that drawing.

A. I should say it is impossible.

71 Q. What are your reasons for this opinion?

Objected to as incompetent and immaterial.

A. If this disc is flat and circular, as shown in this drawing, and of the same thickness, I am almost positive that it is a matter of impossibility for any one to seal the tube as shown in this drawing to this glass disc, for the simple reason that immediately they put the heat on that glass it will crack, thereby preventing the making of a seal. 682

72 Q. Have you had any experience in attempting to seal electrodes of different metals through the glass chamber of an incandescent lamp?

Objected to as incompetent and immaterial.

A. Yes; I have sealed copper—I have attempted to seal copper—and steel; by steel I mean steel and iron; besides platinum wire.

73 Q. Did you succeed in sealing efficiently, so as to enable a vacuum to be preserved, either steel or iron or copper electrodes in a glass chamber?

Objected to as incompetent and immaterial.

A. No, sir; never. The trouble with these metals is that they oxidize when the heat is put to them, and cannot make a perfect seal on account of the air bubbles that are formed between the metal and glass inside of the seal, thereby rendering it so that you cannot make a perfect seal. You can sometimes make a seal that will hold a vacuum of a certain strength, say 25 or 26 inches, but higher than that you cannot go; and even with that vacuum it will not hold for any length of time.

74 Q. So far as your knowledge extends, what is the material, if any, now universally used as electrodes, fused or sealed in a glass chamber for electric incandescent lamps?

Objected to as incompetent and immaterial.

A. Platinum and iridium wire. Some use platinum and some use platinum mixed with iridium.

75 Q. Do you understand why platinum is used for this purpose?

Objected to as incompetent and immaterial.

683 A. It is because it does not oxidize and also because its coefficient of expansion and contraction, although not being exactly the same as glass, is the nearest to that of glass of any metal that you can possibly obtain.

76 Q. Have you read the specifications of the patents in suit?

Objected to as incompetent and immaterial.

A. Yes; I have read this several times.

77 Q. Do you find in the patent in suit any direction or description sufficient to have enabled you or any person skilled in the general state of the art, in June, 1880, to have constructed a practical commercial incandescent lamp, having fibrous material as the material for the incandescent carbons?

Objected to as incompetent and immaterial.

A. Unless I experimented I could not make a lamp from these instructions.

78 Q. As matter of fact, when you tried for the Consolidated Company to make a suitable carbon conductor for them out of fibrous material, were you able to make such a conductor without experiments and personal research?

Objected to as incompetent and immaterial.

A. I experimented there to make them, and found that we could not make a lamp that was practical, or of commercial value, unless we used bamboo fibre.

79 Q. In your opinion, and from your experience and knowledge of the general state of the art, was a direction to make an incandescent conductor of carbon fron vegetable fibrous material a sufficient direction, say in the month of January, 1880, to enable one generally skilled in the art to select the material and construct a practical incandescing conductor for an electric lamp?

Objected to as incompetent and immaterial.

684 A. I had no instruction from any one as to what I had to use. I had to use my own previous experience in making lamps for these people.

80 Q. My question is this: Supposing you, or any one equally skilled in the general state of the art of electric lighting in January, 1880, had been told at that time to make an incandescent lamp, having a carbon conductor made from a vegetable fibrous material—would that direction of itself have enabled you to have selected a proper material, and to construct a suitable conductor?

Objected to as incompetent and immaterial.

A. No, sir; not without experiments.

81 Q. Similarly, would a direction to make an incandescent conductor of an arch shape, of carbonized paper, have been sufficient to have enabled you, or others generally skilled in the state of the art, to have selected the proper kind of paper when carbonized, to make the proper conductor for an incandescent lamp?

Objected to as incompetent and immaterial.

A. Not without experiments on different kinds of paper.

82 Q. I ask you the same question with regard to wood carbons. Would that have been a sufficient description or direction?

Objected to as incompetent and immaterial.

A. You would have to experiment on those things to get the right thing.

83 Q. As matter of fact, have you ever been able, or have you ever known of successful incandescing carbon conductors being made out of any of the wood carbons, generally so called—that is to say, carbons of exogenous woods, such as the willow, maple, poplar, oak and similar trees?

Objected to as incompetent and immaterial.

685 A. I have never known of any practical lamp being made of those woods, or of those fibres.

84 Q. How did you come to testify for the Edison Company in this suit?

Objected to as incompetent and immaterial.

A. Through a mutual friend they asked me to testify in this matter, as he knew that I was an expert in the business.

85 Q. When was that?

Objected to as incompetent and immaterial.

A. On Saturday last.

86 Q. When was the first time that you saw any one connected with the Edison Company?

Objected to as incompetent and immaterial.

A. This morning, when I saw yourself.

87 Q. What payments, if any, have been made to you, directly or indirectly, in connection with your giving testimony here?

Objected to as incompetent and immaterial.

A. My expenses have been paid from Philadelphia here, and I understand and expect that my expenses will be paid all the time that I am detained here.

88 Q. Have any promises of any kind been made to you, in any way, by any one connected directly or indirectly with the Edison Company, or any inducement of any sort been made to you?

Objected to as incompetent and immaterial.

A. None whatever.

Counsel for complainant states that it is now three o'clock, and he cannot proceed with the cross-examination until after the 686 short-hand notes (the testimony having been taken in short-hand) are written out; but that he will be ready to proceed with the cross-examination to-morrow morning at ten or half past ten o'clock, as counsel for defendant may elect.

Adjourned to March 12th, 1889, at 10 o'clock a. m.

NEW YORK, *March 12th*, 1889.

Met pursuant to adjournment.

Present: Amos Broadnax, Esq., for complainant; Walter K. Griffin, Esq., for the defendant.

HENRY E. VINEING, further examined by Mr. GRIFFIN, testified as follows:

89 Q. Referring you to your answer to question 27, and to the lamp mentioned by you in that answer, did such lamp have the flanges and nuts as shown in Fig. 5 of the patent in suit?

Objected to as incompetent and immaterial.

A. It had an arrangement to keep the glass globe fastened onto the bottom of the disc. Something similar to what is shown in the patent. Something similar—I cannot say that it was exactly the same; but something similar. It was tantamount to the same thing—for the purpose of holding the glass.

90 Q. What kind of carbon was used in the lamp?

Objected to as incompetent and immaterial.

A. Ordinary electric light carbon, similar to that used in arc lamps, but of smaller diameter than generally used in the present commercial arc lamp.

91 Q. What was the diameter of the carbon pencil?

Objected to as incompetent and immaterial.

687 A. Between one-sixteenth and one-eighth of an inch—nearer one-eighth of an inch.

92 Q. About how long was the pencil?

Objected to as incompetent and immaterial.

A. From an inch down; not longer, I do not think. To the best of my memory it was somewhere about an inch. An inch was the longest carbon.

93 Q. In experimenting with various fibrous substances for the Consolidated Company as to which you have testified, were those substances subjected to any treatment besides the treatment for the deposition of carbon from gas which you have mentioned?

Objected to as incompetent and immaterial.

A. Yes; the fibres before baking had to be treated with a liquid. The French whisk and bass were treated with strong soda water, or caustic potash, for the purpose of getting the outside coat of the fibre.

94 Q. Did you use any other alkali or chemical when preparing the fibres?

Objected to as incompetent and immaterial.

A. I made some few experiments with cotton and parchmentized it with acid.

95 Q. Was this treatment with caustic soda general with all the fibres?

Objected to as incompetent and immaterial.

A. Not general; no. It was a treatment with caustic potash—of bass, French whisk and manilla. I guess those are the only fibres that I treated with that process.

96 Q. Was Albon Man ever present while you were experimenting or working for the Consolidated Company?

Objected to as incompetent and immaterial.

688 A. Yes; he came there two or three times to my memory to see how I was getting on, and what results my experiments were showing up.

Cross-examination by Mr. BROADNAX:

97 X Q. Referring to the carbons made from the material mentioned in answer to question 8, how long were such carbons, and what was the cross-section?

A. Those carbons, in the case of French whisk, as near as I can remember, were from fifteen to eighteen thousandths of an inch in diameter. In the case of broom they were somewhat smaller than that. In the case of the bass they were somewhat smaller, on account of being able to get a larger number of bass fibres in a bunch, smaller than whisk, and the finer the fibre is—generally the fine fibres in a bunch of bass are longer; that is, they are more even, the cross-sections—they are longer and finer. You can get a longer length with an even cross-section, rendering them more desirable for that purpose. In the manilla they were pretty fine; I should say between eight and twelve thousandths of an inch. The length of them varied according to the average grade of the diameter. If I took a batch of fibres of a certain diameter, I would make the length of those (when finished and treated to a certain resistance) to suit the candle power at which I intended to run them. The exact length I cannot tell you. It was between two and three inches.

98 X Q. What was the length of the filament before it was carbonized?

A. In the case of bass it was seventy-five per cent. longer than what it was after it was carbonized. I have told you before, in answer to the original question, that I cannot give you the length; but the shrinkage of the carbon on bass and broom and these fibres averages twenty-five per cent. That is, they were seventy-five per cent. of the length after carbonization that they were before they were carbonized.

99 X Q. What was the length before carbonization?

689 A. As I told you they are between two and three inches.

100 X Q. What kind of lamp did you use these carbons in?

A. Do you mean the shape of the bulb?

101 X Q. No; but in the incandescent lamp—what kind of lamp did you use those carbons in?

A. I used them in the lamps they were making at that time there—with the same shape—a long tubular—a tube about an inch and a quarter in diameter, round at the top, and five inches long. When the lamp was completed the whole thing ranged from four and a half to five inches.

102 X Q. Do you mean that the loop after the carbon was put in the lamp was from two inches to two and a half inches long; or do you mean that the carbon filament, before it was turned or made into loop form, was that length?

A. Certainly; before it was turned. When I speak of the length of a carbon filament I take it from end to end—not from the top of the loop to the bottom and down the leg at one side. The contents of a carbon are found out by multiplying the cross-section by the total length, and not by the height of the carbon; consequently when you say the length of a carbon you take it from end to end.

103 X Q. Was the willow carbon which you made of about the same size and length as you have mentioned?

A. No, sir; I was unable to get any very great length of willow on account of its splitting.

104 X Q. What means did you have for cutting your filament before carbonization?

A. A cutting machine that they used there at the factory for cutting fibres.

105 X Q. What was the length and cross-section of the paper carbons you made?

A. The length of the cross-sections of the bristol-board carbons that I treated were severally twelve, fifteen and twenty-four thousandths of an inch in diameter. There were some other sizes that
I forget exactly the cross-section of. That was the measure-
690 ment one way. The other way was the thickness of the card-
board, which average twelve-thousandths. The length of them from end to end, as near as I can remember—they stood about an inch and a quarter high and two and a quarter inches when mounted.

106 X Q. That would make a loop of about an inch and a half?

A. Yes; the loop would stand up about an inch and a half; some were a little longer, and some a little shorter.

107 X Q. When did you go into the employ of the Lane-Fox people in London?

A. In 1880, to the best of my knowledge. It is so long ago that I am uncertain whether it was 1880 or 1881.

108 X Q. When you say "Lane-Fox," you mean two individuals, do you not?

A. One individual; Lane-Fox was one man.

109 X Q. Who, if any one, did you know that was skilled in the art of making incandescing conductors for electric lamps of fibrous or textile material, in 1878 or 1879?

A. In 1879, I was aware of John Swan, of New Castle, England; George Lane-Fox, a Mr. Parrot of London; and Mr. Grubb, who was, I believe, Mr. Lane-Fox's assistant.

110 X Q. Were the persons you have mentioned skilled in the art of making such carbons?

A. They were skilled in the art as known in those days. How far their skill reached I do not know; but they were experimenting on that matter. What they knew, or how much they knew, I am unable to tell you, at that time. At that time I knew these people, and knew that they were experimenting in this direction. By "skilled in the art" I understand you to mean a man who is in the business of experimenting.

111 X Q. I mean one skilled in making them—one who had learned the art of making them?

691 & 692 A. The art of making perfectly good carbons that were commercially successful, had not arrived, at that period to its solution. Those men that I have mentioned were experimenting all the time.

112 X Q. Who is the mutual friend through whom you was brought to testify in this case?

A. I had some business with a gentleman here in New York on some patents I was getting out; and he was talking several months ago, with Mr. Dyer.

113 X Q. I ask you who he was. I do not care anything beyond that.

The WITNESS: Is it necessary that you should know?

Mr. GRIFFIN: Yes; state who it was.

A. It was Mr. Benjamin, here.

114 X Q. Do you mean Mr. Parke Benjamin?

A. No; I mean Mr. George Benjamin.

115 X Q. The patent solicitor?

A. Yes.

HENRY E. VINEING.

Sworn to before me,
[L. S.]

WILLIAM T. FARNHAM,
Notary Public and Special Examiner.

693 United States Circuit Court, Western District of Pennsylvania.

CONSOLIDATED ELECTRIC LIGHT COMPANY
vs.
THE MCKEESPORT LIGHT COMPANY.

NEW YORK, *March 8th*, 1889.

Testimony taken on behalf of defendant before William T. Farnham, Esq., special examiner, pursuant to notice.

Present: L. E. Curtis, Esq, for complainant; R. N. Dyer, Esq., for defendant.

The witness, Professor CYRUS F. BRACKETT, a witness produced on behalf of defendant, being duly sworn and interrogated by counsel for defendant, deposes and says as follows:

1 Q. What is your name, age, residence and occupation?

A. My name is Cyrus F. Brackett; 55 years old; professor of physics in the college of New Jersey; reside in Princeton.

2 Q. What knowledge have you of the science of electricity, and what experience have you had in the use of electrical instruments and apparatus, more particularly the apparatus used for electric lighting?

A. I have for many years been engaged in conducting investigations in electrical science, in giving instruction to students in all branches of electrical science, and in the course of the discharge of my duties I have had in my charge, and more or less constantly in use, a great variety of electrical apparatus, and am reasonably familiar with the present state of electrical knowledge. I have followed the course of the development of the art of electrical lighting, and believe that I am tolerably familiar with the principles involved and with many of the details of construction of the apparatus actually employed for that purpose. 694

3 Q. Have you read and are you familiar with the patent in suit, namely, letters patent No. 317,676, granted May 14th, 1875, to Electro Dynamic Light Company, as assignees of William Edwin Sawyer and Albon Man, and entitled "improvements in electric lights"?

A. I have read the patent named in the question and believe that I understand it.

4 Q. Please state what is shown in the state of the art by patents and publications, and as matters of general information within your knowledge prior to the year 1878, bearing upon the invention of the patent in suit or material to be considered in connection therewith.

A. Prior to the invention of the voltaic battery by Volta, which was first described in the year 1800, the only artificial appliances which were known for producing the electric light were such as could be utilized in connection with what is commonly known as static electricity or that which is produced by friction, induction, &c. By means of such apparatus it was well known that one could produce momentary electric light by the passage of the so-called electric spark by the deflagration of metals or other conductors through which electric discharges were made to take place. After the invention of Volta, which gave to scientific men a means of producing a steady current or continuous passage of electricity, it became possible to open new lines of inquiry and study. In general these may be grouped under three heads. First, the heat effects of the current which might be carried so far as to produce a vivid light either by the passage of the current from one conductor to another across a space of air, or by rendering metals or other suitable conductors incandescent. 695 Second, the chemical or electrolytic effects of the current, formed a branch of inquiry. Third, after Oersted's discovery in 1819 that the electric current could exert an influence on the magnet, the department of electro-magnetism was created and researches were vigorously prosecuted in it. The particular line of inquiry which has the most immediate bearing on the subject of electric lighting is intimately concerned with the resistance which conductors can offer to the passage of the electric current. Very soon after the publication of Volta's invention, various persons constructed and put in operation voltaic batteries of sufficient size and power to enable them to produce effects quite comparable with those which are now actually exhibited in practice in the art of electric lighting, and accounts of experiments which were conducted by means of such apparatus were published, and now form a part of the recognized body of scientific knowledge appertaining to this art. I may particularly mention some experiments which were published in 1809 which were carried on by means of a large battery in the possession of Mr. John G. Children, an account of which is given in the Philosophical Transactions, volume 9, part first. One of the experiments was conducted with charcoal which was made to burn with an intense brilliancy. In another experiment, not only was charcoal vividly ignited but various kinds of wires were tried in order to ascertain the amount of each which the battery would heat to redness. The apparent object of the experimenter in this experiment was to ascertain the peculiar property or properties which different materials might possess with respect to the conduction of the electrical current. In the year 1815 appears a paper which was read by Mr. Children, June 15th, in which the properties of different metals were made to appear by using them in the form of chains. In these chains apparently the different links were of different metals, and as the same current must evidently traverse them all, those which the current could most easily heat would be raised to a greater or less degree of incandescence, while the 696 others might remain comparatively cool, and thus their relative properties would easily appear. In an apparent attempt to explain the reason for this difference of behavior an experiment was made in which the circuit was completed by means of two pieces of charcoal. The result of this experiment is stated to be that the evolution of heat and light continued so long as the surfaces remained in contact, and the obvious comment is made by Mr. Children that since no contact could be so perfect as to oppose no resistance to electricity, the resistance of the conductor is the occasion of the heat developed. In the same paper an account is given of experiments in which various platinum wires and bars were heated, also Mr. Children states that fine points of boxwood charcoal intensely ignited in chlorine were not altered nor was any alteration produced in the gas. A similar result followed when the ignition took place in nitrogen. Obviously the experimenter's purpose here was to determine whether the emission of light was due to chemical action as in ordinary combustion, and his comment that neither the carbon, nor the chlorine, nor the nitrogen suffered any change was an evident negative answer.

In the year 1820 was published a paper by Mr. Children in which he gives an account of some researches made by means of the arc light produced by means of a voltaic battery as a means of research, and he made the discovery that the chemical union which does not occur between certain mixed gases when kept in the ordinary condition is immediately produced when brought under the influence of the vivid electric light. It appears that in the production of the arc light used in these experiments charcoal points were employed.

Sir Humphrey Davy, in the year 1821, conducted some experiments having for their object to determine the conditions on which the magnetic disturbance due to the electric current which had recently been discovered by Oersted depend. These appear in a paper published in the "Philosophical Transactions," volume 21, 1821. The immediate object seems to have been to determine whether 697 the peculiar character of the conductor itself was the influential element in disturbing the magnet or whether the disturbance depended on the passage of the current through whatever conductor. To this end Davy employed a piece of charcoal which was made to intervene and form a part of the circuit and the compass needle was brought near to it. In the course of another experiment which had for its primary object to determine if the arc itself could affect the magnet, a column of electric light varying in length from one to four inches according to the rarefaction of the atmosphere was produced between points of charcoal. In the same paper also is a record of some experiments to determine the comparative conducting powers of different materials, some of which were fluid, others were solid, including charcoal and various metals. When a piece of well-burnt compact boxwood charcoal was employed having a width of three-tenths of an inch and a thickness of one-tenth of an inch, being suitably connected to large platinum surfaces it was found that one-inch and two-tenths in length carried off the same quantity of electricity as six inches of platinum wire one two hundred and twentieth of an inch in diameter. It appears from this that Davy was early familiar with that property of conductors which we familiarly speak of as their resistance and he saw the relation of this property to the production of heat when a given current is made to pass through conductors made of different materials, including charcoal which he observed had a high resistance compared with metals. In the collected works of Sir Humphrey Davy, published in 1839-'40, volume 2, he described experiments conducted with a battery of one hundred and fifty series of plates of copper and zinc. He tried the sparking effects of the battery with metals and also with well-burnt charcoal. In the latter case the spark was larger and of a vivid whiteness and evident combustion was produced. Platinum in thin strips was introduced into the circuit and it was fused at the edges.

In volume 4 of the above-mentioned works is described an
698 experiment in which the circuit consisted of several materials. Two platinum wires from the extremity of the battery composed of plates a foot square were plunged into water and it was found that the quantity of gas disengaged from the wires was nearly the same as from an equal number of plates of an inch square. When the fingers of each hand were moistened with water and applied to the extremities of the battery a shock was felt about the same or nearly the same as if there had been no connection between the wires and the water. And while the circuit existed through the body and through the water a wire was attached to a thin slip of charcoal and made to connect the two poles of the battery with the result that the charcoal was vividly ignited. We clearly have in this experiment an incandescent light produced by the passage of a current through a thin pencil of charcoal. Davy also conducted experiments with a large battery made by Mr. Children, in the course of which he fused various metals by means of the current and when he employed points of charcoal an exceedingly vivid light was produced. He also conducted experiments with the great battery at the Royal Institution, having two thousand double plates, and very remarkable results were produced. When charcoal was employed for producing the arc, the pencils, which were one-sixth of an inch in diameter, became intensely ignited and on being withdrawn an arc was produced having a length of four inches. Davy defines exactly what he means by carbon. It signifies "the pure inflammable part of charcoal, lamp-black and other similar substances." "For the common purposes of experiment" he remarks that "the charcoal of light wood such as alder, that has been exposed to boiling water and afterwards ignited to whiteness is sufficiently pure." He evidently means by "ignited to whiteness" that the prepared wood is to be raised to a high temperature by a furnace or its equivalent in the process of carbonization, and not by the passage of a current. He further remarks that such charcoal must be employed immediately after ignition and while yet warm as it rapidly attracts
much moisture to itself from the atmosphere. Speak-
699 ing of the properties of carbon, he remarks that whether
it be coherent in charcoal or in the form of powder, it is infusible by any heat which has hitherto been applied. He states that he had exposed it to the intense ignition of various voltaic batteries and he found that whether *in vacuo* or in compressed gases on which it had no power of chemical action it remained infusible. Speaking further of the varieties of carbon he remarks that plumbago and anthracite are tolerably pure forms of this element, there being in plumbago about one twenty-fifth part iron

and in anthracite small quantities of earthy matter. He particularly mentions the anthracite of Kilkenny, in Ireland, of which "the texture is often fibrous," and states that "the substance has all the characters of well-burned charcoal." In volume 5 Collected Works, Davy records experiments with small pieces of charcoal from willow which had been intensely ignited and acted on by voltaic electricity in a Tor-cellian vacuum. The results secured were different from those when plumbago was employed. In this latter case after the first spark which would generally pass through about one-eighth of an inch there was no continuation of the light. But when the charcoal was employed a flame seemed to issue of a most brilliant purple and formed a conducting chain nearly an inch in length. Some permanent gas was given out during the experiment which he finally succeeded in collecting and investigating. In the same volume Davy records an experiment in which he employed charcoal which had been prepared with great care and through which he sent a current in which platinum instantly fused. The charcoal, while traversed by the current, was immersed in an atmosphere of nitrogen which Davy suspected might be a compound, and he evidently hoped by this experiment that he would be able to decompose the nitrogen at the high temperature produced. He records similar experiments with reference to other well-known compound bodies in which charcoal was ignited to whiteness by the electric current, saying that his view in making the experiment 700 with reference to oxymuriatic acid was to ascertain whether some new combination of carbonaceous matter with oxygen might not be formed. In the conduct of these experiments Davy took special pains to free the carbon employed from occluded gases and moisture by intense ignition in vacuum.

In Philosophical Transactions, 1839, volume 39, part I, is a letter addressed to Faraday by Daniell, in the course of which he recites various experiments and says that he combined a series of a battery of 70 cells for the purpose of observing chiefly the effects of light and heat produced by the current in a state of high intensity of constant action. With reference to one experiment he says: "The flame between charcoal points was of considerable volume, and formed a continuous arch when the points were separated to about three-quarters of an inch. This distance did not appear to be increased in the space exhausted by an air pump." He states that the light and radiant heat were very intense, and cites the effect upon the eyes, skin, &c., comparing them to the midsummer sun. Various metals in the form of wires were rendered incandescent by means of this battery.

In volume 32, "Philosophical Transactions," 1832, Ritchie says, in the course of some experiments on the magnetic phenomena produced by the current, that a piece of charcoal about one and a half inches long was placed between slips of copper fixed perpendicularly in order to ascertain the effect of an astatic needle suspended near the middle of the charcoal. Various experiments on the magnetic effects of the current are described in which charcoal is used as a conductor.

It appears from the state of the art, as already cited, that the various experimentors named, some of them having one purpose in view and others others, were endeavoring to ascertain to what the peculiar effects accompanying the passage of the current through various materials might be attributed, and also the effects of the currents upon the materials themselves or upon compounds which they might be capable of forming. It further appears that in the course of these experiments, compact, well-burned charcoal was fre-
701 quently employed both for producing an intense heat and light when points of such charcoal were separated from each other so as to form an arc, the electric arc, between them, and also when employed as a part of the continuous conductor for conveying the current, in which case it frequently became highly incandescent as it does in the modern practice of incandescent lighting. A definition of what is meant by charcoal is also clearly given, and some of the modes of its preparation in order to secure the best results with its use in connection with the electric current are pointed out; also the best sources from which it may be obtained, and boxwood, alder and willow are mentioned as suitable woods for the purpose. It is apparent that the charcoal employed and designated by the term was usually prepared by the incandescence of wood; in accordance with usage with reference to the word "charcoal," it means wood carbon, unless some qualifying adjective stands in connection therewith. It is quite apparent, for instance, that animal charcoal, or "bone-black," as it is usually called, is not included, as this latter substance contains, besides the pure, combustible carbon, other substances which would render it unfit for the purposes to which it was applied.

In the "American Journal of Science and Arts," volume 16, 1853, an account is given of a special method of carbonizing wood in which superheated steam is employed. Mr. Violette, a member of the commission on powder and saltpetre, gave his attention to the manufacture of charcoal by the method mentioned. The wood is immersed in vapor, and it is readily carbonized since in this manner it is easy to regulate the temperature of the vapor, and the charcoal obtained has a constant and uniform character. M. Violette made his communication to the academy, and in the course of it he showed that the change to charcoal takes place differently with different woods, and that the products of the same temperature differ in elementary constitution. "Charcoal made at 1500° centigrade conducts electricity better than the charcoal of gas retorts and serves perfectly for electric illumination." The
702 temperature which he names is fairly comparable with that which is used in the carbonization of material for the production of conductors for incandescent lamps. He observes that the higher the temperature at which the carbonization is effected, the more compact is the resulting material, and the better suited for electrical conductors. The major part of the communication is with reference to the operations in the manufacture of gunpowder.

In "Watts' Dictionary of Chemistry," volume 1, 1863, is an account of the preparation of charcoal from wood. It is particularly mentioned that wood charcoal is more or less compact according to the amount of wood from which it is formed, the light woods, such as willow, yielding a very porous charcoal having comparatively little power of conducting heat and electricity. Boxwood, on the contrary, yields a very much more compact charcoal which is a good conductor of heat and electricity and is admirably adapted for exhibiting a voltaic light. "The conducting power of charcoal is greatly increased by exposing it in close vessels to a very high temperature. Charcoal retains the form and to a considerable extent the extraordinary structure of the wood, so that a horizontal section exhibits distinctly the concentric rings and the traces of the medullary rays."

In "Comptes Rendus," volume 70, 1870, is an account of the preparation of charcoal when it is formed with the exclusion of air by the use of vapors or gases not containing oxygen and heated to a very high temperature. M. Sidot, who conducted his process according to this plan for this purpose inclosed wood in a porcelain tube in which, by the introduction of such vapors a suitable atmosphere could be formed. On gradually raising the temperature and carrying it to a very high degree and allowing the product to cool, charcoal having peculiar physical properties was produced. He observes that such charcoal is more solid, compact, and retains the form of the material from which it is made, and he states that he finds that the conducting power of such charcoal is very great and
703 that it might with advantage replace hard carbon from the gas retorts to be used in the voltaic battery. It does not perceptibly absorb moisture or gases. The pencils made from this carbon give an electric light far more intense than the light obtained with carbon from gas retorts. This carbon conductor heats up like metal and becomes progressively incandescent in the whole mass without igniting at one point like ordinary carbons. It may be characterized from a point of view of conductivity as wood charcoal transferred into coke. Wishing to obtain a sonorous instrument with this carbon Sidot states that he turned "a bell of ash and submitted it to the action of the carbon sulphide after the process just described, and that this piece of ash became a bell which gives a sound comparable to that of a metal bell of the same diameter." He speaks of carbonizing the most diverse wood, ash, box, hornbeam, lilac, elder and cork, and also says that he has obtained similar results from flax, hemp, cotton, paper and silk. It is to be observed that in the account of his experiments Sidot recognized more fully the hard and compact qualities of charcoal prepared according to his process than others had done before him who had employed a somewhat less efficient method of procedure, such as burying the material in powdered charcoal or in sand so as to thereby exclude the air during the process of ignition. It is to be further noticed that he clearly recognizes that the shape and structure of the carbonized material persists in the finished product so that it was possible to give any desired form to the material to be operated on before the carbonization and thus secure the resulting charcoal in the form in which it was to be employed for any special purpose.

In "Watts' Dictionary of Chemistry," London, 1875, second supplement, it is stated that several years ago Despretz found that all kinds of carbon heated in an electric arc of a battery 500 or 600 Bunsen cells soften and are ultimately converted into graphite. It is further stated that "when wood (of box, ash, hornbeam, alder, lilac or cork) or flax, hemp, cotton, paper or silk 704 is placed in a porcelain tube vapor of carbon sulphide passed over it at or during temperatures till all the air is driven out and then the tube slowly and gradually heated to redness for about an hour, the organic substance is found after cooling to be converted into a kind of coke having the ring of steel, silver, &c., and a great power of conducting heat and electricity. When heated it gradually becomes incandescent through its whole mass without taking fire at any particular part and cools down as soon as the source of heat is removed. It might, perhaps, be used to form the carbon cylinders of Bunsen's battery. It exhibits metallic lustre on its surface, is denser than wood charcoal, and does not sensibly absorb gases. A kind of carbon which is a good conductor of heat and electricity and does not absorb gases is likewise obtained by strongly heating wood in a crucible filled with charcoal powder."

It may obviously be remarked with reference to the charcoal prepared by the method just cited that it is no doubt of the same character as that employed by the early experimenters with the electric current, who prepared in general the charcoal which they used, by the ordinary well-known processes of calcination in close vessels, and who employed them for other purposes than were designed in the later preparation. The object of Davy and the early experimenters was primarily to observe the behavior of the electric current when passed through such conductors. The object of the later experimenters was more particularly to observe the characteristics of the carbon itself, and hence the accounts given more fully specify the character and properties of the charcoal so produced than do the accounts given by Davy and others of an earlier date.

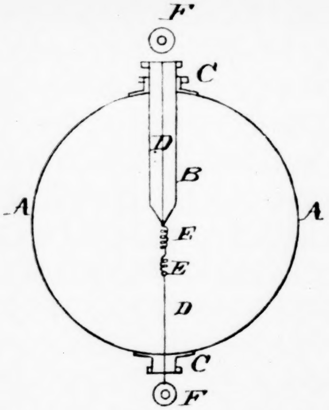
In English patent No. 8644, 1840, to Pinkus, it is stated "that its purpose is to illuminate reflectors or produce lights for lighting said railways or tunnels, or roads, or ways, or streets, or buildings, or mines," by means of electric force produced by motive power. Metallic circuits are employed, which lead from place to place. An electric light apparatus is suitably located. Electric light is 705 to be produced "by well-known methods or any combination of them, what is termed an electric glow or brush, * * * or which glows being produced by electric effects and known methods hermetically sealed in glass globes, in which may be placed air or gas or other substances, which may be rarified or compressed, or in which gases may be generated to increase the illuminating power of said glow or brush, or sparks or heated surfaces." We here have obviously what may be termed an electric lamp in which the light-producing substance to be acted on electrically is enclosed in a hermetically sealed glass globe.

English patent 9053, 1841, to De Moleyns. In this patent are set forth certain "improvements in the production or development of

electricity and the application of electricity for the obtainment of illumination and motion." The second part of the invention in the said patent "relates to the attainment of continued light by the adoption of a mode or arrangement which enables that light to be maintained and regulated and applied to any purpose for which light may be required." After stating that "the usual mode of exhibiting this electrical effect was by arming the electrodes of a powerful voltaic battery with charcoal points or one charcoal point and a fine platinum wire, which points were brought into contact either in the atmosphere or in an air-pump vacuum, and then removed slightly apart," it proceeds to describe the construction which is the feature of this part of the invention. It says: "A glass globe similar to that in present use for showing the electric light *in vacuo* is similarly furnished, with two brass caps in opposite parts of the sphere through which communication may be had with the interior, and by one of which the globe may be exhausted at pleasure." The lamp is provided with an incandescent coil of platinum, and a glass or other tube placed in on one side of the globe and approaching the platinum coil, "is now to be filled with finely pulverized boxwood charcoal or plumbago, and on connection being established between the electrodes of the battery one of the fine platinum coils become white hot
706 & 707 the charcoal which falls through and around both coils
is ignited, and a light pure and intense is thus obtained, which is kept up by the continual changing points of contact of the coils with the charcoal powder, as by its gravity it descends slowly through the tube and falls to the bottom of the sphere, thence to be withdrawn for future use." In this patent we have set forth clearly a glass globe, which can be exhausted at pleasure, through which conductors are introduced which can be brought to a state of incandescence by the passage of an electric current and carbon in the form of boxwood charcoal or plumbago is used in connection with the ignition for the purpose of increasing the light, the carbon being in the form of powder, which is constantly supplied so that as the several particles perform their function, their place is taken immediately by others, the carbon not being consumed, but in performing its function being in a state fit for repeated use for the same purpose.

The figure illustrative of the lamp in the patents is as follows:

E. P. No. 9053 of 1841 of De Moleyn's.



708 The patent states with regard to this drawing that "A A represents the glass globe; B the glass or metal tube with conical end holding pulverized charcoal; C C brass caps through which the electrodes and glass tube pass through air-tight collars; D D copper electrodes to which the terminal platinum coils are attached; E E the thin plantinum wires coiled; F F binding screws to connect electrodes with battery."

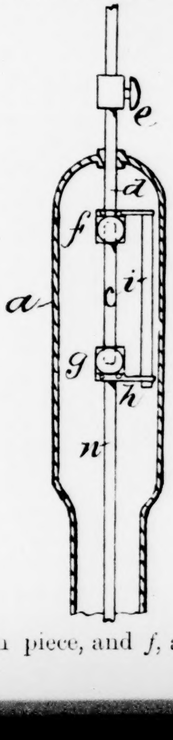
English patent No. 10919, 1845, to King, relates to electric lights, and first describes the conditions to be observed in the construction of an incandescent electric lamp with a conductor of platinum. In figure 2 of the patent a lamp is shown intended to employ carbon as the incandescent conductor. A Torricellian vacuum is produced within which the incandescent carbon is to be placed and the electric current is transmitted through it by means of a platinum wire which is sealed into the top of the glass bulb while a copper wire hangs from the lower end of the carbon into the mercury, while the clamps or forceps shown in the accompanying figure which hold the carbon are connected together by a porcelain rod. That form of carbon which is employed is that which is formed on the interior of coal-gas retorts, which has long been used and is well suited to this purpose, and can be worked into the form of either small pencils or thin plates by the aid of the saw and file. The patent remarks that as carbon " will bear a very high temperature without fusion or volatilization, it may be employed when a very intense light is required."

When platinum is used the lamp is not exhausted but the patent says, " when carbon is used it becomes necessary on account of the affinity of its substance for oxygen at high temperature, to exclude it from air and moisture. To accomplish this in the most perfect manner it should be enclosed in a Torricellian vacuum." And it subsequently shows that " when the apparatus is suitably sealed it

may be applied to submarine lighting and also to the illumination
of places where it is necessary to guard against the inflamma-
709 tion of highly combustible or explosive compounds as in
powder magazines, mines, &c."

References to this patent of King and to the experiments of Starr, the inventor, may be found in the literature on the subject. Thus the "Mechanics' Magazine," London, 1846, volume 44, contains a full copy of the specification of the Scotch patent of this invention, and a note by the editor subjoining paragraphs from his commonplace book "which may suffice to show not only the want of novelty in Mr. King's imported invention, but the point at which the labors of men of science in this department have arrived." These paragraphs describe a light for mines by M. de la Rive under the date of November 8, 1845, which appears to be an arc light employing cylinders of coke enclosed in a glass globe hermetically sealed, and the experiments of Professor Groves under date of December 7th, 1845, on incandescent platina in a closed vessel and also on carbon points. This article was replied to by a letter under date of May 21, 1846, signed William Williams, claiming that Starr, the inventor, was the first to produce an incandescent lamp. The following is a copy on a reduced scale, of figure 2 of King's patent showing the Torricellian vacuum lamp, described in the patent as employing an incandescent conductor of carbon:

710 *E. P. No. 10919 of 1845 of King's.*

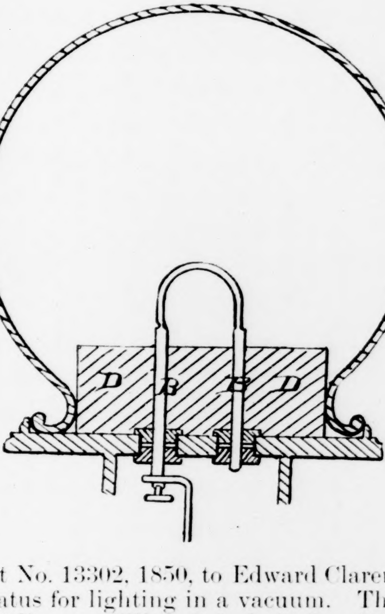


c represents the carbon piece, and *f*, and *g*, the forceps which hold it.

English patent 11076, 1846, Greener and Staite, is for "certain improvements in ignition and illumination." The invention is first stated to consist generally in the illumination of buildings, etc., "by means of solid prisms or cylinders of carbon enclosed in air-tight vessels of glass or some other transparent substance and ignited or rendered luminous by currents of voltaic or magnetic electricity." Continuing, it says: "Both carbon and platinum have been before employed as media for the development and exhibition of electric light, but carbon, even in the purest states in which it
711 has hitherto been available, when ignited or rendered luminous in an air-tight glass vessel by means of electric currents has been found to give out various extraneous matters which interfere with the continuity of the light, or which being precipitated on the inside of the glass vessel obscure and darken the same. * * * Now to obtain for the purpose of our invention a carbon absolutely pure, or at least more nearly approaching absolute purity than any heretofore known, we proceed as follows: We take a quantity of what is known in commerce under the denomination of lamp-black, or of charcoal reduced to a state of powder, or of coke also reduced to powder, which has been purified by the application of electricity from sulphur or other metallic mixtures, * * * and digest the same in dilute nitro-muriatic or other acid; we then strain the lamp-black, or charcoal, or coke from the acid and wash it several times with water, and we next wash it in some weak alkaline solution or carbonated alkaline solution and finally we wash it with distilled water until no traces of impurity are perceptible." Thus purified, the carbon is dried and then converted into solid prisms or cylinders, both solid and hollow, by means of a hydraulic or screw or fly press. "And sometimes the better to insure perfect dryness and homogen-ousness we expose the prisms or cylinders to intense heat in a furnace for about twenty-four hours." The prisms or cylinders are provided with acuminated surfaces, or they may have plain surfaces. When a hollow cylinder of this compressed carbon is used it may be placed in circuit by means of two hollow cones of platinum between which the carbon cylinder is placed and which are connected with the circuit wire." "We think it unnecessary to describe either how the air-tight vessel which is to enclose the illuminated body should be mounted or how the electric currents are to be conveyed to and from the voltaic battery or the magnetic machine employed, because there are many well-known modes of doing so, and we do not claim to have invented anything in that respect. We desire it farther to be understood that we
712 lay no claim to the employment of carbon, platinum or other and like difficult*ly* fusible metal enclosed within air-tight vessels as a medium for the development and exhibition of electric light, the suitableness of both bodies for that purpose when so enclosed (subject to the difficulties aforesaid) being long well known." This patent evidently describes an incandescent electric lamp having for a conductor a compressed body of powdered carbon, which the patent says may be charcoal, and which is enclosed in a suitable air-tight vessel.

English patent No. 12212, 1848. This is Staite's patent, covering the incandescent lamp with iridium arch-shaped form of conductor. The conductor is an arch-shaped piece of irridium secured to platinum wires. The lamp is shown as mounted on a bracket, one part of the circuit going through the bracket and the other through a wire passed through an arm of the same. A circular controller or key is provided for making and breaking the circuit, and in one form the metal holders or leading conductors are passed through a block of glass or other similar bad conductor of heat, "so that the heat and radiant light may be developed with as little loss of the former as possible by radiation." This block of glass seems to fill the neck of the globe and makes the entire interior of the lamp chamber of glass. The following is a copy of figure 25 of the patent on a reduced scale, D D being a block of glass, B B the platinum conductors leading to the arch of iridium which forms the incandescent conductor of the lamp:

713 *E. P. No. 12212 of 1848, of Staite's.*

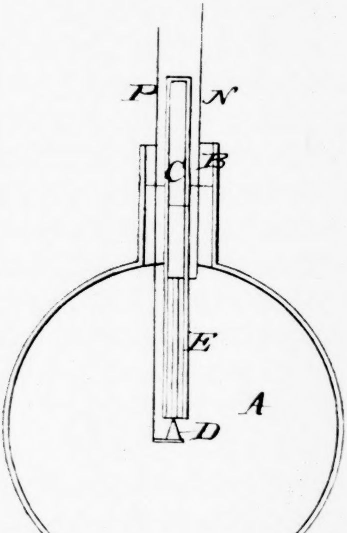


English patent No. 13302, 1850, to Edward Clarence Shepard, describes an apparatus for lighting in a vacuum. The description is substantially as follows: "When it is desired to light by means of the incandescence of charcoal, I employ an arrangement of apparatus similar to that represented in figure 10. A is a glass globe which may, if desired, be ground or obscured on the inside in order to disperse and soften the intensity of the light. The stopper B of this globe is very carefully luted, and two insulated polar wires, P and N, of about two millimeters in diameter are passed through it.

One of these wires is soldered to the side and towards the upper end of a copper tube, C, of about one decimeter (four inches) in leng th. This tube is intended to hold a little cylinder of charcoal which 714 is kept constantly pushed down from above by a small cylinder of lead, which is of a weight adjusted to the purpose. The other polar wire comes out under the lower end of this tube at about one centimeter (three-eighths of an inch) distance from its extremity and terminates in a little cone, D, of prepared charcoal or coke, and against the top of which the little charcoal cylinder E rests, which, when the current is established, becomes incandescent and remains in that state a very long time, because the small portions which are consumed are continually replaced by a portion of the cylinder which the metal presser forces onto the top of the cone. A tube of glass or other suitable substance also passes through the stopper and admits of its being connected to the pneumatic receiver in order to create a vacuum in the globe. The tube is afterwards cut and hermetically sealed in order to prevent the re-entry of air."

The following is a reduced copy of figure 10 of the patent, which shows the apparatus for lighting in a vacuum described in the patent by means of the incandescence of prepared charcoal:

715 *E. P. No. 13302 of 1850 of Shepard's.*



Adjourned to 6.45 p. m.

New York, *March 8th*, 1889—6.45 p. m.

Present: Mr. Dyer, Mr. Griffin, Mr. Kerr.

Direct examination of Prof. Brackett resumed:

In this patent of Shepard we clearly have described a lamp for incandescent lighting by means of electricity, which consists of a globe in which a vacuum can be produced and with provision for detaching from the pneumatic apparatus and hermetically sealing. 716 In the interior of this globe is found a cylinder and a cone of prepared charcoal, together with a device by which they are kept continuously in contact so that at the point of contact which offers a greater resistance incandescence is maintained while there is but little wasting of the materials employed.

English patent No. 212 of 1852 to Slater & Watson, entitled Improvements in the application of electricity to illuminating purposes.

This patent describes the making of electrodes for the arc electric light by mixing beechwood charcoal with other materials and carbonizing a mass of the same in a mould, the electrodes being afterwards cut from the mass of carbon. The patent then proceeds to describe the method of making these arc-light electrodes as follows:

"We have found that good electrodes giving a steady achromatic light may be prepared by the following process, from well-burnt beech charcoal, selected from the small wood, or, as they are technically termed, 'loppings;' boxwood will do as well. A piece of the charcoal sawn into required size for the electrodes is steeped in a solution of caustic lime for about a quarter of an hour; it is then taken out, dried and placed into a crucible containing powdered charcoal, and a lid being firmly and closely luted onto the crucible, it is exposed to a white heat for about half an hour; it is then taken out after the crucible is cooled, placed into a saturated solution of alum, and after having soaked for about half an hour it is dried, and again brought to a white heat as before. It is again removed and plunged whilst hot into treacle or any thick saccharine or carbonaceous fluid and finally once more ignited. If the operations have been properly conducted it is now very hard, quite free from any traces of lign*i*ous structure, a perfect conductor and burns moderately slowly, equally and noiselessly when forming the terminal of the voltaic arc."

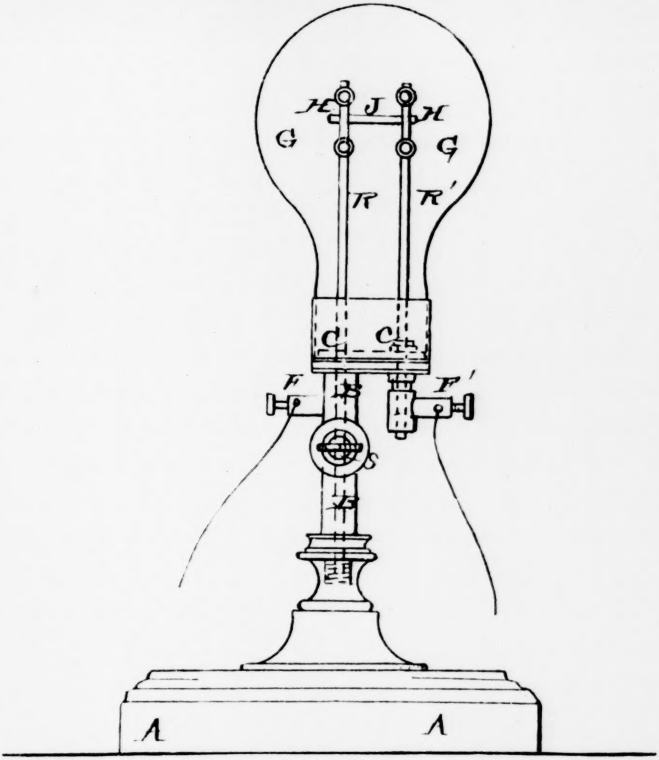
717 English patent, No. 14198, 1852, to Martin John Roberts, after setting forth various other matters, the patentee remarks, "Another part of my invention consists of a mode of obtaining electric light by passing a current of electricity through a thin piece of graphite, coke or charcoal or other infusible body being a conductor of electricity, while it is enclosed in a vacuum or space not containing any oxygen or other matter which might cause the combustion or destruction of it when brought into an incandescent state by the action of a current of electricity." This part of the invention is shown in figure 5 of the drawing of the patent, respecting

which the patentee remarks, "I have shown an elevation or side view of an apparatus which may be used for this purpose, but I desire it to be understood that I do not claim any of the elements or parts of which this apparatus is composed apart from the combination thereof. In this figure A is a stand upon which the hollow pillar or tube B can be screwed; this tube is furnished with a stop-cock S by which its passage can be closed air-tight. On top of the pillar is a screw C about one and a half inches in diameter, which receives the neck of the globe G also furnished with a cap and screw to allow it to be screwed air-tight down upon the tube B. The tube B has a binding screw F soldered to it for the purpose of making connection with a galvanic battery and the tube is also in metallic connection with the rod R, having at the end of it a clip H for the purpose of holding the piece of graphite or other substance through which I wish to pass the electricity. Another rod R′ also furnished with a similar clip H′ passes through the head of the pillar or tube B, but is preserved from coming into metallic contact with it by having the rod enveloped with ivory at D or other non-conductor of electricity. At the bottom of the rod R′ is another binding screw F′ for the purpose of connecting it with the other pole of the battery. Now, the mode of operation with this apparatus is as follows: A piece of very thin graphite about one-half an inch long, one-half an inch wide and as thin as conveniently can be made is fastened at each end into the clips H and H′ and firmly secured. The globe G is screwed air-tight upon the pillar D, the stop-cock S is opened, 718 and the whole apparatus by a screw at the bottom B screwed down upon an air pump or air-exhausting syringe; by this the air is drawn out of G and as perfect a vacuum as can conveniently be made, obtained. When this is done the stop-cock is shut and the apparatus is then removed from the pump to its stand A and a galvanic battery is put in connection with it by the binding screws F F′, the electricity passes through the rods, and a thin piece of graphite J, which becomes white hot from the passage of the electric current, and no combustion will ensue if the vacuum be perfect and no matter within the globe to cause combustion of the graphite; or if the graphite be not otherwise destroyed the light continues as long as the electricity flows through the graphite with sufficient strength.

And in respect to this part of my invention I claim the production of light by passing electricity through a thin infusible body being a conductor of electricity in the manner hereinbefore described.

The following is a copy of figure 5 of the patent which is referred to in the following description:

719 *E. P. No. 14198 of 1852 of Roberts.*



In this apparatus for producing the electric light by means of
incandescence we have a globe of glass furnished with suitable fittings
for connection with a means of exhausting, and also fittings
suitable to connect it with the wires leading from the voltaic battery.
In conducting connection with the latter fittings are provided
within the globe means of conveying the current to be employed
through a thin slip of graphite or other substance through
which it is desired to pass the electrical current. And the
720 patentee especially mentions coke, charcoal or other infusible
body being a conductor of electricity. The patentee has thus
secured, so far as the state of the art rendered it convenient to do so,
the advantage to be obtained by highly heating carbon, which is
infusible, without contact with it of oxygen, which would tend to
destroy it by combustion.

In Bink's English patent, No. 119, 1853, the patentee remarks that his "invention relates to the forms, arrangements and modes

of working the electrodes and to the materials of which to construct the electrodes for producing light by electricity." In alluding to the state of the art he remarks, "In the ordinary arrangements of the carbon electrodes for producing light by a current of voltaic electricity two rods or pencils of solid charcoal are used." He describes as one feature of his invention the use of a number of rods of charcoal so as to produce several arcs in the same lamp at the same time. Respecting another point of the invention he says, "The second part of my invention consists in using for the carbon electrodes the charcoal obtained by subjecting lignite to destructive distillation in closed vessels, that is, I fully carbonize lignite and employ the hard, close-grained charcoal thus obtained as the light-giving electrodes for which it is admirably adapted and has not hitherto been used." With respect to another feature of the invention he says: "I affix thin slips or cuttings of charcoal or charcoal veneer by some adhesive material to the surface of slips, bars, plates or other forms of metal to act as the conductor and to obtain improved forms and kinds of electrodes for the production of electric lights." It appears that the patentee proposes to use carbon in the form of rods for the purpose of maintaining the electric lights in the arc form as well as the use of carbon in the form of thin plates or veneers for incandescent lighting. It will also be remarked that the particular form of carbon that he proposes to use is charcoal, and he mentions as a special substance from which it may be prepared, lignite. Lignite is partially reduced wood or other
721 vegetable matter in its progress from its condition in the organic state toward coal. And what he proposes to accomplish is simply the completion of the process which is frequently effected naturally and thus to procure a form of vegetable fibrous carbon which is comparable with that already alluded to in this statement of the art as used by Sir Humphrey Davy.

English patent No. 2547, 1856, to Way, sets forth improvements in obtaining light by electricity. He clearly recognizes that "heretofore in obtaining light by means of electricity electrodes of charcoal have usually been employed."

English patent No. 588, 1857, to Charles Weightman Harrison for the invention of improvements for obtaining light by electricity. It describes the construction of carbon pencils from wood charcoal. It says: "I form pencils or solid-carbon electrodes by suspending small rods or pencils of wood charcoal upon a frame of iron which I place within a heated gas chamber or retort, where it will be subjected to a high degree of heat. By this process the charcoal is rendered hard and lasting."

English patent No. 2841 of 1857 to Way, for obtaining light by electricity, describes an electric lamp in which two rods or pencils of charcoal are pressed together by springs. An electric current passes through the charcoal pencils, producing incandescence at their ends where the greatest resistance is offered to the current. A jet of mercury is caused to fall upon the incandescent portion of the charcoal pencils.

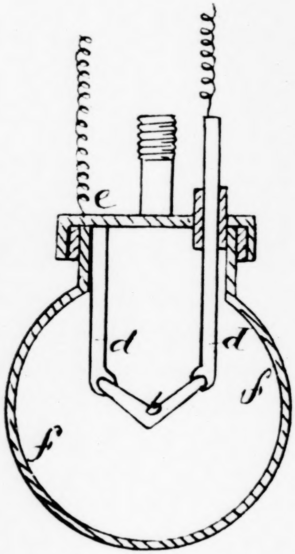
English patent No. 3164 of 1857 to Burleigh and Danchell, describes the manufacture of various articles of carbon, among them being "electrodes for electro or galvanic purposes" and "charcoal pencils." The patent describes the taking of various carbonaceous matter, including "vegetable charcoal," either by itself or mixed with and rendered plastic by a suitable carbonizable cementing medium. The material is given the form of the completed articles by moulds, "after which the objects are baked or burned in closed vessels."

722 English patent No. 3809, 1872, to Konn, described an arch or V-shaped conductor enclosed in a glass globe filled with nitrogen. In the specification the author remarks: "One or more conductors which are preferably graphite, are enclosed in a species of lantern, hermetically closed and filled with nitrogen or other gas that does not support combustion, and are maintained therein by any convenient method of support. To produce the electric current an ordinary magneto-electric machine, such as those of Wild, Noble and others is employed, and the current is led into the lantern by means of a wire to one of the graphite conductors (when the lantern contains more than one), and in passing through the conductor the electricity heats it to redness and causes it to give out a brilliant light. The current is then led to the second graphite conductor, and passing through that, producing a similar effect, is led to a third, and so on till all the conductors in a particular lamp have been illuminated, when the current is led to those in the next lamp and so on to the end of the series." In the drawings accompanying said specification are shown the modes of construction in some of which the carbon to be rendered incandescent is in the form of straight bars or rods suitably confined in conducting supports which are connected with the means of producing the electric current, the whole being enclosed. One form is shown and described in which is used a "carbon stem which is V-shaped, the electric current passing down one side and up the other side of the V, the light being formed at the angle at the bottom. This stem is suitably supported and enclosed in a glass lamp or case filled with nitrogen or gas incapable of supporting combustion as before, and the current of electricity is applied as in the first instance, or in any convenient manner." The patentee also remarks, with reference to the conductor to be rendered incandescent, "the stem is composed of graphite or a composition of the usual description, compressed or formed with a reduced diameter at or near its central part, as at B, the ends C, C, being of larger diameter and clipped or held in socket frames, D, D, which pass through the lantern
723 ends, E, E, and are connected to the circuit wires from the magnets or from the battery. Any number of the carbon stems can be employed in the same manner, and the current of electricity made to pass from one stem to the other until the whole or any two or more are charged for lighting as desired. The lanterns are composed of the two ends, E, E, the lips of which receive the glass, F, of the required shape, and in such a manner that the whole can be hermetically closed for preventing electrical contact with the atmosphere which is essential for the purpose of practically

carrying the invention into effect, and in order to fulfill its object more completely the lanterns are charged with nitrogen or other gas, which does not support combustion." Reference to this specification and the accompanying drawings, makes it clear that in Konn's improvements he contemplates the use of carbon in the form of rods, also in an arch or V-shaped form, enclosed in suitable glass vessels which are to be filled with gas incapable of consuming the conductors when raised to a high temperature. He lays special stress on the fact that in order to carry out his invention successfully it is necessary that these chambers be hermetically closed so as to avoid contact of the highly heated materials with the air. He obviously recognizes the power of carbon when raised to a very high temperature as would be necessary in incandescent lighting to combine with oxygen if it were permitted to do so, and has taken care to provide means to avoid this effect and so to secure permanence in the operation of his apparatus.

The following is a copy of figure 8 of the Konn patent, showing the lamp having the V-shaped carbon stem:

724 *E. P. No. 3809 of 1872 of Konn's.*



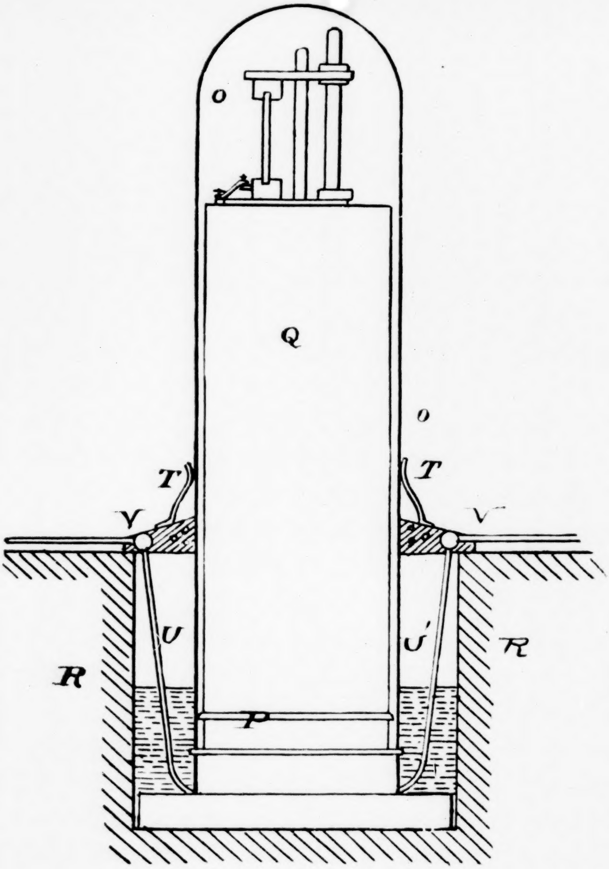
English patent No. 91, 1873, to Konn, describes an apparatus similar to that in Konn's patent already referred to except that the apparatus is used for heating and the globe instead of being of glass is of metal. In other respects the apparatus is similar to that just referred to. In this patent of 1873, it is stated with regard to the V-shaped carbon burners: "It is evident that stems of other shapes

may be used." It may be remarked with reference to this patent that while its general similarity of form and construction is apparent, the material used for the incandescent part of the apparatus which is to be hermetically sealed within closed vessels charged with azote (nitrogen) or other gas, is described as being solid rods of carbon, the patentee evidently not restricting himself as to the particular variety of carbon used. The V shape of the
725 stem, as he calls the incandescent portion, is clearly shown
in the accompanying drawings and referred to in the specification.

English patent No. 441, 1875, to Kosloff, entitled "Improvements in the production of electric light and in apparatus therefor" corresponds with United States patent 166,877, August 17th, 1875. It describes a very complete lamp construction having a globe sealed in liquid at the bottom and containing carbons in its upper end, the whole of the lower portion of the globe being filled with a block of porcelain or glass, which prevents the conduction of heat to the sealing and through which the conductors leading to the carbons run. The construction of this lamp is quite similar to Sawyer and Man's in respect to locating the carbons at the upper end of the globe and the cutting off the conduction of heat to the sealing. The globe is also closed by glass instead of by a metal plate.

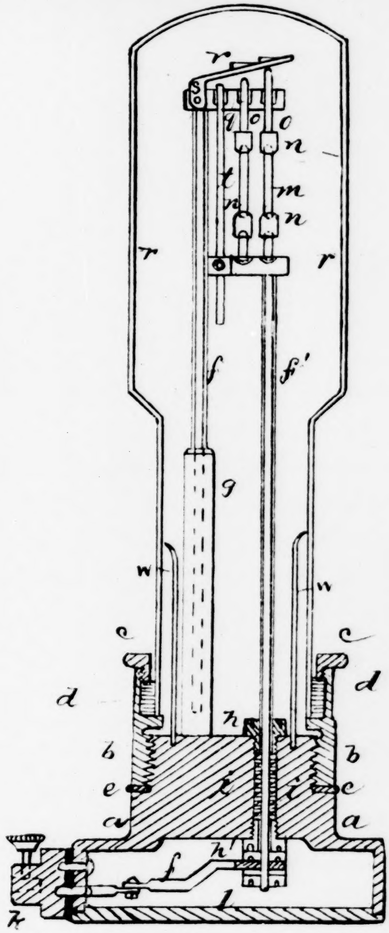
The following is a reduced copy of figure 4 of the drawing of the patent referred to which shows the general arrangement of the lamp structure:

726 *E. P. No. 441 of 1875 of Kosloff's.*



English patent No. 970, 1875, also to Konn, shows a later construction than that of Konn's patent 3809, of 1872, with very complete arrangements for sealing the lamp. A number of carbons are located in the upper part of the globe with a shutter
727 circuit closer for closing the circuit to the carbons in succession. It is a form of lamp well known and illustrated in many books relating to the subject of electric lighting. A very complete and elaborate description of the lamp is found in the patent fully illustrated by the accompanying drawing. The following is a reduced copy of figure 2 of the drawing of the patent:

728 *E. P. No. 970 of 1875 of Jenson's.*



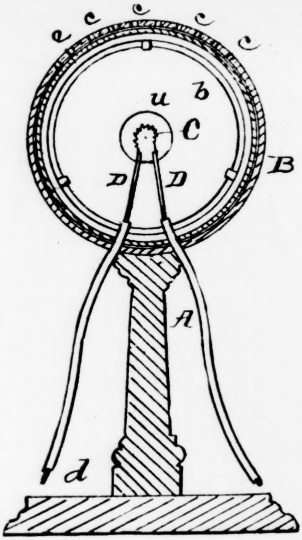
English patents Nos. 4805, of 1876, and 4905 of 1876, show arc lights with curved carbons.

729 March 9th, 1889—11 a. m.

Present: Mr. Curtis, Mr. Dyer, Mr. Griffin.

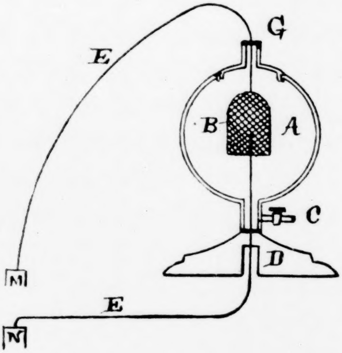
United States patent of Gardiner and Blossom No. 20706, June 29, 1858, electric signal light, shows a signal light having an incandescent platinum in an arch form enclosed in a protecting globe, which, however, appears to be open to the air. The following is a copy of figure 3 of the drawing of Gardiner and Blossom's patent:

U. S. Patent to Gardiner and Blossom, No. 20706, Dated June 29, 1858.



United States patent of Woodward No. 181,613, granted August 29, 1876, for electric light, shows a lamp having an incandescent carbon enclosed in a hermetically-sealed glass globe from which air is exhausted and in which a rarefied gas that will not unite chemically with the carbon when hot is placed, the lamp chamber 730 being hermetically sealed. The following is a copy of figure 3 of the drawing of the patent:

U. S. Patent to Woodward, No. 181,613, Dated Aug. 29, 1876.



A is the glass globe, B is the carbon, C is the air-tight stop-cock to be used in exhausting the air from the globe A, and for the injection of the rarified air into the globe of the same. E, E, are conducting wires. The vessel is hermetically sealed at the ends G, G, of the tubes, and D is a stand upon which the lamp is placed.

United States patent to Kosloff, No. 160,877, dated August 17, 1885. Electric light. This describes the same lamp as is described in English patent 441 of 1876, as before stated.

Ladyguine's light.

A description and exhibition of Ladyguine's light at St. Petersburg is contained in several of the publications which republish an article from the Russian paper called the "Golos," No. 129, of May 11–23, of 1873. An example of one of these republished articles is contained in the Journal of the Society of Arts, London, 1872–'3, volume 21, August 22, 1873, page 179.

It describes a public exhibition of Ladyguine's light in St. Petersburgh in the presence of more than one hundred specialists from different countries, "representatives of science, honorable 731 visitors and many reporters who were all deeply interested and unanimously decided that the trial was really successful." The article says, referring to Ladyguine's light: "By his newly invented method only one piece of charcoal or other bad conductor is required, which being attached to a wire connected with an electro-magnetic machine is placed in a glass tube from which the air is exhausted and replaced by a gas which will not at a high temperature combine chemically with the charcoal. This tube is then hermetically sealed and the machine being set in motion by means of a small steam engine the charcoal becomes gradually and equally heated and emits a soft, steady and continuous light which by a most simple contrivance can be strengthened or weakened at the option of those employing it, its duration being dependent solely on the electric current which of course will last as long as the machine is kept in motion." This evidently describes an incandescent lamp and in a hermetically sealed glass chamber in which is contained a single piece of incandescent charcoal suitably connected with conducting wires leading from a source of electricity and from which the air is exhausted, the globe being subsequently filled with a gas which will not chemically combine with the charcoal. Being hermetically sealed it becomes independent of the exhausting apparatus and so a portable lamp.

In regard to the state of common knowledge respecting pneumatic apparatus prior to the date named in the question, it may be stated that early in the history of the modern air pump it was a common practice to connect the exhausting cylinder by means of a suitable tube with a ground plate upon which the vessel to be exhausted was placed. By ground plate I mean a plate made truly flat and free from irregularities as nearly as may be. The edge of the glass receiver generally employed was and still is in modern practice ground so as to fit accurately upon the plate just mentioned. The material of such plate has commonly been either glass or metal. When the apparatus is destined to be used in connection with chemical operations in which corrosive gases are frequently involved,

glass is usually employed. When such use is not contem-
732 plated, metal may be employed and frequently is, and not
infrequently the same air pump is furnished with a series of plates several in number, some of which are made of metal, others of glass, in order that the single pump may be adapted to the various uses to which it may be destined. The several plates are furnished with screws of uniform pitch so as to be adjusted to the tube connected with the exhausting cylinder and can replace each other as occasion may demand. When it is required within a receiver in the course of any experiment to maintain for a longer time than would be convenient in connection with the pump when the exhaustion of the receiver has been complete it, together with the plate on which it rests, is detached from the pump by unscrewing the plate, and thus the pump is liberated for subsequent use. When even very accurate grinding of the plate and fitting of the receiver thereto has been secured a high vacuum cannot be maintained continuously for a great length of time, and it is the common practice in the use of such apparatus to adjust the receiver upon the plate by means of some soft plastic material, not infrequently tallow or tallow mixed with wax and oil or some form of pomatum. In pneumatics it is not infrequently required to fit two pieces of apparatus together so as to maintain the union gas tight when the apparatus to be joined does not necessarily contain a vacuum. But when it is employed to hold gases under varying pressure sometimes very high, and when it would be inconvenient on account of the manipulations involved to employ the usual method of making joints tight by means of screws with washers; in such cases clamps are well known and have been for a long time. Such clamping devices may, it is well known, be constructed so that the movable parts are held together by means of screws, wedges or cams, and the bayonet device is not infrequently employed.

5 Q. Please examine the patent in suit and state what features of novelty, if any, you find in the apparatus therein described and illustrated.

A. The patent in suit says that "our invention, speaking
733 generally, relates to that class of electric lamps employing an
incandescent conductor inclosed in a transparent, hermetically sealed vessel or chamber from which oxygen is excluded," that is, it relates to the class of electric lamps described by most of the patents and publications referred to in my last answer, and notably the lamps of Pinkus, De Moleyn, King, Greener and Staite, Shepard, Roberts, Konn, '72 and '75, Kosloff, Woodward and Ladyguine. The patent in suit says that the invention "constitutes an improvement upon the apparatus shown in letters patent No. 205,144, granted to us June 18, 1878." This prior patent to the same inventors is said by the patent in suit to show the construction of the lamp chamber, while another early patent to the same inventors (No. 210,809, dated December 10, 1878) is said to show the electric connections which are made in the base of the lamp. The construction of lamp chamber, its sealing, the atmosphere contained within it, the manner of conducting the electric

current to the inclosed incandescent conductor, and in fact all the features of the lamp, except the material and form of the incandescent conductor itself, are stated by the patent in suit to be shown and described in the two early patents to the same inventors. These features, however, are much older even than the early patents to the same inventors which are referred to in the specification of the patent in suit, since substantially the same lamp construction is proposed by all the patents and publications relating to incandescent electric lamps prior to the year 1878, which have already been referred to by me. It is also merely a reproduction of the ordinary air-pump construction in which the early experiments of Davy and others were tried when a vacuum or confined gas was employed.

One feature of the construction of the lamp chamber seems to be considered of importance by the patent in suit, namely, the employment of a glass plate or stopper for closing the open lower end of the lamp chamber. The tubular conductors which support the conductors within the lamp and complete the electric circuit connections therewith pass through holes formed in this glass 734 plate, and the patent states that this lamp chamber construction makes the wall forming the chamber of the lamp "wholly of glass, by which all danger of oxidation, leakage or short-circuiting is avoided."

The glass plate is ground to the flange on the bottom of the chamber "to form an air-tight joint" and the plate is clamped to the flange on the chamber. Of course, as generally known from experience with pneumatic apparatus, such a joint is not "air tight," but may be somewhat improved in its character by the use of a plastic material. We find in the patentee's earlier patent No. 205,144, which gives a more complete description of the lamp chamber that the ground edges are coated "with fir balsam or some cement in order to better insure that hermetical sealing which is indispensable to the preservation of the incandescent conductor."

The use of a glass plate instead of a metal plate for closing the open end of the chamber is very old in air-pump receivers, and the glass plate is only a well-known substitute and equivalent for a metal plate for the same purpose. The plates which close the open ends of the lamp chamber in Roberts' patent (Eng. pat. No. 14198 of 1852) and in Konn's patents (Eng. pat. 3809 of 1872 and 970 of 1875) is probably in each instance a metal plate, but I consider it the full equivalent of the glass plate of the lamp chamber of the patent in suit. It is not the transparent character of the plate which is taken advantage of, since, in the patent in suit, the plate is covered by a metal cap, and, in addition, the light rays in that direction are cut off by a solid diaphragm which fills the lamp chamber just below the burner. This diaphragm is described in patent No. 205,144 as "a disk of soapstone, porcelain or other refractory substance." So far as leakage is concerned the glass plate would have no advantage over the metal plate. The "danger of oxidation" would be greater with the glass plate than with the metal plate, since the only oxidation that is injurious is that of the carbon conductor which in the presence of oxygen is consumed. If any

traces of oxygen are left in the lamp chamber or gain access to it they will attack the carbon and destroy it. Should the oxy-
735 gen be taken up by the oxidation of the metal plate the
danger would be avoided. The remaining advantage, that of avoiding short-circuiting, is merely fanciful, since there is not the least trouble in such a lamp construction as that described in the patent in suit in securing the proper insulation of one of the conductors from the metal plate as is done by Roberts and Konn, and if the cement which seals the tubes into the glass plate of the lamp of the patent in suit is effective as a sealing it will also be effective as an insulator.

However, even outside of the air-pump receivers, which have glass bottom plates and from which the lamp chamber of the patent in suit is taken, the closing of the open end of the globe by a glass plate is old in incandescent electric lamps.

Kosloff (Eng. pat. 441 of 1875 and U. S. patent 166,877, dated Aug. 17, 1875) uses a base of porcelain or glass, upon which the chamber rests. He also fills the lower part of the lamp chamber with a block of the same material, this latter feature being significantly similar to the use of a porcelain disk by the patentees of the patent in suit, since it is obvious that the space between the porcelain disk of the lamp chamber of the patent in suit and the bottom plate is not utilized, and the porcelain disk might with the same effect be extended in the form of a block and stand on the bottom plate as it is in Kosloff's lamp. Kosloff's lamp is sealed by a liquid, and so also may be the lamp of the patent in suit, since it is stated in the patentee's earlier patent No. 210,809, which is referred to in the patent in suit for a fuller description of the sealing, that instead of using beeswax as a sealing agent "even an oil or other liquid will answer the purpose equally well." Kosloff uses olive oil. The glass plate for closing the lower open end of the globe is also used by Staite (Eng. pat. 12212 of 1848), so that in the lamps of both Kosloff and Straite we have the wall of the lamp chamber "wholly of glass" in the same sense that it is in the lamp chamber of the patent in suit, and the patent in suit is also antici-
736 pated in this respect, as has already been stated by the two
1878 patents of the same patentees.

The entire lamp construction thus being admitted to be old by the patent in suit itself as being in the earlier patents to the same patentees, and being shown to be old in still earlier patents, there only remains to be considered the incandescing conductor. The patent in suit says: "Our invention relates more especially to the incandescing conductor, its substance, its form and its combination with the other elements composing the lamp. Its object is to secure a cheap and effective apparatus, and our improvement consists, first, of the combination in a lamp chamber composed wholly of glass, as described in patent No. 205,144, of an incandescing conductor of carbon made from a vegetable fibrous material, in contradistinction to a similar conductor from mineral or gas carbon, and also in the form of such conductor so made from such vegetable carbon, and combined in the lighting circuit within the exhausted chamber of the lamp."

The patentees say that they "have made use of carbonized paper and also wood carbon." The shape or form described and shown for the incandescent conductor is an arch shape, although a V-shape burner and burners with rectangular bends insteads of curvilinear ones are described as the equivalent in shape. No method of preparing the material for carbonization or for carbonizing it *as* described. These are to be done "substantially according to the methods in practice before the date of this improvement."

The material, then, is a carbon from vegetable fibrous material of which paper and wood are illustrations, and the form is an arch or a V shape, or a form like an arch but with rectangular bends instead of curvilinear ones.

Now, first as to the material; carbon from fibrous vegetable material—that is, wood carbon or charcoal, was the first material used for producing the electric light, both by means of the arc and by incandescence. It is described as so used in the papers read by
Davy and others early in the present century. When later
737 the properties of vegetable fibrous carbon, not only from
wood but also from paper, cotton, hemp, flax, &c., were more fully investigated, as appears in the articles of Violette, Sidot and by Watt's Dictionary, its increased efficiency for electric lighting purposes when prepared at very high temperatures, for which purposes it had already been used, was noticed. Of the patents, De Moleyn (Eng. pat. 9053, of 1841) used pulverized boxwood charcoal for producing incandescence in an exhausted electric lamp; Greener and Staite (E. P. 11076, of 1848) used in an air-tight lamp chamber, an incandescent conductor made from powdered charcoal pressed into shape and then further carbonized, which would have the effect of bringing the charcoal to a higher state of carbonization and make it a more perfect carbon; Shepherd (Eng. pat. 13302, of 1850) used a charcoal pencil for incandescence in an exhaust lamp chamber; Roberts (Eng. pat. 14198, of 1852), used a charcoal slip or pencil for incandescence in an exhausted lamp chamber; Binks (Eng. pat. 119 of 1853) used electrodes formed by carbonizing lignite which is a vegetable fibrous material, and also used thin plates or cuttings of charcoal or charcoal veneer; Hamson (Eng. pat. 588 of 1857), made electric light pencils by subjecting small rods or pencils of wood charcoal to further carbonization; Burleigh and Danchell (Eng. pat. 3164 of 1857) formed carbon pencils by moulding powdered charcoal and then subjecting the formed material to further carbonization; and Ladyguine (Journal of Society of Arts, 1872–3), used incandescent charcoal in a lamp chamber filled with an inert gas.

In view of these patents and publications, I cannot see that there is any novelty in the use of vegetable fibrous carbon as the incandescent conductor of the lamp of the patent in suit. It is old as a material and its use for the burners of incandescent electric lamps is old. The anticipating patents and publications describe the method of preparation and carbonization more fully than does the patent in suit, and it does not appear that the patentees of the patent in suit have improved the carbon by introducing any new features in its method of preparation. As to this the patent 738 in suit says that the method of preparation is old and does not describe it. From their statement in the patent in suit that the method of preparing the vegetable fibrous carbon is old, it might be inferred that the material was old and that its method of preparation was old, but that the use of the particular carbon for the burner of an incandescent electric lamp was new and that the novelty consisted in substituting the fibrous vegetable carbon for gas-retort carbon for that purpose; but it will be seen that even a new use of an old material, or the substitution of one old material for another cannot be said to be a novel feature of the patent in suit, since the same material is shown by the prior patents and publication to be old for the same use.

Some of the patents and publications refer to the material as "wood charcoal," others as charcoal prepared from some particular wood, while others speak generally of "charcoal." The term charcoal when used alone and without any qualifying adjective means wood carbon, since that is the ordinary form of charcoal. In the original application for the patent in suit, the patentees made a correct use of the term when they referred to "wood carbon" and "charcoal" as meaning the same thing. "Animal charcoal" is always referred to as such, or more usually as "bone black."

As to the form of the burner, Staite (E. P. 12212 of 1848) used a true arch form for his incandescing burner in a lamp chamber, the burner being made of the metal iridium. Gardiner and Blossom (U. S. patent No. 20706, dated June 29, 1858) used as a burner a platinum coil as an incandescent conductor burned into the form of an arch in a lamp chamber; while Konn (Eng. pat. 3809 of 1872 and 91 of 1873) used a V-shaped carbon burner inclosed in a hermetically sealed glass chamber filled with nitrogen, and he says, referring to the shape, that "other shapes may be used." The advantages of the shape are present whatever may be the material, whether it is metal or carbon.

739 From the foregoing statement it follows that I fail to find a single feature of novelty in the apparatus described and illustrated in the patent in suit.

The inventors, Sawyer and Man, made no substantial advance in the art, or none, at least, that is shown or described in the patent in suit. They simply repeated the experiments of earlier patentees and experimenters without producing as a result of their experiments a lamp that was more practical than those that had gone before. Certainly none of the credit of the production of the modern incandescent lamp which has made electric lighting by incandescence a possibility can be given to the patentees of the patent in suit by reason of anything that is therein described or shown.

6 Q. Referring now to the first claim of the patent in suit, state whether or not in your opinion there is any novel and useful invention described therein, giving your reasons for any opinion you may express?

A. The first claim of the patent in suit describes an incandescing conductor for an electric lamp made "of carbonized, fibrous or textile material and of an arch or horseshoe shape." The shape being old, as stated by me in my last answer, in metal and in carbon, and the material or particular kind of carbon being old, also as stated in my last answer, I cannot see that the conductor is given any element of useful novelty by taking the old material and giving it the form which has been used for the same purpose in metals and in carbon from other sources.

7 Q. Do you agree with the opinion expressed by complainant's expert, Mr. Pope, in answer to X Int. 119, that the advantages of the material are substantially independent of the form in which the material may be in?

A. I do. I may go further and say that I think they are entirely so.

8 Q. Referring now, to the second claim of the patent in suit, state whether or not, in your opinion, there is any novel and useful invention described therein, giving your reasons for any opinion you may express.

A. The second claim is for a combination, the elements of which seem to be "an incandescing conductor of carbonized fibrous 740 material," and "a transparent hermetically sealed chamber, in which the conductor is enclosed." The electric circuit is mentioned in the claim, but since all incandescent electric lamps are intended to be used in an electric circuit, and all have means for connection with the circuit wires, I take it that the statement in the claim only makes certain the character of use of the apparatus. In this claim, the form of the burner is omitted, and the invention is made to rest on the combination of the burner of a particular kind of carbon with the lamp chamber.

If it is to be considered that no valid combination between a carbon burner of a particular kind of carbon, and a transparent hermetically sealed chamber exists, then any of the incandescent electric lamps, of which a number have before been referred to, having such a chamber, and using a carbon burner of another kind of carbon, such as gas carbon, or even using a metal, would, in view of the general knowledge that wood carbon, gas carbon, and other forms of carbon, and various metals may all be used for producing electrical incandescence, deprive the claim of all novelty. But if the combination is to be considered a valid and operative one and one that can only be deprived of novelty by finding the peculiar carbon in the peculiar chamber, then the patents of De Moleyn, Greener & Staite, Shepard & Roberts, and the publication of Ladyguine, form each an anticipation of the combination. These lamps in addition all have circuit connections and are described as used in an electric circuit, so that the conditions which may be meant by reference to the electric circuit in the claim, are also present in these lamps.

9 Q. Referring now to the fourth claim of the patent in suit, state whether or not, in your opinion, there is any novel and useful in-

vention described therein, giving your reasons for any opinion you may express.

A. The fourth claim of the patent in suit is for a combination of three elements—the chamber, the circuit conductors leading into it and the burner. The chamber, which is the first element, is stated to be made wholly of glass, hermetically sealed, and out of which all carbon-consuming gas has been exhausted or driven, 741 which refers, I take it, to the fact that the chamber of the lamp has a glass bottom plate sealed by clamps and cement to the bottom of the globe and the air is exhausted from the globe and a vacuum left in it, or it is filled with nitrogen or hydrogen gas. The electric circuit conductors, forming the second element, are described in the claim as "passing through the glass wall of said chamber and hermetically sealed therein," which, I take it, refers to the fact that the holes through which the conductors pass are sealed air-tight with cement; the burner, which is the third element, is described in the claim as "of carbon made from a fibrous or textile material, having the form of an arch or loop."

The lamp chamber and the circuit conductors (the first two elements of the claim) are the same as in the early patents to the same patentees (205,144 and 210,809). They are also the same as the chambers and conductors of De Moleyns, Greener & Staite, Staite, King, Shepard, Roberts, Konn (72 and 75), Kosloff (Eng. pats. and U. S. P.), Woodward and Ladyguine, as I have explained in answer to question 5. This leaves only the burner to be considered—its material and form. In fact the claim becomes simply the putting of the burner of the first claim into the old lamp chamber, or the same thing as the second claim with the form of the burner added. As stated in my answer to question 5, the material is old in other forms and the form is old in other materials, and the advantages of the form are independent of those of the material. The combination of the three elements of the fourth claim, when the form of the third element or the burner is disregarded, is found in a number of patents and publications, while if the material of the burner is disregarded the combination of the three elements is found in other patents or publications.

Taking the patents of Roberts (E. P. 14198 of 1852), and Konn (Eng. pat. 3809 of 1872), for illustration; they both describe lamps having the two circuit conductors entering from one side of the chamber and terminating in clamps for holding the carbon burner, which clamps are in the same horizontal plane. Roberts 742 has a straight fibrous carbon burner, while Konn has an arch-shape hard carbon burner. No change would have to be made in either lamp in order to exchange the carbon burners, and the straight burner of Roberts has the same substantial advantages as the arch burner of Konn and of the patent in suit, since if the Roberts lamp is reversed in its position there will be no obstruction to the downward reflection of the light.

The advantages of the material being independent of the advantages of the shape, I do not see what novelty is left for the combination described in the fourth claim of the patent in suit.

10 Q. You have stated in your answer to Q. 5 that the inventors Sawyer and Man made no substantial advance in the art, or none at least that is shown or described in the patent in suit. Please state what in your opinion was the advance in the art that marked the departure from the old and unsuccessful lamps towards the modern and successful incandescent lamp?

A. In the older forms of incandescent lamp the glass chamber employed for maintaining a vacuum or for containing non-combustion supporting gases was usually of considerable size and thickness and not made continuously in one piece. Several disadvantages were attendant upon this fact, first, owing to the fragile character of glass and the large dimensions, unequal expansion and different parts dependent thereon, the whole was liable to fracture and so destruction. Moreover, with any such device it was very difficult if not impossible to maintain, even for a moderate period, a sufficiently high vacuum in case the incandescing conductor was placed in a vacuum; and in case it were not placed in a vacuum but in some gas which does not contain oxygen, the conductor if sufficiently small was liable to injury from the so-called washing of the contained gas, an effect which is due to the rapid and continuous collision of its particles against the hot body. Moreover, in order to practical success it was necessary that the leading conductors which pierce the glass chamber for the introduction of the current should be hermetically sealed in the proper sense of the word, that is, should be composed of some material which, 743 while able to convey a current, does not greatly differ in its coefficient of expansion from the gas through which it passes so that the two may be fused into mutual and close connection. And again, as making the art of incandescent lighting successful, it was necessary that the size of the incandescent conductor be so reduced that it should offer a very high resistance to the passage of the current in order that the electric energy might be conveyed to the lamp with a high potential and small current instead of, as had been the practice in earlier times, with a large current of low potential, for thus the cost of the distributing conductors could be greatly reduced and so the art put in economical practice. The modern incandescent lamp combines the various features which have been pointed out, namely, continuous chamber, hermetical sealing, practically complete exhaustion, and incandescing conductor within the chamber, offering a high resistance.

11 Q. Where, first, do you find set forth the embodiment of these conditions which you have stated are the elements of the modern incandescent lamps?

A. They appear to me to be first set forth in United States patent 223,898, January 27, 1880, to Thomas A. Edison.

12 Q. Referring to the lamp structure described and shown in the patent in suit, what, if any, would be the practical defects of such a structure in your opinion?

A. It would, in my opinion, be very difficult to maintain in such a structure a nearly perfect vacuum even though it could be produced. Such a structure would offer very serious obstacles in the production of such a vacuum from the large amount of surface to which air or other contained gases would be necessarily adherent, and which would fail to be removed by the pump; and even supposing that it could be so produced, it would be very difficult to maintain such a vacuum owing to the necessary imperfections in the joining of the portions of which the chamber is composed, namely, the upper or tubular portion furnished with a flange to the lower glass plate through which the conductors pass.

744 Such a lamp would be open to all the disadvantages attendant on pneumatic apparatus in which it is sought to obtain and maintain a vacuum from imperfect closure of the joint, or in other words, from leakage. Another practical disadvantage of the structure shown is that the incandescent portion is necessarily so large and of so short length as to offer very little resistance, and, therefore, require a current of greater intensity and lower electromotive force, making, therefore, a lamp that would not be practicable.

13 Q. Considering the structure of the lamp of the patent in suit as illustrated in the drawings of the patent, would it be practically feasible in your opinion to seal the glass plate *y*, to the flange, *x*, by fusion of the glass?

A. I do not think it would.

14 Q. Would it be feasible in your opinion in such a lamp structure to fuse the glass plate upon the tubular conductors which are shown as passing there through?

A. I think not, and I will give as a reason for the opinion I express that in order that this may be done safely, the tube itself must be composed of such conducting substance, and, therefore, metallic as shall have a coefficient of expansion under all changes of temperature substantially the same as glass. Only one such metal is known, and even in that case the difference in the coefficient of the expansion, and that of glass is sufficient that when a large wire or a tube offering a large surface is brought in contact with glass so fused, the unequal expansion between the two is so great as in a short time to fracture the surface of the glass in contact with the metal and render the contact between the two less intimate, and so subject to leakage. This, however, with a small wire does not occur, since it can accommodate itself to the changes of temperature without producing fracture of the glass in contact with it.

15 Q. Would the lamp structure of the patent in suit in your opinion be suitable for maintaining with sufficient stability any definite condition of the atmosphere within it whether a vacuum or non-combustion supporting gas to make the lamp a practically useful structure for the purposes of electric illumination?

745 A. In my opinion it would be wholly unsuitable for such purpose.

16 Q. Please state whether or not in your opinion there is a sufficient description in the specification of the patent in suit as to the character of the fibrous material to be used for the burner, its selection, its preparation for carbonization and its carbonization to enable others generally skilled in the art as it existed at the date of

the application, namely January 9, 1880, to produce a practically operative incandescent conductor without experiment?

A. I do not think there is enough of direction or explanation to enable one to produce such a conductor as the question names. First, as to the selection of materials, the patent is indefinite. In the specification we find the inventors to declare that they have used carbonized paper and also wood carbon. In my opinion it would not be sufficient, if paper were to be resorted to, simply to state that fact, inasmuch as papers are manufactured and are well known in a great variety of forms having a great variety of properties. Some of them, beside the fibrous material of which they may be supposed to be chiefly composed and on which their integrity depends, are loaded with mineral and earthy matters, some of them containing more or less of chemical substances, as alum, all of which, leaving mineral residue in the part remaining after carbonization, would render it liable to fusion and so to destruction, while other papers have such great want of uniformity in the disposition of the fibres of which they are composed that the carbonaceous residue left after incineration would not be of uniform texture, but would be more or less dense at certain portions, and more or less wanting in density at others, and the result in the use of such material would be very irregular heating on the passage of the current, and probable destruction of the continuity of the conductor by a process which would be set up very similar to that which goes on between points of carbon when the arc light is produced. As respects the use of wood for the same purpose, a very similar line of remark is applicable. Out of the great variety of woods known to us, very few will furnish a material which, on carbonization, would be applicable 746 to this purpose, the reason being very much the same as that which has been assigned for the failure in case paper were used. More in detail: In the woods with which we are familiar in temperate climates, the distribution of woody matter in any given mass of wood is very irregular, and the relative amount of real wood present in a given bulk is not infrequently very inconsiderable when compared with the bulk. It is noticeable in the wood from the conifers which is made up mostly of wood disposed in cells very large as compared with the air spaces between them. In most of the exogenous woods the disposition of the fibres of the wood is such that no continuous small rod could be cut from it such that every cross-section of it would represent the same amount of woody material as every other. This results from the fact that in the structure of such wood, beside fibres which are more or less parallel, there are others present which cross these, and so turning the fibres aside from their straight and regular course would render it certain that in attempting to cut from such wood a regular form, some of the fibres would be cut across, the result being irregularity in the distribution of the matter in the finished product, and when an electric current is transmitted through such material, those portions in which the carbon residue is least abundant in cross-section would be most intensely heated, and the process technically known as "arcing" set up, by which the conductor would be destroyed.

It seems to me, therefore, that one setting himself to construct a lamp in accordance with the patent, supposing that such a lamp could be successfully made, would find in addition to the task set before him in the patent, a full field of experimentation into which he must enter and make trial with various papers or woods before he could hope for success. As to the process involved in the reduction of the raw material to the form of carbon, suitable for this purpose the patent gives no sufficient disclosure. For these reasons I think not enough is disclosed to enable one skilled in the art to make a practically operative conductor.

747 17 Q. In making such a conductor from wood carbon, is it in your opinion essential to operativeness that the material should be cut from the wood in one way rather than in another and if so do you find anything in the specification of the patent in suit to indicate how this is to be done?

A. In my opinion it is of vital importance that the material should be cut from the wood, supposing a proper one to be selected so as to have the form or extended length of the conductor taken from the wood along and parallel with its fibrous structure rather than cut across the grain; for only in the former method could we hope to secure sufficient uniformity of material or homogen-ousness of structure in the carbonized residue. There is nothing whatever mentioned in the patent with respect to the necessity of this or any direction given as to the mode of carrying it out.

18 Q. How large a proportion of vegetable growths even if the material were prepared for carbonization and carbonized with the advanced skill of the present time would in your opinion be at all suited for manufacture of incandescent lamp carbons or would make a lamp which would be practically operative?

A. In my opinion only an exceedingly small fraction of the whole number of growths known to us would fulfill this condition, and it may not, perhaps, be amiss to give my reason. If we examine the class of grasses, it will be found that the structure furnished by the stems or the leaves, or indeed by any part of such grasses, does not possess sufficient homogen-ousness of structure and uniformity of density in material to fulfill the conditions required. When the silicious outer covering of the straw is removed we come upon a structure which varies in density in such a way that in my opinion it would be almost, if not wholly, impossible to shape conductors from them possessing a requisite uniformity, and if we turn to the exogenous woods the same remark is true in a higher degree perhaps. The separate annular layers of wood have not uniformity of density throughout their entire extent, but on the contrary it varies somewhat with the advance of the season during which it is deposited, and between the annular layers

748 or at that portion which lies between the central parts and the contiguous annular layers the wood is very open and spongy. Moreover, the wood is generally traversed in the direction of its length with cellular structure, giving to it such a character that the residue after carbonization would, in my opinion, be wholly wanting in the characteristics requisite for such a conductor, and I

believe it has been found by experiment that such woods are quite unsuited to the purpose generally. It is only in that small class, and only comparatively few members of that, even, that present the pith, the cells and the whole structure bundled together in parallel distribution known as indogenous plants that I should expect to find success in carrying out the invention. When I say this I do not mean that such knowledge was generally in the possession of scientific men at the time of the application of this patent, but that it has been subsequently discovered. Answering the question specifically, then, I say only a very small number of materials indicated in the question would be found suited.

19 Q. Did there, in your opinion, exist in the general knowledge of the art prior to Jan. 9, '80, a sufficient knowledge of the conditions relative to the selection of the material and its preparation for the purpose of making burners for incandescent lamps to make the statement contained in the patent in suit in regard to the material and its preparations sufficiently definite to enable persons skilled in the art without further experiment to produce a practically operative conductor or burner for incandescent lamps?

A. I do not think there did.

20 Q. Referring to the original application for the patent in suit and to the patent as issued, please state whether or not, in your opinion, the same substantial invention is described and claimed in the original application that is described and claimed in the patent in suit?

A. In my opinion the invention described and claimed in the original application could only be said to be the same invention as described and claimed in the patent in suit in the most remote and general sense. It appears to me that a decided change in the relative importance of the elements set forth has been made. In the original application I find the following language: "Our present invention specially relates to the incandescent conductor; its object is to secure a cheap and effective apparatus, and our improvement consists in the employment of an incandescent arc of carbon in the circuit as a light-giving medium." In the patent as issued it is stated: "Our invention relates more especially to an incandescing conductor, its substance, its form and its combination with the other elements composing the lamp. Its object is to secure a cheap and effective apparatus, and our improvement consists, first, of the combination in a lamp chamber composed wholly of glass, as described in patent No. 205,144, of an incandescing conductor of carbon made from a vegetable fibrous material in contradistinction to a similar conductor made from mineral or gas carbon, and also in the form of such conductor so made from vegetable carbon and combined in the lighting circuit with the exhausted chamber of the lamp." In the application, it is further remarked: "Our improved burner or incandescent arc consists of an arch-shaped or semi-cylindrical piece of carbon, A, mounted in its clamps." In each of the claims the arch shape is a prominent feature and appears to be regarded as such in the invention. In the patent as issued this feature sinks into relative 749 insignificance, prominence being laid upon the carbonized fibrous or textile material. In claim one of the patent as issued the language is: "An incandescent conductor for an electrical lamp of carbonized fibrous or textile material and of an arch or horseshoe shape." It will be seen that the simple arch shape in the application is the last-mentioned feature in the claim and has a correlative or partially equivalent form mentioned in connection with it. The second claim also of the patent as issued mentions the material but omits the form. In the fourth claim the form is stated to be that of an arch or loop. It thus appears to me that there is a wide departure in the scope of the patent as issued from that which was embraced in the original application. 750 In the application the applicant states, "We have tried carbonized paper covered with powdered plumbago, wood carbon or charcoal, and ordinary gas carbon." In the patent as issued they say: "In the practice of our invention we have made use of carbonized paper and also of wood carbon." In the language employed in the application the carbonized paper is covered with powdered plumbago. No such fact is mentioned in the patent as issued. Also in the patent as issued it is to be noticed that they omit to mention the use of gas carbon. It thus appears that at the time of the issue of the patent in some way an advance had been made in the art in the direction of success as it has been finally secured in practice which was not exhibited in the original application, and so the scope of the patent as issued is, it seems to me, different from that set forth in the original application.

21 Q. I call your attention to the fact that in the original application "wood carbon or charcoal" is stated as one of the materials used, while in the patent as issued this is replaced by the words "wood carbon." Do you attach any significance to this change?

A. It seems to me that the omission of the words "or charcoal" would tend to direct the mind of one skilled in the art away from a material of a very general character to one more specific, and that thus one may see that the patentees are following along in the line which had already successfully been entered upon by others and by a skillful use of language were endeavoring to cover an essential improvement in the art of incandescent lighting, which if covered at all in the earlier application was so vaguely covered as to be of no practical use.

22 Q. I call your attention to the fact that the original application says, "We have tried carbonized paper covered with powdered plumbago," and that no further description is given than that of what is meant by the paper carbon mentioned in the third claim of the application. Please state whether or not, in your opinion, the 751 expression "carbonized paper covered with powdered plumbago" had any definite and ascertained meaning in the art at the date of the application.

A. I do not think it had. Moreover, the expression seems to me ambiguous in its character. Certainly with no further knowledge than was extant at the time of the application, I believe one would hardly know whether paper was first to be carbonized and then covered with plumbago, or whether the paper was to be covered with plumbago and then carbonized, and whichever is to be done there are no directions given for the doing.

23 Q. Assuming that the expression means that paper such as blotting paper is to be filled as thoroughly as possible with powdered plumbago by rubbing and hammering the powdered plumbago into it, and that then it is intended to carbonize the paper by passing an electric current through it, what would be the result of such a process in your opinion, and would it have any degree of usefulness in the manufacture of burners for incandescent lamps?

A. I answer the question as it stands, that it seems to me no possible warrant in the language for such an interpretation exists since the expression is, "covered with powdered plumbago;" but supposing plumbago to be rubbed and hammered into the texture of the paper so that it could convey a current and then the current were applied, if this were done in the open air, the probability is that at the points where the ordinary metallic conductors come in contact with the paper so filled with plumbago, the paper itself would be consumed, or if this were not the case it is hardly probable that the plumbago could be so equally and uniformly mixed as to offer the same resistance throughout the whole extent, and if not, wherever the resistance were greater, owing to the scarcity of the plumbago, the carbonization would first take place and would be carried to excess, the texture being burned out and the continuity of the structure interrupted and the carbonized conductor destroyed. It would seem to me, therefore, that if any success were to be obtained, the operation must be
752 carried on in an exhausted vessel, and then, even, it seems to be very doubtful if one could succeed in carbonizing the paper at all uniformly. But supposing this were done, there would still remain the want of uniformity in the texture of the paper which is essential to a homogen-ous and uniform conductor such as must be employed in an incandescent lamp. It, therefore, seems to me that the entire direction is vague, indefinite and not likely even with the light which we have at present to be successful in whichever way it were attempted to be carried out. Of course, I do not mean to deny that once in a while out of many trials some partial success might in some way be obtained but nothing practical.

24 Q. I call your attention to the fact that the original application for the patent in suit speaks of "wood carbon or charcoal" as one of the forms of carbon employed. Please state what you would understand by that expression as the art was generally known at the date of the application.

A. The expression "wood carbon or charcoal" would mean, I suppose, nothing other than the carbonaceous residue which remains after burning the ordinary oxogonous woods commonly known in this country. That is certainly its ordinary signification.

25 Q. I call your attention to the fact that in the patent as issued the lamp chamber is described as "composed wholly of glass," and that at another point it is stated "that the entire wall of the chamber is formed of glass," and that at another point in the

specification of the patent in suit it is stated that "another important advantage resulting from our construction of the lamp results from the fact that the wall forming the chamber of the lamp through which the electrodes pass to the interior of the lamp is made wholly of glass by which all danger of oxydation, leakage or short circuiting is avoided;" while in the original application for the patent in suit no such specific description is given of the lamp chamber. Please state what significance, if any, you attach to this change between the original application and the patent as issued.

753 A. It would seem to me that the change in language pointed out in the question would indicate that the patentees were endeavoring to cover a lamp chamber better adapted to, and more in accordance with, the requirements which the subsequent progress of the art had shown must be met. The language would certainly seem to be better adapted to indicate such a form of lamp chamber as in recent practice of the art has been found to be suitable.

26 Q. If that expression "made wholly of glass" has been applied to any particular character of lamp, kindly state what the kind of lamp is and where you find the expression first used.

A. Equivalent expressions are first found, I believe, in patents granted to Thomas A. Edison, No. 223,898, January 27th, 1880, and is also found in 227,229 May 4th, 1880, for an incandescent lamp. In the specification the patentee points out the disadvantages which have attended the construction of lamps prior to the date of the said patent respecting the difficulty of making them maintain a vacuum, and he shows that his intention is to construct the chamber wholly of glass and to melt and hermetically seal the platinum wires leading to the incandescent conductor into the wall of the glass, thus suggesting a new line of departure in the construction of incandescent lamps.

27 Q. As used in the patents of Edison referred to by you, what does the expression "made entirely" or "wholly of glass" mean, and is the construction of lamp described in those patents the construction to which that expression has usually been applied since the date of those patents?

A. The expression in the patents referred to means made entirely of glass without joint so that it may be properly said that it is composed wholly of glass, and that the glass is whole, entire, without joint, and it describes the lamp which is usually understood to be meant when one says composed wholly of glass.

28 Q. You have stated that in the patents of Edison referred to an old lamp construction is described, and the fact that it
754 was impossible or impracticable to maintain a vacuum in such a construction set forth, and that the patents then proceed to describe the improved construction, namely, the lamp chamber made wholly or entirely of glass as one in which such a vacuum can be maintained. Please state in what material respect, if at all, the old lamp chamber described in the patents of Edison

referred to as being that used before his invention differs from the lamp chamber described in the patent in suit.

A. In the older lamps, before the invention of Edison, the chamber was either ground to and fitted upon the glass plate and cemented thereto or the approaches to the chamber were guarded by metallic caps which were cemented thereto or in general were closed by devices which were incapable of maintaining for a long period of time a practical vacuum. These decided disadvantages are wholly obviated by the construction which he proposed for it is found that when the only passage into the chamber is by means of platinum conductors hermetically sealed by fusing the glass, that the joint is practically as tight as if no such conductor entered. It is found by fusion of the glass after the exhaustion, and thus making it continuous without any opening, that there is no communication with the air, and consequently no destruction of the vacuum results, which could not be secured in the older practice. In the lamp chamber shown in the patent in suit substantially the old line of practice is followed, namely, portions of the chamber are brought together and attempted to be fitted by joints. Moreover, the conductors are secured to the openings through which they pass by means of cement, thus making it liable to all the imperfections which have been pointed out. In all material respects these points of construction were present in the lamps to which Edison alludes as having been in existence before the date of his invention.

29 Q. I call your attention to the fact that in the patent in suit, referring to the tubular conductors which pass through the holes in the glass bottom plate, *g*, the patent says "the sealing of the electrodes where they pass through the glass wall is done with any suitable cement or in any of the well-known methods of sealing glass upon metal electrodes previous to the filing of this application," while in the original application no such statement was made, and in patent No. 205,144 the glass plate is described as being drilled with two holes through which pass the bolts protected or not by cloth or paper lining, the holes through which the bolts pass being sealed with balsam or some cement. What significance, if any, do you attach to this change between the original application and the patent as issued?

A. It would seem, in view of the language cited in the question, that one might say that the invention as set forth in the patent as issued has been made broader so as to include, is possible, any mode of sealing the electrodes which should not be open to the objections specifically pointed out and shown in the patent referred to in the original application, namely, that which has already been pointed out; the leakage of air into the vacuum when produced which must inevitably occur in such a structure. It appears to be an attempt to make the patent cover the methods of introducing and sealing the conductors into the lamp which are now well known and practiced in the art of incandescent lighting where the incandescent lamp is a closed chamber exhausted and hermetically sealed.

30 Q. Would the structure shown in the drawings of the patent in suit, in your opinion, be adapted for having the electrodes where

they pass through the glass wall, sealed as in any of the well-known methods of sealing glass upon metal electrodes previous to the filing of this application?

A. In my opinion they would not, as I have heretofore pointed out.

31 Q. Are all commercial incandescent electric lamps manufactured at the present time provided with carbons of carbonized fibrous material?

A. They are not. On the contrary, it is the practice in some cases to reduce carbon-holding materials to a homogeneous structure by the immersion of the same in some agent by which they are put in partial solution so as to coalesce or sometimes to be completely dissolved in menstra precipitated, and the resulting compound drawn out into a suitable conductor which may be subsequently carbonized. 756 For instance, woody matters may be put into a plastic condition on being immersed into strong sulphuric acid containing about half its bulk of water, and then those materials may be subsequently formed, and carbonized, gun cotton may be put in solution, and from the solution a non-fibrous material may be prepared from which the incandescing portion of the lamp may be made by carbonization. And various other processes effecting a similar result may be employed and are, as I understand, in the practice of the art.

32 Q. The opinion has been expressed in substances by complainant's experts that the mere mention of carbonized paper in the original application for the patent in suit forms a definite indication that the inventors intended to reduce the fibrous material to shape and size in at least one direction before carbonization. Please state whether you concur in this view?

A. I do not understand the language of the patentees to be intended to be explicit on that point to that extent. I should rather suppose that they intended to indicate in a general way what the conductor was to be made of. And the paper is rather indicative of the material than of any process through which that material might have been put. And I further think that in course of experiments to secure a suitable conductor from that material it is more than likely that one would find it necessary to go through a great variety of experiments not only in the selection of materials to be carbonized, but in the treatment of the carbonized product. For instance, if conductors so produced should not offer sufficient resistance or should not be sufficiently uniform, it is manifest that the experimenter would naturally think of filing, or scraping, or grinding or in some way reducing the thicker portions of the conductor in order to secure uniformity and so better results. And as a matter of fact I believe an experimenter would have to go through some such trial. No doubt if the patentees experimented with such conductors they found it necessary to treat the carbonized product in the way indicated. 757 Indeed I believe I have heard that they stated that a conductor so formed might be cemented to a plane surface and filed, afterwards liberated and re-cemented upon the filed surface and the second surface reduced in a similar manner.

Last part of the answer objected to as hearsay.

33 Q. The patent in suit states, "An important practical advantage which is secured by the arch form of incandescing carbon is that it permits the carbon to expand and contract to varying temperatures to which it is subjected by the electric current, as turned on or off, without altering the position of its fixed terminals. Thus the necessity for a special mechanical device to compensate for the expansion and contraction which has heretofore been necessary is entirely dispensed with, and thus the lamp is materially simplified in its construction." Please state whether or not in your opinion a carbon conductor of the size of that shown in the drawings of the patent in suit would be given the advantage mentioned in the manner just quoted from the specification of the patent by reason of its having the arch or semicircular form shown in the drawings?

A. I do not think it would. As shown, the thickness relative to its other dimensions and relative to the chamber itself is such that supposing the conductors to which it is attached to be rigidly fixed then a notable expansion ought to occur in the incandescing conductor; I do not see that any advantage would be given to it by its curved shape, for it would be, in my opinion, quite as likely to break in the form shown as it would be in the form of a rod, as had been in the art before.

34 Q. Is there any such advantage in the modern incandescent
lamp arising from its capacity to contract and expand with-
758 out breaking or disturbing the position of the fixed terminals,
and if so, to what is that advantage and operation due?

A. In my opinion there is such an advantage in the modern fixed lamp. It is due primarily to the thinness and consequent flexibility of the conductor and to its great length, both of which would enable it, if expanding between fixed points, to flex laterally or to curve itself in any direction to accommodate itself to any increased strain upon it, and so, liability to rupture, in my opinion, is not present. As a matter of fact it does not usually occur.

35 Q. Would that characteristic of the carbon conductor in the modern lamp be present, whatever its form, whether that of a loop, or a straight piece?

A. It undoubtedly would, owing to the fact which I have just mentioned, namely, its minute diameter, and its great length.

36 Q. What, then, is the advantage, if any, of using a loop form of the conductor, such as is used in the modern lamp?

A. The primary advantage is to allow a great length of conductor.

37 Q. I called your attention to the fact that the matter quoted from the specification of the patent in suit in my question No. 33 does not appear in the specification of the original patent as filed. What significance, if any, do you attach to this difference between the original application and the patent as issued?

A. It would seem to me to be rather designed to make the patent cover the advantages of a device which were not clearly shown in the drawings, or set forth in the specification of the original application; namely, to give to the incandescent conductor of the lamp a property by implication, involved in the language which was, in my opinion, really not present in the lamp as shown in the original application, but which is embraced, and is necessarily useful in modern incandescent lamps.

759 PRINCETON, NEW JERSEY, *March* 11, 1889—8 p. m.

Present: Mr. Dyer, Mr. Curtis.

Professor CYRUS F. BRACKETT—cross-examination.

By Mr. CURTIS:

37½ X Q. To which of the patents and publications referred to in your answer to question 5 do you particularly refer in your answer to question 6?

A. So far as the portion of the answer relating to the shape of the conductor is concerned, attention may be called to the lamp described in the English patent to Staite, Konn, 3809 of 1872, and 91 of 1873, and U. S. patent to Gardiner and Blossom. As to the material, I may refer to the papers from the Philosophical Transactions, the collected works of Sir Humphrey Davy, and that of Violette and Sidot, Comptes Rendus, Watts' Dictionary, edition of 1863 and 1875. English patents to De Moleyn, Greener and Staite, Shepard, Roberts, Binks, Burleigh and Danchell, Harrison, and the publication of Ladyguine's light.

38 X Q. Do you find in either of these patents or publications, taken by itself, a description of an incandescent conductor for an electric lamp of carbonized fibrous, or textile material, and of arch or of horseshoe shape?

A. No; I believe they are not both present, both the carbonized fibrous material and the horseshoe shape in any one of the publications named.

39 X Q. Which one of these, if any, do you consider an anticipation of the first claim of the patent in suit?

A. There is no one of them that singly presents an incandescent conductor of carbonized fibrous material, and at the same time of an arch or a horseshoe shape, but it seems to me that the form being old and the material being old, nothing new is disclosed in this claim which was not previously well known, for I cannot 760 conceive that there would be any invention in taking a form which was old and a material which was old, and both used for the purpose of an incandescent lamp, and bringing them together.

40 X Q. Then, as I understand, you find one characteristic of the conductor of the first claim of the patent in suit in some of the publications and patents, and the other characteristic in other patents or publications, and you do not think it would constitute invention to put the two together and thus make a conductor like that described in the claim?

A. The statement in the question expresses my opinion, and my reason is that whatever of advantage there may be in the form, if any, it appears to me does not depend upon the material; and whatever advantage there may be in the material does not depend upon the form. And both the form and the material being old, as shown in the previous answer, my opinion with reference to the claim is as stated, that it does not disclose any invention.

41 X Q. Which one of the patents or publications to which you have referred contains, in your opinion, the most satisfactory and complete description of an incandescent conductor for an electric lamp of carbonized fibrous or textile material without reference to the shape of such conductor?

A. The material which would result from the process of treatment described by Violette to which reference has been made, would, it seems to me, be more likely to fulfill the conditions required in a practical lamp than would be likely to be embodied by the use of what is commonly understood as charcoal or carbonized wood. It seems to me also that the material which would result from the process of Sidot would likewise have some of the characteristics which would be required. Also material described in Binks' English patent which consists of carbonized lignite. The Violette publication I refer to is found in "American Journal of Science and Arts," vol. 16, 1853, page 270. And Sidot's process is described in "Comptes Rendus," tome 70, page 605.

761 42 X Q. These two publications and the English patent to which you refer, contain then on the whole the best description you can find in any of the patents or publications referred to in your answer to question 5 of an incandescing conductor for an electric lamp of carbonized fibrous or textile material?

A. I think so. I do not remember one better than this would be likely to be.

43 X Q. Referring now to your answer to question 8, do you find in either of the patents or publications there referred to taken by itself, all of the elements of the combination of the second claim in the patent in suit combined as described in the specification of the patent?

A. The claim appears to be a combination claim. If we are to take into account the transparent or glass chamber adapted to be sealed in some way to which electric conductors are fixed so that the current can be led into it, as is the case with all incandescent lamps, and indeed all lamps for electric lighting, and if the incandescent material is to be of carbonized fibrous material, then everything set forth in the claim is to be found in patents to which allusion has already been made, and notably English patents De Moleyn, Greener and Staite, Shepard, Roberts, and the publication of Ladyguine in the "Journal of the Society of Arts," London, 1872–'3, volume 21.

44 X Q. Does either one of these patents or publications contain, in your opinion, a better description than the others of the combination of the second claim of the patent in suit, or are they all equally good?

A. I have not carefully considered that question, and should want to review the exact statements and drawings made with reference to them before expressing an opinion.

45 X Q. Will you kindly do so?

A. It would seem that the lamp shown and described in English patent to Roberts and also the English patent to Shepard and the Ladyguine lamp publication described in the "Journal of the Society of Arts." It would seem that it would be among those 762 which one would select as better fulfilling the condition in the question.

46 X Q. If you were to make any selection among these last, which would you select as on the whole best fulfilling the conditions of the preceding question?

A. My present impression is I should select Roberts, though I confess I have not given very much attention to that particular phase of the subject.

47 X Q. But you think that the Roberts patent is certainly as good as any of the others for this purpose?

A. I think it might be.

48 X Q. Do you think that all the patents and publications you have referred to in your answers to the last three questions are direct anticipations of the second claim of the patent in suit?

A. It seems to me that they are. Some of them, I think, certainly are. They appear to present everything which this combination calls for.

49 X Q. Which of them do you think certainly are?

A. I am not prepared to say that they are not all of them. They certainly present the incandescing conductor of carbonized fibrous material. They are presumed to be furnished with connections for the electrical circuit of course in any case, and they are enclosed in a transparent chamber capable at least of being as completely hermetically sealed as is the lamp described and shown in the patent in suit, and claimed in claim 2.

50 X Q. Referring now to your answer to question 9, do you mean to express the opinion that either of the patents or publications there referred to is a direct anticipation of the fourth claim of the patent in suit?

A. Implicitly, yes. By implication it is there in several of them. In the English patents and publications to which allusion has just been made are found a transparent chamber adapted to be pumped out and sealed or to contain an atmosphere not composed of oxygen; they are furnished with conductors for the introduction and utilization of the electrical current; they utilize an incandescing conductor made of carbonized fibrous material, and although 763 they do not show this in the form of an arch or a loop, yet the advantage of the material, whatever that may be, is present, and further it may be remarked that in the form of an incandescing conductor shown in the patent in suit no substantial advantage is secured as regards permanence of connection with the metallic electrodes to which it is attached, and since the form of the incandescing conductor shown is made in other materials, it seems to me that so far as this element alone is concerned the substitution of carbon for metal, which was shown in one of the patents already alluded to, prevents the claim entirely from including any patentable novelty.

51 X Q. In which one of the patents and publications to which you have referred do you find on the whole the best description of all the elements of the combination of the fourth claim of the patent in suit combined in the manner there described?

A. As regards the form, the English patent to Staite; as regards the material, those which I have just mentioned in answer to 43 X Q. I have, however, omitted to mention that in earlier patents granted to the same patentees substantially the same structure of lamp is shown so far as the chamber, the electrical connections and means of exhaustion are concerned. The incandescent material, however, is in a different form.

52 X Q. In which of the prior patents and publications do you find the best description of the whole combination?

A. If we might substitute for the carbonized fibrous or textile material a structure of carbon which was not fibrous, but which would have in such lamp substantially the same properties, I should mention English patent 3809 to Konn, 1872. The lamp, although not having a chamber wholly of glass, but being closed with metal plate, is, in my opinion, however, quite equivalent in that respect since no advantage comes from a glass plate, the metal plate being quite as easily fitted and quite as firmly secured, even better. In all other essential respects I should regard the lamp as the equivalent, inasmuch as the electrical connections, the exhausted 764 chamber or one that may be exhausted, the carbon incandescent body, which in a lamp of that sort would be quite the equivalent of the fibrous material, and supposing the lamp to be efficient, I see no reason why Konn might not be regarded as a complete equivalent. It is true that in exact terms of fibrous material the Konn combination is not the equivalent of the other. But for practical use I think it would be quite.

53 X Q. Have you assumed throughout your deposition with regard to the patent in suit that such a carbon conductor as is described in the Konn patent referred to is the full equivalent for the carbon conductor made of fibrous or textile material described in the patent in suit?

A. When comparing lamps of low resistance and therefore adapted to a current of great intensity I should so consider them although I have not been influenced by that consideration. When considering a lamp of practical utility in the modern sense an incandescent lamp, I should by no means regard the material used for the incandescent conductor which might be obtained from suitable fibrous material as the equivalent of that which probably would be obtained in the treatment of hard gas coke, as is shown in the patent of Konn.

54 X Q. Do you think then that for lamps of low resistance the two are equivalent but not for lamps of high resistance?

A. Hardly that. But I think that for lamps of high resistance what is commonly known as gas carbon would be a very poor material with which to construct the incandescing conductor owing to the difficulty in manipulation. I should expect better success in the construction of such lamps in the use of suitably chosen fibrous material cut to form, and carbonized. By this answer I mean by no means to deny that if it were possible practically and in a commercial way to construct lamps having incandescent conductors of small cross-section in great length from gas coke which might be perhaps made in sufficient density and uniformity, such lamps might in my opinion take the place of those constructed by 765 the ordinary well-known modern practice. I do not, however, believe it is possible, and in comparing the lamp of Konn with any other lamp in which the incandescing conductor is made of fibrous material, I should think that an injustice would be done the latter construction.

55 X Q. In your answer to question 16 you state in substance that the patent in suit does not in your opinion contain sufficiently definite instructions in regard to the making of the carbon conductor to enable one skilled in the art and knowing only what was known in regard to such subjects prior to 1880 to make a practically useful incandescent conductor from carbonized fibrous or textile material. Please state what further directions ought, in your opinion, to have been given in the patent in suit, on this point in order to make the patent sufficiently definite and explicit.

A. "Fibrous" and "textile" are words covering a great variety of substances, and in that variety of substances are found very diverse qualities. I do not believe that either "fibrous" or "textile" is a sufficient definition of the material which must be employed for carbonization in order to produce a practically valuable lamp for electric lighting by incandescence. As already pointed out in answer to a question in this direct examination, I have remarked that there is great want of uniformity in the structure of most woods, vegetable substances which would naturally be employed for this purpose, for I take it the patent does not mean substances of animal origin, since it is the usual custom when such bodies are reduced to the form of coal to specify by the addition of a distinctive word such as "animal" charcoal. The constructor who should undertake to make a lamp with all this uncertainty and vagueness would in my opinion find himself totally wanting in that explicit direction in the choice and treatment of his materials which would properly be employed so that he would be obliged himself to become an inventor, or perhaps better, a discoverer, by entering upon a wide range of experimentation. I do not for this reason think that sufficiently explicit direction is given. I do not 766 mean, however, to say that one might not with what is set forth in the patent construct some sort of a lamp with which some unsatisfactory result might be secured; but a practical one I do not believe he would obtain, for he is not told what to select or how to treat it, as I think he ought to be.

56 X Q. In view of our present knowledge, what direction ought

to have been given in regard to selection and treatment of the material?

A. It seems to me at least a class of fibrous substances to be employed should have been named, since the great majority of such things turn out to be wholly unfit for such use. It seems to me it would have been well also to point out the exact mode of carbonization so as to procure the best product.

57 X Q. What do you mean by pointing out the best mode of carbonization?

A. If, for instance, the carbonized incandescing conductor is to have an arch shape, the workman is left entirely in the dark as to whether he should take an ordinary piece of wood and cut it in an arch form, or whether he should take a piece of wood with the fibres running parallel and bending it into that form and holding it under constraint in a closed receiver away from the air, put it through the carbonizing process. This he would be left to find out for himself. Now, as I understand it, if he fell upon the first plan and attempted to cut the arch piece from ordinary wood and then to convert it into a carbonized conductor, all the difficulties which I before pointed out would be present, namely, the want of homogen-ity in the final structure both when heated to that temperature at which it would be useful in a lamp, the action known as arcing would be certain to take place and the conductor be destroyed and the lamp become useless; and the same remark is true if having carbonized the wood before it was reduced to form he should then attempt to cut the arch piece from the charcoal thus produced.

58 X Q. In your answer to question 11 you state that you find
the embodiment of the elements of the modern incandescent
767 lamp first described in United States patent No. 223,898 to
Thomas A. Edison. Did you mean to include in this a description of the proper method of making an efficient incandescent conductor?

A. Certainly not.

59 X Q. When was the patent to Edison, to which you have referred, applied for?

A. November 4th, 1879.

60 X Q. Do you find in the Edison patent referred to a sufficiently definite and explicit description of the process for making an incandescent conductor for an electric lamp to enable a person skilled in the art, as it stood in January, 1880, to make a practically efficient incandescent conductor for an electric lamp?

Objected to as incompetent, immaterial and irrelevant, and as not warranted by the direct examination.

A. The patent in question seems to me to give much fuller information on this point than the patent in suit. It certainly names materials that may be used for this purpose; it names processes by which they may be put in the desired form; it names a process by which they may be protected during carbonization and shows a mode of adaptation to the electrodes that lead to and from the lamp. Some information is certainly communicated in "I have discovered that even a cotton thread properly carbonized and placed in a sealed glass bulb exhausted to one-millionth of an atmosphere," &c.; also the language that "if a thread be coiled as a spiral and carbonized, or if any fibrous vegetable substance which will leave a carbon residue after being heated in a closed chamber be so coiled," &c. This language certainly points in the direction in which one must proceed, and is in that respect fuller than the patent in suit. Other quotations may be made from the specification pointing in the same direction. Thus, "If the cotton thread is liable to be distorted through carbonization it is to be coiled between a helix of 768 copper wire. The ends of the carbon or filament are secured to the platinum leading wires by plastic carbonized material and the whole placed in the carbonizing chamber." The copper is then eaten away with nitric acid, and the carbon residue is employed as an incandescent conductor in the lamp. These directions seem to me more explicit than any contained in the patent in suit.

61 X Q. Referring now to the selection of material, would it in your opinion be sufficient to refer merely to the cotton and linen thread without giving any directions as to what kind of such thread should be selected?

Objected to as incompetent, immaterial and irrelevant, and as not warranted by the direct examination.

A. It would seem to me that the direction would be far more explicit than any given in the patent in suit, and probably quite sufficient to lead to some success, inasmuch as the cotton and linen thread as usually found in the market are quite uniform in cross-section, and therefore in quantity of material contained in any cross-section, and would be likely to furnish a carbon residue of tolerable uniformity throughout its entire length. I take it for granted that if thread were used, any one skilled in the art would select a thread of suitable size when making allowance for the shrinkage in carbonizing to give him a carbon wire for a conductor suited to his purpose. Exactly what would be suited to his purpose would depend upon the conditions under which he proposed to use the lamp as respects the electro-motive force and the value of the current at his disposal. In this respect both are alike silent, both the patent in suit and the patent alluded to.

62 X Q. Is the cotton and linen thread of commerce more uniform in thickness than the paper of commerce?

Same objection as before.

769 A. I should say yes, almost of necessity from the mode of manufacture. Perhaps not in thickness, strictly speaking, but in the quantity of material present in any section. The most important reason for this opinion is that most papers which are not glazed or smooth are quite wanting in uniformity of thickness. Those which are, are made apparently uniform in thickness by being passed through heavy calender rolls so that the excess of material at any one point is condensed, and while the difference in thickness might not be apparent, the difference in quantity of car-

bonaceous residue would very likely be too great for the purpose in question.

63 X Q. Is it not a fact that the thread as found in commerce is frequently glazed with substances which would be deleterious to the carbon and filled with dyes and other substances which would unfit it for use for its purpose as much as paper is so unfitted?

Objected to as incompetent, immaterial and irrelevant, and as not warranted by the direct examination.

A. I do not think so to the same extent. The very purpose to which thread is put, to be drawn many times continuously through a fabric, almost of necessity compels the manufacturer to secure uniformity. And if it be glazed with such substances as are named in the question, the excess of such glazing or stuffing would be generally removed in the process of manufacture. I do not, however, mean to say that thread is by any means the best material, or that in modern practice one would be likely to employ it.

Adjourned to Tuesday, March 12th, at 9 a. m.

770 PRINCETON, N. J., *March* 12, 1889—9 a. m.

Present: Mr. Dyer, Mr. Curtis.

Professor CYRUS F. BRACKETT—cross-examination resumed.

By Mr. CURTIS:

64 X Q. In your answer to question 28 you say that in the old forms of lamp construction referred to in the Edison patent No. 223,898, the globe was ground to and fitted to a glass plate or closed by means of metal caps. To what prior patent or publication did you refer when you said that the globe was ground to and fitted to a glass plate?

A. In that part of my answer in which the expression ground or fitted to a glass plate was employed, I had reference to the early state of the art in which experiments were tried in an illuminating chamber consisting of the ordinary plate of the air pump with its filled glass receiver, the grinding and fitting being of precisely the same character as that of the patent in suit. I referred to the early publication in the Philosophical Transactions and the collected works of Davy coupled with the general knowledge as to the construction of air-pump receivers, and indeed also the English patents of Staite and Kosloff; the United States patent of Kosloff and the two 1878 patents of Sawyer and Man to which I have already referred, namely, 205,144 and 210,809.

65 X Q. In your answer to question 21 what is the "essential improvement in the art of incandescent lighting" to which you refer?

A. I should say primarily it consisted in the employment of an incandescent conductor of considerable length and very inconsiderable cross-section, so that currents of high potential and of small quantity can be successfully employed for producing the light.

And this general requisition would compel one constructing 771 such lamps to employ material suited to be put into such a general form, namely, if I may so express it, in the form of a wire of carbon rather than the form of a short thick block. Of course I do not now allude to the lamp chamber or to fittings, conductors, &c., merely to the active part of the apparatus.

66 X Q. How would the omission of the words "or charcoal" to which you refer in your answer to question 21 help the patentees to cover such an essential improvement as you have now specified?

A. If the term "charcoal" remained standing in the patent, so wide a range of material would be indicated that it seems to me one who should attempt to construct a lamp would be about as well off and not much better than he would have been if no material whatever had been named. The word carbon would, to my mind, indicate that an attempt was made to exclude the vaguer meaning which would be conveyed by the simple term charcoal, which has a commercial signification and means the residue after the ignition of ordinary wood, and especially when the term wood carbon is considered in connection with the hints given in the specification, it would be an indication to my mind that the patentees intended to cover some form of carbonaceous residue resulting from a structure different from that of ordinary wood.

67 X Q. In your answer to question 31 you say that some of the modern incandescent lamps have conductors which are not made of carbonized fibrous or textile material. Are you familiar with the construction of all the incandescent lamps in commercial use in this country at the present time?

A. I cannot say that I am familiar with them all. I know something of several varieties.

68 X Q. What manufacturers of incandescent lamps in this country use carbons which are not made of carbonized fibrous or textile material?

A. It is my understanding that the lamps which are made by the United States Electric Lighting Company employ a material which in the final preparation before carbonization is not 772 fibrous. It is my understanding also that the Bernstein lamp employs a material, which though fibrous in the first place, is so treated as to become at least partially not so before calcination. I think also the Vitrite and Luminoid Company.

69 X Q. What is the material used by the United States Electric Lighting Company to which you have referred?

A. I suppose it might properly come under the general class of the celluloids, which I believe is a structure obtained by dissolving wood fibre and special treatment so that its fibrous character has disappeared. It is known as tamidine.

70 X Q. Do you know whether all the lamps or only part of those made by the United States Company are made of this material?

A. I do not.

71 X Q. How largely are the Bernstein lamps and the Vitrite

and Luminoid lamps in commercial use as compared with those having conductors made of fibrous materials?

A. I am unable to give any very close estimate. I suppose, however, not so large as the lamps having the fibrous material.

72 X Q. Do you know how the carbons of the Bernstein and Vitrite and Luminoid lamps are prepared?

A. I do not know the details. From a conversation with Mr. Bernstein himself some years ago I got the general impression that in the lamp as constructed by his company silk, which may be regarded as an animal fire, was first treated with some preparation and afterwards the resulting substance was subjected to a high temperature, leaving practically a tube of carbonaceous residue which was employed as the incandescent conductor of the lamp. With reference to the preparation of the material in the Vitrite and Luminoid lamp I can give no special information.

74 X Q. In your answer to question 15, in what sense did you understand the expression "a practically useful structure for the purpose of electric illumination" to be used?

A. By the expression employed, I should understand a
773 lamp which might fairly be said to be beyond the experimental stage in which it might be able to maintain its integrity for a few hours or days as the case might be and to be such as might be offered to the public with an expectation of a life somewhat comparable with that which now obtains in the modern electric lamp. I should not consider it a practically useful lamp if it had to be re-exhausted from time to time, or if it had to receive any special care on the part of the attendant to fill it with gases not containing oxygen so as to prevent its destruction. I suppose it would be difficult to draw an exact line between a practical and a non-practical lamp.

75 X Q. What is the average lifetime of the modern incandescent lamps which you have assumed in your answer to the last question?

A. I should hardly think a lamp would be called a practically useful lamp which would not maintain its integrity at least one or two thousand hours of continuous use. I have some in my possession which perhaps were in my mind unconsciously, that have been used upwards of three thousand hours.

76 X Q. How nearly to these figures would it be necessary that the lifetime of the lamp of the patent should approach in order to make it in your opinion a practically useful structure for the purpose of electric illumination in the sense in which you understood those words to be used in your answer to question 15?

A. Assuming as the basis of the answer that the question means a lamp to be employed for ordinary illumination in our houses, I think that if such a lamp in its original cost of construction and in the care of its maintenance should consume an amount of money and time which would be greater in value than that which would procure an equal illumination by the ordinary illuminants, gas, oil, it would be ruled out of the field of competition and decided as a non-practical lamp. Further, if it were to compete with the modern improved incandescent lamps in public use, the amount of its illumination and the time during which it could be afforded, together with the cost of the lamp, must be such that it can 774 fairly come in competition. It may, however, be said that what in one period of the development of the art will be called the practical lamp in view of the principles just mentioned, would not be so at a subsequent period when better results could be secured by further practice. Now, in my answer to the question, I was influenced, doubtless, by the consideration that to be a practical lamp it should be one which could enter into competition, all things considered, with the illuminants then in use, and on that basis my judgment rested that the lamp would not be one which would properly be called a practical lamp.

77 X Q. Referring now to the time when the patent in suit was applied for, and leaving out of consideration competition with modern incandescent lamps, how many hours would the lamp have to last, in your opinion, to meet the requirements of question 15, as you understood said requirements in your answer to that question?

A. It would be very difficult to name any exact number of hours, but certainly I should say such a lamp ought to be able to maintain itself in a useful condition in daily use through several weeks.

78 X Q. How many hours per day for several weeks, and how many weeks do you mean by "several"?

A. Well, say five or six hours a day, and "several" may mean indefinitely ten or twelve.

79 X Q. Would any of the lamps described in the prior patents and publications to which you have referred, as in your opinion anticipating the claims of the patent in suit, be practically useful lamps?

A. I do not think they would.

80 X Q. Would they be practically operative lamps for any purpase?

A. No doubt they would, and no doubt the lamp shown in the patent in suit might be for some purposes for a short time.

81 X Q. In your answer to question 4 you refer to the English patent of King, No. 10919 of 1845, and quote from the specification the paragraph relating to the use of the lamp for 775 submarine lighting. What do you understand by the expression "when the apparatus is suitably sealed," used in this paragraph?

A. I understand if in case an incandescent conductor of carbon, which is liable to be consumed if oxygen be present when it is in action, were employed in the construction of a lamp, and if in such lamp a vacuum were produced, and it were hermetically closed, then such a lamp might be used in submarine lighting.

82 X Q. What do you mean by "hermetically closed"?

A. I mean the same thing as is to be understood by the language "suitably sealed." Those are the words that the patentee uses. By closing, I mean sealing.

83 X Q. Do you understand this paragraph quoted to refer to any different construction or further sealing of the lamp than is

shown in figure 2 of the patent and described in the part of the specification preceding this paragraph?

A. There is nothing in the patent by which this question can be decided, I believe. In the structure shown a platinum wire enters the top of the illuminated chamber and is sealed to the glass constituting it in the usual way, I suppose. But the connection with the electric conductor at the bottom is to be made through a copper wire which communicates with the lower end of the incandescent carbon rod. When the Torecellian vacuum is made, as is pointed out in the patent, it is not easy to see how the same sort of seal can be made at the lower extremity of the lamp, for it is manifestly impossible to fuse the glass and the copper wire together so as to effect that purpose. It appears, therefore, that some other sealing than that alluded to in the question or at least some other arrangement for closing the tube than would be employed in simply fusing the glass and lower conductor together is contemplated by the patentee.

84 X Q. Would it be practicable to use the lamp for submarine lighting with the mercurial seal such as used in barometers?

776 A. It would be entirely possible to use such a lamp. It certainly would not be a very convenient one.

85 X Q. Would it in your opinion require any invention to use a platinum wire for the lower connection and seal it into the glass in the same manner in which the upper wire is sealed into the glass?

Objected to as immaterial, irrelevant, and incompetent and not warranted by the direct examination.

A. Probably not.

86 X Q. The art of sealing platinum wires into glass so as to obtain a tight joint has been well known in the art for forty or fifty years, has it not?

Objected to as immaterial, irrelevant, and incompetent and not warranted by the direct examination.

A. It has.

87 X Q. In what classes of apparatus had such a joint between glass and platinum been used prior to 1880?

Objected to as immaterial, irrelevant, and incompetent and not warranted by the direct examination.

A. It had been used in the construction of eudiometric apparatus for the analysis of gases, in some forms of electrolytic apparatus for decomposing liquids; and somewhat more recently, in the construction of vacuum apparatus, Geissler tubes, &c., but prior to 1880.

87½ X Q. Are you familiar with the construction of Geissler tubes as practiced prior to 1880?

A. I am. I frequently constructed them myself.

88 X Q. Were the enclosing chambers of Geissler tubes made entirely of glass?

A. They were.

777 89 X Q. For what purpose were the platinum wires sealed into the glass chamber?

A. To serve as electrodes for the application of the electric current.

90 X Q. Were Geissler tubes exhausted to a high vacuum and also charged with various gases?

A. They were not in general exhausted to a high vacuum in the modern sense. They were, however, charged with various gases.

91 X Q. How was the charging with gases and the exhaustion effected; and how were the Geissler tubes sealed up so as to leave the chamber wholly of glass?

A. The chamber being suitably shaped in glass by the art of the glass-blower, and having its electrodes inserted and fused therein, and being furnished with one or more accessory tubes, the Geissler tube itself was usually, when any other gas than atmospheric air was to be employed, rinsed out by the transmission of the gas to be experimented upon for a considerable time until all the air might be presumed to be swept out of it, one of the tubes employed for that purpose closed the other connected with the air pump and the exhaustion carried on to such a degree of exhaustion as the pump was capable of producing, and in this condition the sealing lamp was applied to the tube still remaining connected with the air pump and it was closed off by the fusion of the glass.

92 X Q. The accessory tubes to which you have referred were made of glass, as I understand, sealed to the body of the chamber?

A. They were. Sometimes only one such tube was employed.

93 X Q. Were such Geissler tubes made in complicated forms and originally out of two or more separate pieces of glass?

A. They were sometimes.

94 X Q. How were these separate pieces joined together?

A. By fusion.

95 X Q. All this work, as I understand, was well known in the art prior to 1880?

778 A. It was.

96 X Q. In your answer to question 13 you say it would not be feasible to seal the glass base plate shown in the patent to the flange of the globe. Why would this not be feasible?

A. Several reasons may be given. In the construction of the Geissler tubes and such apparatus it is well known that the glass employed must be of the same kind, that is to say, having pretty rigorously the same coefficient of expansion; otherwise when sealed together changes of temperature inevitably crack the joints. The character and thickness of the tubes which are employed where such joints are to be made must in general be very considerably less than is shown in the chamber and the plate exhibited in the patent in suit. In the description and drawings shown in the patent in suit it would seem to me impracticable to effect a complete union by fusion between the chamber itself and the glass plate shown. Certainly the difficulty of the operation would be such as to render the practical manufacture of such lamps extremely difficult if not impossible.

97 X Q. These difficulties, I understand you, were well known prior to 1880?

A. I believe they were.

98 X Q. In your answer to question 14 you say it would not be feasible to seal the tubular conductors into the glass base plate of the lamp even if they were made of platinum. Are you quite sure that it would be impracticable to seal platinum tubes that would answer the purposes of the lamp described in the patent and shown in the drawing into a glass base plate so as to form a tight and durable joint?

A. In my opinion it would be wholly impracticable to seal such platinum tubes into a glass base plate such as is shown in the drawing and described in the patent, and I give as further reasons that the tubes shown are of sufficient diameter to be closed with screws which are to be turned in after the exhaustion has taken place,
which fact implies a considerable diameter in the tube which
779 would in my opinion be wholly incompatible with the integ-
rity of the structure when such platinum tubes were fused
to so thick a glass plate. Of course I do not mean to express the opinion that such a construction might not possibly be effected by exercising great care, but I do not think it could be so effected readily and frequently as to make it a practically useful mode of constructing an incandescent lamp of the type shown.

99 X Q. Please answer the question without reference to the thickness of the glass plate, assuming that the constructor is at liberty to use any thickness of plate he desires.

A. Assuming a plate sufficiently thin to allow the glass-blower to effect a union, it would, in my opinion, in such a lamp be entirely unable to endure the pressure upon it when the lamp was exhausted. It seems to me that the construction shown implies a plate of considerable thickness.

100 X Q. Then, as I understand it, you would be considerably surprised if it turned out to be a fact that ordinary glass-blowers skilled in the construction of Geissler tubes as they were made before 1880 could readily seal such platinum tubes as I have referred to into a glass base plate which would answer all the purposes of that shown in the drawing of the patent in suit?

A. I should certainly be surprised if I were shown a lamp constructed in the manner shown in the drawing in the patent in suit, that is to say, having a glass base plate sufficiently thin to adapt itself to the art of the glass-blower in sealing in the platinum tubes of sufficient size to be useful which, at the same time, was able to maintain both perfect union and so prevent leakage and sustain the atmospheric pressure which would necessarily be present in such a lamp.

101 X Q. In your answers to the last four or five questions, do you take into account the statement contained in the patent No. 205,144, referred to in the patent in suit as describing more fully the construction of the base of the lamp, that "the form of the

stopper B may be changed to that of a stopper ground into
780 the end of the globe A, as stoppers are ground into bottles"?

A. Yes; this would make no change in my answers.

102 X Q. In your answer to question No. 10 you enumerated among what you consider the essential differences between the old and unsuccessful incandescent lamps and the modern successful incandescent lamps an incandescent conductor offering a high resistance to the passage of the current so that the electric energy might be conveyed to the lamp with a high potential and small current. In this answer you had in mind, had you not, the adaptation of such lamps for use in parallel or multiple arc?

A. Not necessarily.

103 X Q. Would this be a necessary or desirable feature of a lamp to be used in large numbers in series in the same circuit?

A. Of course if many such lamps, each offering a high resistance, were placed in series, a limit would soon be reached in the resistance which they would offer so that the potential required to send a current through them would become undesirably high. But in any use of an incandescent lamp it is clear that the heat, and so the light being dependent on the resistance offered by the incandescent conductor, the resistance should be sufficiently great to fulfill its function economically. I only mean to be understood that in the modern practice, however the lamps are joined, such a resistance is sought to be obtained as will permit the temperature necessary to illumination to be maintained without the use of too large leading wires or conductors.

104 X Q. Do you know that as a matter of fact modern incandescent lamps are now largely used in series?

A. I believe they are in some cases.

105 X Q. Do you know whether in commercial practice the carbon conductors of such lamps are made of low or high resistance?

A. Lower, of course, than were used in parallel circuit.

781 106 X Q. Do you know what the resistance commonly employed is for such lamps when worked in series?

Objected to as immaterial and irrelevant because the lamp of defendant in evidence in the case is a high-resistance lamp intended for use in multiple arc.

A. I do not think any direct answer can be given to the question unless the number in the series were mentioned and the other conditions involved in the circuit.

107 X Q. Do you know that as a matter of fact modern incandescent lamps are successfully worked in series commercially, or with carbons as short and as thick as that shown in the drawing of the patent in suit?

A. I know that in the art lamps of very low resistance compared with that used by the defendant are in use in series. Exactly how small such resistance and how thick such incandescent conductors may be, I am not prepared to state.

108 X Q. Do you think it would be impracticable to construct lamps commercially with platinum conductors fused into the glass

large enough for supplying current to a carbon conductor of the dimensions shown in the drawings in the patent in suit so as to make successful and operative lamps in that way?

A. It might not be by adopting some other disposition of the plate. If the conductors were to pass through a plate as shown in the drawing and described in the specification I believe it would be.

109 X Q. Suppose they were sealed in *in* the same manner in which platinum wires were sealed in the Geissler tubes prior to 1880, would it be impracticable to construct lamps in that way?

A. It might not be.

110 X Q. Do you think it would be?

A. I think it could be done.

111 X Q. Do you think there could be any particular difficulty
in it assuming the state of knowledge that workers in glass
782 had prior to 1880 in the construction of Geissler tubes and
the other similar apparatus to which you have referred in
your previous answers?

A. Probably not, but I do not believe that lamps made with conductors so large as are implied in the question would be as long-lived as those employing the smaller conductors.

112 X Q. Do you think it would have required any invention for a person skilled in the art of making Geissler tubes and similar apparatus as the art stood prior to 1880 to have sealed such conducting wires in *in* the way indicated in my previous question?

A. It might not require invention or be difficult to seal such wires into glass in the way indicated, and I should say it would rather require skill than invention.

113 X Q. Would it have required any invention on the part of a person skilled in the art of making Geissler tubes as the art stood prior to 1880 to have used accessory glass tabes for filling and exhaustion in the manner you have described in connection with the construction of Geissler tubes instead of the tubular electrodes described in the patent in suit?

A. I should think not.

114 X Q. This was a well-known device, was it not, in such apparatus for filling and exhausting a chamber required to be hermetically sealed?

A. It was.

115 X Q. In addition to the apparatus you have referred to as constructed and well known prior to 1880, with platinum electrodes fused into the walls a chamber made entirely of glass, would not Prof. Crooks' radiometers come within this description and were they not known prior to that time?

Objected to as immaterial and irrelevant.

A. They would, and they were known prior to that time.

116 X Q. These were exhausted to a very high vacuum, were they not?

Same objection.

783 A. They were.

117 X Q. And the chambers were constructed with especial reference to maintaining such a vacuum, were they not?

Same objection.

A. They were.

Redirect examination by Mr. DYER:

115 Re-D. Q. In giving your answer to X Qs. 41 and 42 did you have particularly in mind the material as a material or its use as an incandescent conductor or both?

A. More especially the material as a material.

116 Re-D. Q. You have been asked on cross-examination as to the manufacture in America of incandescent lamps having carbons made from carbonized non-fibrous material. What do you understand the fact to be with regard to the manufacture of such lamps in England?

Objected to, unless the witness knows of his own knowledge what the fact is.

A. I believe that in England lamps are largely manufactured using carbon conductors composed of non-fibrous materials more largely than any others.

117 Re-D. Q. Referring to your answers to X Qs. 75 and 76 and thereabouts, how long do you think a carbon burner raised to a degree of heat suitable for lighting purposes would last in such a lamp construction as that described in the patent in suit?

A. My general answer is, I believe it could not be very durable. It probably would last not more than a few hours at the utmost. My reason for this opinion is that owing to the high temperature it would be extremely difficult to exhaust it so thoroughly that a residuum of air would not remain quite competent either by the yielding of its oxygen to consume it or by the collision of the 784 remaining nitrogen to destroy it, supposing a vacuum sufficiently high to be maintained. But I should think it would be extremely difficult to maintain such a vacuum, and, if not, the carbon would certainly soon be destroyed.

118 Re-D. Q. To what extent, if at all, would this opinion be modified, if such a lamp structure were attempted to be filled with nitrogen gas or other gas not containing oxygen either at atmospheric pressure or in a rarefied condition?

A. I do not believe that this change would greatly prolong the useful life of the lamp, though it might do so somewhat

119 Re-D. Q. What in your opinion would be the relative value for electric lighting purposes of the lamp described in the patent in suit and those of the prior patents of Roberts, Shepard, Konn, Kosloff and others which you have referred to as anticipating the claims of the patent in suit?

A. About the same.

120 Re-D. Q. Would there be any material difference in this re-

spect between the lamp of the patent in suit and those of the earlier patents referred to?

A. I do not think there would be.

121 Re-D. Q. You have stated on cross-examination that it was well known in the construction of Geissler tubes and other apparatus before the year 1880 that the separate glass parts of a vacuum chamber could be secured together by the fusion of the glass, and that platinum wires passing into the chamber could be sealed into the glass by the fusion of the glass upon the wires. Please state whether or not in your opinion the lamp structure described and illustrated in the patent in suit is one adapted or designed for the application of these known facts in its construction?

A. It does not appear to be designed for that mode of construction and in my opinion it is very poorly adapted to it.

Recross-examination by Mr. CURTIS:

122 Re-X Q. Why is the lamp structure just referred
85 to poorly adapted to the construction employed in the
Geissler tubes?

A. For reasons already referred to in my previous cross-examination and in my direct examination. The great extent of the chamber, the presence therein of large metallic surfaces, offer serious obstacles in the proper exhaustion of the vessel to render any sealing, however efficient, useful; but more especially, the size of the conductors shown, even though they were made of platinum, the thickness of the glass through which they pass, would be very unfavorable elements in the finished product, inasmuch as they would tend constantly to leakage for the reasons I have already pointed *at*.

123 Re-X Q. Was this all well known prior to 1880?

A. Certainly not so well appreciated prior to that time as since. It was not the practice, I believe, in the construction of Geissler tubes, and it certainly was not possible in the nature of the case to have recourse to the high temperature which is available in the construction of the lamp in order to secure the more perfect vacuum. This difficulty of securing a perfect vacuum is one which increases with the high temperature. In the modern lamp chamber, being small, the residue of air is proportionally small and the danger to the incandescent conductor is thereby diminished. These elements were certainly not so thoroughly appreciated prior to 1880 as they have since come to be.

124 Re-X Q. The facts in regard to the glass-work were fully known, were they not, prior to 1880?

A. They were.

125 Re-X Q. And the other facts to which you refer had been investigated and published by Crooks and Stearns in connection with their work on the radiometer, had they not?

A. They had.

126 Re-X Q. Have you ever made any experiments with the lamp structure shown and described in the patent in suit to de-

termine the facts upon which the opinions you have expressed are based?

786 A. I have not. My answers are rather based on the behavior of lamps of the ordinary construction in which incandescent conductors are present in a hermetically sealed glass chamber in which some manifest imperfection had come to be evident, as the overheating of one of the conductors causing an imperfect sealing. Such a lamp through the minutest possible opening speedily receives enough of air from the outside to cause its destruction, even though the injury be so slight as to escape detection otherwise.

127 Re-X Q. Have you made any experiments with incandescent lamps filled with nitrogen or other inert gas?

A. I have not. My answer touching that subject is based on the well-known fact that the Crooks phenomenon is set up in high vacua when any gas is present, namely, the particles of the gas whatever they may be, are put in a state of high activity, and on suitably devising the apparatus by the mere collision of such particles without the passage of the current in the ordinary sense pieces of metal are heated to incandescence and even to fusion, thus losing their integrity, and I infer the same thing would happen with carbon conductors.

128 Re-X Q. Are you aware of the fact that many of the present commercial incandescent lamps are made with quite low vacuum and residual atmospheres of various inert gases?

A. I believe it to be so.

129 Re-X Q. And are not such lamps as a rule fully as successful as lamps exhausted to a very high vacuum?

A. Not with conductors of the same minuteness in cross-section, I believe. When such lamps are, however, in successful operation, I believe they do not attain a very high vacuum.

130 Re-X Q. What English lamps do you believe to contain a non-fibrous carbon?

A. That usually known as the Swan lamp, I believe, which I understand is very largely manufactured in England.

787 131 Re-X Q. Do you know how the Swan carbon is made?

A. Only in general. I believe one of the actions which I have already explained in this examination is resorted to, the result of which is similar to that which is obtained in the production of parchment paper. Fibrous material treated with zinc chloride or possibly with sulphuric acid is reduced to a gelatinous form and then shaped and freed from the chemical used and finally carbonized.

132 Re-X Q. The carbon is made, is it not, by partially parchmentizing a cotton thread but still leaving sufficient coherence in the thread to maintain substantially its original shape?

A. I understand that to be the case.

Re-redirect examination by Mr. Dyer:

133 Re-re-D. Q. How far, if at all, are your opinions with regard to the practicability of the lamp structure of the patent in suit as-

sisted by your practical experience with and knowledge of pneumatic apparatus in which the same conditions are reprodued?

A. Very largely. I may say in response to this question that a common-class experiment which I have been accustomed to exhibit is the production of a form of electric light similar that shown in the Geissler tube by employing a tube which can be connected with the air pump and also by electrodes at its extremities connected with the inductorium and by putting both the pump and the inductorium in action proceeding progressively to exhaust the tube when the various Geissler phenomena show themselves. If with such an apparatus a good vacuum be obtained so that the phenomenon is well displayed and then it be closed by an exceedingly well ground and fitted stop-cock, the leakage into such a tube so readily takes place that the whole series of phenomena can be observed in the reverse order without difficulty, thus showing that the
788 air makes its way readily through the sealing employed in such apparatus which does not differ essentially from that shown in the patent.

CYRUS F. BRACKETT.

Sworn to before me—

WILLIAM T. FARNHAM,
Notary Public and Special Examiner.

NEW YORK, *March* 21, 1889—3 p. m.

Met pursuant to adjournment.

Present: Amos Broadnax, Esq., counsel for complainant; R. N. Dyer, Esq., counsel for defendant.

The witness, Professor CYRUS F. BRACKETT, being recalled and resworn on behalf of the defendant, deposes and says as follows in answer to questions by defendant's counsel:

1 Q. Assuming that the expression fibrous or textile material used in the first and fourth claims of the patent in suit means that the material which is carbonized is both fibrous and textile, does the defendant's lamp, which you can assume is provided with a carbon made from the stalk of the bamboo, in your opinion, employ such a fibrous or textile material?

Question objected to on the ground that it is not competent or material upon any issue involved in this case.

A. I do not think it does, for the reason that if we are to consider the material both fibrous and textile whatever definition may be given to the word "textile" it is obvious that bamboo is not such a material, inasmuch as it is quite unsuited to be either spun or woven, nor is it suited to be made into paper. In no sense, therefore, would the defendant's lamp employ such a material as is indicated in the question.

789 2 Q. Please state whether or not, in your opinion, the principles of construction used in Geissler tubes as to sealing the glass parts together to form a vacuum chamber, exhausting and sealing the same by means of a glass tube and sealing platinum

into the glass for carrying an electric current into the vacuum chamber were prior to the issue on January 27, 1880, of Mr. Edison's patent No. 223,898, and prior to the publication of his work upon incandescent lamps in the "New York Herald" of December 21st, 1879, applicable to lamp structures like that of the patent in suit, or known or recognized as equivalents for the corresponding features of lamp structures like that of the patent in suit?

Same objection.

A. I do not think they were. A Geissler tube comprises a chamber of glass into two points of which at least are fused platinum electrodes for the introduction of the current into the chamber which is more or less completely exhausted. The work of exhaustion is usually accomplished by connecting the tube with a suitable exhausting apparatus, an air pump for instance, and after having formed the vacuum by means of the pump, it is hermetically sealed at the blast lamp. The exhaustion of the Geissler tube may be and is in practice carried through various stages of completeness depending on the purpose which the experimenter has in view. The phenomena occurring in the tube will vary in character, depending on the completeness of the exhaustion and the character of the residual gas contained in it. The term does not necessarily imply that the exhaustion shall be carried to that degree which we know as a high vacuum. The platinum electrodes which are fused into the glass may be very small, inasmuch as the current necessary to produce the phenomena may be of very small quantity, but is usually of high potential. The whole phenomena depending on the passage of the current through the air space or space occupied by other residual gas taking place in the gaseous 790 medium precludes the idea of the electrodes being brought in contact. They are usually separated by very considerable distances, oftentimes several feet. It appears to me, therefore, that the principles involved, namely, the minuteness of the platinum wires used for electrodes, the fact that they do not come in contact either immediately or mediately by any conducting material save a gaseous one, that the chamber does not necessarily contain a high vacuum, seem to me not to be applicable to the construction of incandescent lamps, as they are known in the art.

3 Q. Please state whether or not, in your opinion, the principles involved in the construction of the chamber forming the Geissler tube, namely, the making of it in a continuous piece of glass with the joints closed by the fusing of the glass and the using of platinum wires passing through the glass walls and sealed into them by the fusing of the glass upon the wires were, prior to the publication of Mr. Edison's invention, useful in or applicable to the construction of the lamp chambers of incandescent lamps, giving your reasons for any opinions you may express?

Same objection.

A. It does not seem to me that they were. Such incandescent lamps as were known or had been proposed prior to the work of

Edison alluded to, employed incandescent conductors requiring currents of great strength to bring them to the necessary degree of incandescence to render them luminous, and this fact is incompatible with the small conducting wires which are universally employed in Geissler tubes, for if such wires were used they would either fuse directly on the application of sufficient current or by the resistance which they offer would develop sufficient heat to cause them to rapidly expand before the glass in contact with them could be heated to the same temperature, the result of which would be that a stress between the platinum electrodes and the glass would be produced 791 sufficient to break asunder the union or fracture the glass. A necessary consequence of this would be that the chamber would not retain its exhaustion, air would be admitted, and immediately begin its destructive effect by oxidizing the incandescent conductor and it would then only be a question of time, usually a very short one, before the conductor would be completely destroyed or rendered unserviceable. And, further, an inspection of the various devices for incandescent lighting, and especially the one shown in the patent in suit, reveals the fact that it was contemplated that the life of the carbon would not continue for any great length of time and accordingly the chambers enclosing the incandescent conductor and more or less suited to maintain a vacuum or to enclose an innocuous gas were so constructed as to be readily taken apart for the purpose of renewal. The idea does not seem to have occurred to the early workers in the art of incandescent lighting to construct an apparatus such that when the carbon should fail to fulfill its function the whole could be thrown away or replaced by a new lamp. The effort seems to have been to construct what might be called a lantern with its adjustable portion which could be removed giving access to the interior for the renewal, from time to time, of the incandescent conductor. For these reasons I have given the opinion first stated. I do not think that the principles involved in the construction of the Geissler tube were at all applicable to the construction of incandescent lamps at the date mentioned.

4 Q. What would be the effect of attempting to enclose a carbon of the size of that shown in the patent in suit or of those used by the early experimenters, in a glass chamber like that used for Geissler tubes?

Some objection.

A. The effect would be, in my opinion, that if the electrodes of the Geissler tubes were not made larger than usual there would be failure to heat the conductor intended to be incandescent, and 792 so the lamp would be useless; but if we assume that the platinum electrodes entering the chamber and fused into it were of sufficient size to carry a really useful current, then an effect which I have already pointed out would take place, namely, the unequal heating between the platinum electrodes and the glass would result in its immediate fracture and so the lamp would be rendered useless.

5 Q. Why would this unequal heating take place?

Same objection.

A. The immediate effect of the current would be to heat the platinum electrodes to high temperature before the glass would have time to become equally heated and expand with it, supposing their coefficients of expansion were the same, and thus fracture would occur. But, secondly, the coefficients of expansion are not the same, and the difference becomes mischievous in proportion to the size of the platinum electrode which is fused into the glass.

6 Q. What change, if any, in your opinion, in the principle of the incandescent lamp was necessary before the Geissler tube construction of chamber could be applied to such lamps?

Same objection.

A. In my opinion, it was absolutely necessary to abandon the old lines of procedure in which the incandescent conductor was of large cross-section, and therefore required a current of great intensity to operate it, and to set out on a wholly new line, namely, to employ as the incandescent conductor an infus*a*ble material offering great resistance to the passage of the current, so that it could be heated to incandescence by a current of small intensity by employing a sufficient electro-motive force to cause the current to pass. By adopting this plan the size of the platinum electrodes could be reduced in like manner, small platinum wires could then be employed and successfully fused to the glass 793 so that the danger of fracture would be removed, and the further advantage would be offered that the enclosing chamber could be made of small size, and therefore more completely and thoroughly exhausted in the accomplishment of which the very structure of the lamp itself offers very important aid, namely, before sealing, and while the exhausting pump is in operation after a tolerably perfect vacuum has been formed, the electric current can be sent through and the whole heated, thus expanding the air and removing that which adheres to the filament and to the glass walls, and thus enable the constructor to reach what is now known as a high vacuum, which is the essential condition of long life in the lamp, and therefore of its commercial usefulness.

7 Q. Do you include such lamps as that shown in the patent in suit under the statement contained in your last answer with regard to the old lamps having conductors of large cross-section?

Same objection.

A. I do. By the expression large cross-section I mean relatively to the length of the conductor. Certainly, the one *one* there shown would come under that class.

8 Q. When was the radical change in the art made which you have referred to in your answer to question 6, which made it possible to apply to incandescent-lamp construction the construction of chamber that had been used in Geissler tubes?

Same objection.

A. The principle was announced in a publication in the "Herald" of December 21, 1879, and also in the patent granted to Thomas A. Edison dated January 27, 1880, number 223,898.

9 Q. Please state whether or not, in your opinion, the Geissler tube radiometer construction of enclosing chamber was known or recognized prior to the time of the Edison publication you
794 have referred to, as the equivalent or substitute for the structures which had been used or suggested for use as the enclosing chambers of incandescent electric lamps?

Same objection.

A. I believe it was not. I know of no publication in which it is set forth, nor do I know of any lamp construction in which it is shown prior to that date. And in my opinion, as already set forth, such a construction was wholly inapplicable to the lamps which were known before that date.

10 Q. Since the giving of your prior deposition in this case have you changed your views with regard to the application of the Geissler tube construction to incandescent electric lamp as stated by you on cross-examination?

A. No; I have not. I stated in answer to cross-question 111 of my prior deposition that I did not believe the lamps "would be as long lived as those employing the smaller conductors." At the time of giving my prior deposition I did not have the particular considerations bearing upon this special topic as fully in mind as at the present time, and consequently I did not state my views as fully as I have now done. It does not clearly appear by the general statements of my prior deposition that it was my opinion that platinum wires of sufficient size to carry the current to a carbon conductor of the dimensions shown in the patent in suit could probably be successfully sealed into glass by the fusion of the glass, but that in the use of lamps made in that way the lamps would not have a useful length of life, since the rigid sealing would be quickly broken and permit oxygen to enter the lamp chamber and destroy the carbon. That was my opinion then, as it is now after full consideration, but possibly it is not clearly expressed by my prior deposition. If it should be considered that there is any conflict between my two depositions on this topic, I, of course, desire that my present deposition, which is given with a fuller con-
795 sideration of the special topic and a fuller presentation of my views, should be taken as my opinion.

Without intending to waive his objection as above noted, complainant's counsel proceeds to cross-examine the witness.

10 X Q. Are you aware of the fact that previous to January 1st, 1880, the manufacture and sale of paper from bamboo was a well-known article of commerce?

A. I believe that paper had been manufactured from the leaves of the bamboo, but I am not aware that the fibre and especially that portion of the stalk which has since been employed in the construction of incandescent lamps was so used. I do not think it has been.

11 X Q. Do you know that previous to the date mentioned in my last question, paper had been made and sold as an article of commerce, from what is known as cane or bamboo stalks, leaving out altogether the manufacture of paper from leaves of the stalk?

A. I am not aware of that fact if it be such. I very much doubt if from that selected portion of the bamboo stalk which is employed in the construction of incandescent lamps by Mr. Edison, paper has at any time been manufactured. It may be true that from some portions, from material in such respects resembling it such paper has been manufactured and has been on sale. I will venture the opinion, however, that if one were to take the bundles of prepared bamboo as they go to the lamp factory as his entire stock he would be quite unsuccessful in the manufacture of paper therefrom.

12 X Q. What portion of the stalk of the bamboo does the Edison Electric Light Company make their incandescent conductors?

A. As I understand it, the portions selected are not taken indiscriminately from the bundles of woody fibre which make up the
entire stalk of the plant, but only the firmest and most com-
796 pact portion which lies very close to the exterior after
removing the silicious covering with which that plant is invested.

13 X Q. Generally speaking, do you mean by your last answer that defendants make their illuminating conductors of the straightest and best part of the fibre embraced or making part of the bamboo stalk?

A. While it is true that the portions are selected in which the fibre runs parallel with each other, which I suppose is the condition of fibre alluded in the expression "straightest," yet I do not understand that this is the only quality, but it is quite as important that that portion be taken in which the fibres are most closely compacted together and this is precisely the part which I think would be ill suited to the manufacture of paper.

CYRUS F. BRACKETT.

Sworn to before me,

WILLIAM T. FARNHAM,
Notary Public and Special Examiner.

PHILADELPHIA, PA., *March 13th*, 1889.

Met pursuant to adjournment and upon agreement of counsel.

Present: S. A. Duncan, Esq., for complainant, and R. N. Dyer, Esq., and W. K. Griffin, Esq., for defendant.

Counsel for defendant offer in evidence as exhibits on behalf of defendant the following patents and publications referred to by the witness Prof. C. F. Brackett, and the same are marked as follows:

(1) Pages 32 to 38 inclusive of the Philosophical Transactions of the Royal Society of London, for the year 1809, vol. 9, part I, published in London, Eng., in the year 1809.

(2) Pages 363 to 374 inclusive of the Philosophical Transactions

of the Royal Society of London, for the year 1815, vol. 15,
797 part I, published at London, Eng., in the year 1815.

(3) Pages 21, 26 & 27 of the Philosophical Transactions of the Royal Society of London, vol. 20, sec. 2, published at London, Eng., in the year 1820.

(4) Pages 425 to 439, inclusive, of the Philosophical Transactions of the Royal Society of London, for the year 1821, part I, vol. 21, published at London, Eng., in the year 1821.

(5) Philosophical Transactions of the Royal Society of London, part I, vol. 39, published at London, Eng., in the year 1839, commencing at page 89, the same being a letter addressed to Michael Faraday, Esq., by J. Frederick Daniell, Esq., entitled, "Fifth letter on voltaic combinations, with some account of the effects of a large constant battery."

(6) A paper by the Rev. William Ritchie on experimental researches in voltaic electricity and electro-magnetism, commencing at page 292, vol. 32, part I, of the Philosophical Transactions of the Royal Society of London, for the year 1832, published at London, Eng., in the year 1832.

The foregoing six papers are marked respectively "Defendant's Exhibit Philosophical Transactions, paper No. 1, paper No. 2, paper No. 3, paper No. 4, paper No. 5, and paper No. 6."

(7) Collected works of Sir Humphrey Davy, vol. 2, pages 211 to 213 inclusive, published at London, Eng., in the year 1839.

(8) Collected works of Sir Humphrey Davy, vol. 2, pages 216 to 220, published at London, Eng., in the year 1839.

(9) Collected works of Sir Humphrey Davy, vol. 4, pages 109 to 112, 221, 231 and 232, published at London, Eng., in the year 1840.

(10) Collected works of Sir Humphrey Davy, vol. 5, pages 172 and 173, and pages 220 to 222, and 275 and 285, published at London, Eng., in the year 1840.

The four foregoing extracts are marked in evidence "Defendant's Exhibit Extracts from Collected Works of Sir Humphrey Davy."

798 (11) A paper entitled "Overheated steam applied to the carbonizing of wood," published at page 270, vol. 16, of the American Journal of Science and Arts, published at New York, in the year 1853, and the same is marked, "Defendant's Exhibit Violette Paper."

(12) Paper by M. Sidot, published at page 605, vol. 70, of the Comptes Rendus, published at Paris in the year 1870, and a translation into English of the same paper, the same being marked "Defendant's Exhibit Sidot's Paper."

(13) Watts' Dictionary of Chemistry, vol 1, pages 759 and 760, published at London, Eng., in the year 1863.

(14) Watts' Dictionary of Chemistry, second supplement, page 255, published at London, Eng., in the year 1875.

The two foregoing papers are marked in evidence as "Defendant's Exhibit Extracts from Watts' Dictionary of Chemistry."

(15) Blue Book copy of English patent No. 8644, A. D. 1840, to

Pinkus, and the same is marked "Defendant's Exhibit Pinkus English Patent No. 8644 of 1840."

(16) Blue Book copy of English patent No. 9053, A. D. 1841, to De Moleyns, and the same is marked "Defendant's Exhibit De Moleyn's English Patent No. 9053 of 1841."

(17) Blue Book copy of English patent No. 10919, A. D. 1845, to King, and the same is marked "Defendant's Exhibit King's English Patent No. 10919 of 1845."

(18) Blue Book copy of English patent No. 11076, A. D. 1846, to Greener & Staite, and the same is marked "Defendant's Exhibit Greener & Staite's English Patent No. 11076 of 1846."

(19) Blue Book copy of English patent No. 12212, A. D. 1848, to Staite, and the same is marked "Defendant's Exhibit Staite's English Patent No. 12212 of 1848."

(20) Blue Book copy of English patent No. 13302, A. D.
799 1850, to Shepard, and the same is marked "Defendant's Ex-
hibit Shepard's English Patent No. 13302 of 1850."

(21) Blue Book copy of English patent No. 212, A. D. 1852, to Slater & Watson, and the same is marked "Defendant's Exhibit Slater & Watson's English Patent No. 212 of 1852."

(22) Blue Book copy of English patent No. 14198, A. D. 1852, to Roberts, and the same is marked "Defendant's Exhibit Roberts' English Patent No. 14198 of 1852."

(23) Blue Book copy of English patent No. 119, A. D. 1853, to Binks, and the same is marked "Defendant's Exhibit Binks' English Patent No. 119 of 1853."

(24) Blue Book copy of English patent No. 2547, A. D. 1856, to Way, and the same is marked "Defendant's Exhibit Way's English Patent No. 2547 of 1856."

(25) Blue Book copy of English patent No. 588, A. D. 1857, to Harrison, and the same is marked "Defendant's Exhibit Harrison's English Patent No. 588 of 1857."

(26) Blue Book copy of English patent No. 3164, A. D. 1857, to Burleigh & Danchell, and the same is marked "Defendant's Exhibit Burleigh & Danchell's English Patent No. 3164 of 1857."

(27) Blue Book copy of English patent No. 2841, A. D. 1857, to Way, and the same is marked "Defendant's Exhibit Way's English Patent No. 2841 of 1857."

(28) Blue Book copy of English patent No. 3809, A. D. 1872, to Konn, and the same is marked "Defendant's Exhibit Konn's English Patent No. 3809 of 1872."

(29) Blue Book copy of English patent No. 91, A. D. 1873, to Konn, and the same is marked "Defendant's Exhibit Konn's English Patent No. 91 of 1873."

(30) Blue Book copy of English patent No. 441, A. D. 1875, to Kosloff, and the same is marked "Defendant's Exhibit Kosloff's English Patent No. 441 of 1875."

(31) Blue Book copy of English patent No. 970, A. D.
800 1875, to Jensen (Konn), and the same is marked "Defend-
ant's Exhibit Jensen's (Konn's) English Patent No. 970 of
1875."

(32) Blue Book copy of English patent No. 4805 of 1876, to Werdermann, and the same is marked "Defendant's Exhibit Werdermann's English Patent No. 4805 of 1876."

(33) Blue Book copy of English patent No. 4905, A. D. 1876, and the same is marked "Defendant's Exhibit English Patent No. 4905 of 1876."

(34) Specification and drawing of United States patent to Gardiner & Blossom, No. 20706, dated June 29, 1858, and the same is marked "Defendant's Exhibit Gardiner & Blossom's Patent of June 29, 1858."

(35) Specification and drawing of United States patent of Kosloff, No. 166,877, dated August 17, 1875, and the same is marked "Defendant's Exhibit Kosloff's Patent of August 17, 1875."

(36) Specification and drawing of United States patent of Woodward, No. 181,613, dated August 29, 1876, and the same is marked "Defendant's Exhibit Woodward's Patent of August 29, 1876."

(37) Specification of French patent to Le Molt, dated January 31, 1849, and the same is marked "Defendant's Exhibit Le Molt's Patent of 1849."

(38) Mechanics' Magazine, vol. 44, pages 312 to 316 and page 348 inclusive, published at London, Eng., in the year 1846, and the same is marked "Defendant's Exhibit Extracts from Mechanics' Magazine of 1846."

(39) Journal of the Society of Arts, London, 1872–'3, vol. 21, page 779, published at London, Eng., in the year 1873, and the same is marked "Defendant's Exhibit Published Description of Ladiguin's Electric Light."

It is stipulated and agreed that the copies of publications just offered in evidence may be used with the same force and effect as the original publications, subject to the correction, at any time before the closing of the proofs, of any errors that may be found therein and the addition of any further extracts from said publications that complainant's counsel may desire to add thereto.

801 Complainant's counsel admits that the said publications were published at the respective dates above mentioned, reserving the right, however, to withdraw this admission at any time before the closing of the proofs upon allowing defendant a reasonable time for making proof in regard to the time of such publication.

Counsel for defendant states that he has been unable as yet to obtain a copy of the French patent of Gaudoin, set up in the answer, but expects daily to receive a full copy of such patent by mail from France, and he requests counsel for complainant to stipulate that such copy may be offered in evidence when received even if defendant's time for taking testimony has then expired. The patent will be offered to show a description of the manufacture of carbon pencils for arc lights and other uses by first cutting sticks of wood into the shape and size desired for use and then carbonizing such sticks.

Complainant's counsel states in response to the above request that he thinks the matter may more properly be considered when defendant's counsel has received the paper to which reference is made.

Defendant's counsel states that the foregoing Blue Book copies of English patents and printed Patent Office copies of United States patents are offered in evidence in lieu of certified copies of such patents in accordance with the stipulation between counsel heretofore made and entered upon the record of this case.

The witness, Professor GEORGE F. BARKER, a witness produced on behalf of defendant, being duly affirmed and interrogated by counsel for defendant, deposes and says as follows:

1 Q. What is your name, age, residence and occupation?

A. George F. Barker; age, 53; residence, Philadelphia. I am professor of physics in the University of Pennsylvania.

802 2 Q. What knowledge have you of the science of electricity, and what experience have you had in the use of electrical instruments and apparatus, more particularly the apparatus used for electric lighting?

A. I have been a professor of physics and of chemistry for 25 years or more, and during that time I have had occasion to inform myself with regard to the science of electricity, not only for the purpose of my own experiments, but also for the purpose of teaching this subject to my classes. I have always had at my command a sufficient supply of electrical apparatus for purposes of experiment and of demonstration, and have endeavored to keep myself informed of the progress of electrical science, not only in its theoretical but also in its practical directions. I have followed the progress of electric lighting, especially have made myself more or less familar with the various forms of apparatus required for the generation, distribution and utilization of electricity, for purposes of lighting and the transmission of power.

3 Q. How extensive was your knowledge of and experience with air pumps and other pneumatic apparatus, prior to 1878?

A. Before going to college I was employed for five years in the manufacture of philosophical instruments and apparatus, and of course at that time had an opportunity to become familiar with the construction of air pumps and similar devices for producing a vacuum. Subsequently in the cabinets of apparatus which have been in my charge at the various institutions where I have acted as professor I have been in possession of and have used for instruction and investigation various forms of air pumps both of the older and of the newer kind; the latter being of both the Geissler and the Sprengel form.

4 Q. How extensive has been your experience in the comparison of patents for inventions?

A. I have been frequently called on, during the last fifteen or twenty years, to act as expert in patent causes in matters involving questions of invention and the scope of patents. I have testified in cases involving the facts and principles of both chemical and physical science, and particularly in those which concern

803 the production and distribution of electricity and electric lighting.

5 Q. Are you familiar with the patent in suit?

A. I have read the said patent and believe I am reasonably familiar with it.

6 Q. Have you examined the various patents and publications which have been offered in evidence on behalf of the defendant?

A. I have.

7 Q. Please state whether or not you agree with the witness Professor Cyrus F. Brackett, who has already testified as an expert for defendant, in the statements made by him in answer to question 4 as to the state of the art prior to the year 1878, bearing upon the invention of the patent in suit.

A. I have read the answer referred to in the deposition of Professor Brackett in this case, and I agree with him entirely as to the state of the art prior to 1878, so far as concerns the invention which is the object of the patent in suit. I might state in addition, that the use of carbonized fibrous material for electric lighting purposes has been familiar to me ever since I had any knowledge of the subject of electric lighting. As early as 1853 or '54 I learned from my reading that the pencils which were used for the production of the electric light were made of charcoal, and preferably of boxwood charcoal. Accordingly, following directions which I remember to have read, I produced some of the said pencils by sawing pieces of boxwood into the shape of square rods, placing these in a crucible which was afterward filled with sand and heated to the temperature of complete carbonization. After cooling I found that the said carbon pencils were good conductors of electricity, and I used them for the purpose of producing electric light by incandescence; this incandescence being produced at the points of contact of the said pencils, the battery employed not having sufficient tension to allow of their being separated for the production of an arc.

804 8 Q. In making these charcoal pencils by first cutting boxwood to the shape and size desired and then carbonizing it, do you understand that you were making use of a method well known in the art for the production of these pencils at that time?

A. I considered at the time that I was simply making use of a well-known method for the production of these pencils, that I was following simply an obvious process for that construction and that there was no originality in my thus making them. This, I might add, is one of the methods described for making these pencils in the English patent of Slater and Watson, No. 212 of 1852.

9 Q. Do you agree with Professor Brackett in the conclusion reached by him in answer to question 5, that in view of the state of the art there is no feature of novelty presented by the apparatus described and illustrated in the patent in suit?

A. I do. In the art of electric lighting prior to 1878 two well-known forms of producing the light were employed. In one of these, known as the arc light, the current passed through an intervening space of air from one electrode to the other. In the other the conductor was continuous, but was of so high resistance that the current heated it up to a temperature at which it emitted light;

and this light was, therefore, called an incandescent light. Evidently in lighting by incandescence it is desirable that the material employed should be infusible, so as to withstand as high a temperature as possible; and inasmuch as the amount of heat developed is proportional to the resistance of this conductor, it is desirable also that this resistance should be high. These conditions point out carbon as the substance most suitable to form the incandescing conductor. It is practically infusible and it has a very high resistance. The defect of carbon, however, for purposes of incandescent lighting lies in the fact that it is readily combustible at the high temperature required. Hence we find in the state of the art two directions along which inventors have moved in the production of incondescent lighting. The one set of inventors relying upon the advantages possessed by carbon, have sought to overcome the 805 difficulty resulting from its combustibility by enclosing it in globes of glass, which have either been exhausted of air or in which the air has been replaced by gases containing no oxygen, and which, therefore, do not support the cumbustion of the carbon. The other set of inventors have sought to replace the carbon by some other material as infusible as possible; and have for this purpose employed platinum or iridium or an alloy of these two metals, enclosing the said conductor in a globe, simply for the purposes of protection.

Adjourned to Thursday, March 14th, 1889.

PHILADELPHIA, *March 14th*, 1889.

Met pursuant to adjournment.

Present: Same counsel for defendant, and L. E. Curtis, Esq., for complainant.

The witness continues in answer to the last question:

Experiments had been made by Davy and others very early in the history of the art with both the arc and incandescent lights *in vacuo* as well as in the air. The apparatus which was used for this purpose was some form of ordinary air-pump receiver, either bell-shaped (and resting upon the plate of the air pump) or egg-shaped and closed by suitable taps at its extremities. Subsequently the form of the glass enclosing vessel was somewhat modified, and assumed various shapes more or less spherical in form in some part of it. This enclosing vessel being called in general the globe. I entirely agree with Prof. Brackett in regard to the state of the art concerning the construction and use of the apparatus employed before 1878 for the production and maintenance of the vacuum by means of the air pump and receivers of various forms at- 806 tached variously thereto. I entirely agree with him that it was a common practice before that date to use receivers of various sizes and shaped in many cases like a long and narrow bell jar, the said receivers having separate plates of glass or metal, ground to fit their open ends. The said plates were perforated and had attached thereto some device by which the exhaustion could be effected. In these forms of apparatus I believe it was found impossible to obtain a vacuum without placing between the ground surface of the glass bell jar or globe and the ground surface of the plate some kind of unctuous substance such as tallow, beeswax or cerate. Such a device essentially it seems to me, is the form of lamp which is described in the patent in suit. It consists substantially of an elongated bell jar which is called the globe and which is ground at its lower edge, and of a plate of glass having perforations through which it may be exhausted (or the air in it may be replaced by some other gas) and through which also the conducting wires pass. In the bell jar or globe of the Sawyer-Man patent, the bell jar or globe has, it will be observed, a flange around its lower edge for the purpose of increasing the thickness of the glass at that point, and so the thickness of the ground surface there; this device being also well known in the art, and having been used upon the lower edge of glass receivers used with the air pump long prior to 1878.

I also find described in the patent in suit the use of carbon from vegetable, fibrous or textile materials, as the material of the incandescing conductor, as contradistinguished from the use of mineral or gas carbon for the same purpose. I find in the state of the art before the date of the patent in suit the use of both mineral carbon and of carbon from vegetable fibrous material as the incandescing conductor of an electric lamp. I find further that this carbonized fibrous material was used in the said incandescent lamps, or was described for such use, either in the form of straight pencils or in the form of arch or equivalent shapes.

807 Moreover, I find various devices for electric lamps, both arc and incandescent, shown and described in the various publications and patents which have been put in evidence herein and to which Professor Brackett has referred at length in his deposition. It seems to me that these devices are a natural outgrowth of the scientific principles and experiments already referred to, and I entirely agree with Professor Brackett that in view of the state of the art thus set forth, the apparatus shown and described in the patent in suit presents no feature of novelty.

I agree also with Professor Brackett in the opinion that the patentees of the patent in suit made no progress in the art of electric lighting as this art was known at the time of their invention, and that, therefore, the device which they produced and which is set forth in the said patent presents no features of novelty, and is essentially similar to devices which had been before employed for a similar purpose.

10 Q. Professor Brackett has expressed the opinion that in such a lamp construction as that shown in the patent in suit a metal plate would be the full equivalent of the glass plate *g* of the patent. Please state whether or not you agree with him in this opinion, giving your reasons.

A. I agree with him entirely in this opinion. The function of the plate referred to is simply to close the mouth of the lamp chamber. The lower end of this lamp chamber is ground flat, and the plate is also ground flat, and the cementing material is placed between the two ground surfaces for the purpose of insuring that hermetical sealing which is indispensable to the preservation of the incandescent conductor. I do not see that any object is secured by making the said plate of glass which would not equally well be secured by making it of metal. As I have already pointed out, this device itself is only a substantial copy of the early forms of receivers and air-pump plates in use twenty years ago or more. The patent in suit claims as the advantages of making the wall forming the chamber of the lamp wholly of glass, that all danger of 808 oxidation, leakage or short circuiting is avoided. But it seems to me that an air-tight joint could be quite as well secured with a metal plate, especially if as is the case with the device of the patent, fir balsam, or some similar cement, be placed between the ground edges of the lamp chamber and the plate upon which it rests. I do not understand how the oxidation of the metal plate when used to close the lamp chamber can be a danger, especially in view of the fact that in a previous patent of the same inventor's a piece of sodium, one of the most oxidizable of metals, was introduced into the lamp chamber to remove any oxygen which might possibly gain admission to it. It seems to me that, so far as the oxidation of the carbon conductor is concerned, it will be greater with the glass plate than with the metal one, since by supposition, if the metal one were oxidized, the oxygen necessary to this operation would be oxygen contained in a lamp chamber, and which would be prejudicial to the carbon conductor unless removed by combining with the metal plate. It seems to me further that no advantage of preventing short circuiting is material in this case, since there would seem not to be the least difficulty in properly insulating the conductors, even with a plate made of metal. Moreover, the transparency of the glass does not appear to be involved in this case.

11 Q. Please state what, in your opinion, are the defects, if any, in the lamp structure of the patent in suit, and state whether or not the same criticism can be made of the lamp structures shown by the prior patents and publications.

A. The defects of the lamp structures of the patent in suit seem to me to be many and obvious. In the first place, the shape and size of the lamp chamber are awkward and cumbrous, rendering it the more liable to accident. The glass is made of considerable thickness, and so is liable to fracture from changes of temperature when in use. Again, it does not consist of glass united con- 809 tinuously and in one piece, and the two parts being ground together upon flat surfaces, cannot be maintained air-tight for any length of time, even if some plastic material be interposed between the surfaces. Moreover, the conductors passing into the lamp are made of a metal highly expansible by heat, and are of large size, so that, by the necessary changes of temperature to which the lamp is subjected, the differential expansion between the glass plate and the conductors which pass through it, sooner or later results in serious leakage at these points. For these reasons it seems to me that it would be quite impossible to maintain even a moderate vacuum in such a lamp as that which is described in the patent in suit, and therefore all the more would it be impossible to maintain the much higher vacuum which experience has shown to be necessary in order to maintain the integrity of the carbon conductor for any length of time. The defects now referred to do not seem to me to be lessened by the employment of nitrogen or some other inert gas in the lamp chamber instead of a vacuum.

In this case, as experiment has shown, the amount of current necessary to maintain the conductor at the high incandescence required in such lamps is very greatly increased and the lamp is thereby rendered much less efficient than it would be if a vacuum were made in it. Again, the presence of a gas at atmospheric pressure in the lamp chamber, even when this gas is inert, has been shown to seriously injure the carbon conductor, and ultimately to destroy it, in consequence, as it is supposed, of the rapid abrasion of this conductor by the action of the gas molecules upon it. Even supposing that the inert gas were contained in the lamp chamber under the ordinary atmospheric pressure, and without rarefaction, it would, in my judgment, be extremely difficult to maintain the purity of the atmosphere within the lamp owing to the facility and rapidity with which gases diffuse into each other; the oxygen of the air under these circumstances being thus able to penetrate into the lamp chamber, thus oxidizing and destroying the carbon conductor. Another defect
810 which seems to me to exist in the lamp of the patent in suit consists in the size of the incandescent conductor. The resistance of a conductor is the greater the longer this conductor and the smaller its cross-section. To judge from the drawings of the said patent, this carbon conductor would have a very low resistance, probably not more than from one-half an ohm to an ohm. Such a low resistance as this, it is quite evident, would be fatal to the use of this lamp upon a multiple-arc circuit; since the size of the conductor required to convey the energy necessary to maintain such lamps in operation would necessarily be enormous. Even if they were used in a series circuit (an arrangement extremely undesirable and impracticable for general house illumination), the defects of the lamp, owing to the large size of the carbon conductor, would be still most serious. Not only would the amount of current necessary to maintain these conductors at the necessary incandescence be very great, owing to their large size, but their conductivity for heat would be very great, and so also would be that of the clamps necessary to maintain good contact with the carbon. A very material fraction of the energy thus expended upon the lamp would be conducted away and wasted uselessly as heat; and this without adding in any way to the production of light. This excessive production of heat in the lamp of the patent in suit seems to have been conceded by the patentees, who attempted to obviate its evil effects upon the lamp itself by placing the carbon conductor at the upper extremity of a long bell-shaped receiver or globe as far away as possible from the base, and, therefore, from the cementing ma-

terial which united the lamp chamber to the base, so as to reduce the liability to fusion of this material and the consequent leakage of the apparatus. By placing the carbon conductor at as great a distance as possible from the lamp base, the danger of leakage around the large-sized, metallic conductor at the points where they passed through the glass was diminished.

Even though the integrity of the lamp should be pre-
811 served by these devices, and also by making the conductors
leading up from the base of the lamp to the incandescing
conductor of a curved or zigzag form, whereby the radiating surface is very largely increased, yet the fact remains that so large a quantity of useless heat was produced in these lamps that these devices were necessary in order to protect them. In other words, beside the energy which is utilized as light in these lamps, there is another amount of energy which in my judgment may amount to nearly or quite as much more, which is expended uselessly in the lamp, and which not only produces no light but which requires the use of special and complex devices to prevent it from producing serious injury to the lamp structure.

The defects which have now been stated with regard to the lamp of the patent in suit are, I believe, all of them old defects, which are common to the lamps already referred to in the state of the art, as shown in prior patents and publications. Thus the lamps of Shepard, Roberts, Konn & Kosloff were similar, apparently, in size and shape to the lamp of the complainant's patent, the glass was made of considerable thickness, and the lamp chamber was attached to a plate of glass or metal, by some suitable cementing material. Moreover, the conductors for carrying the currents into the said lamps were also of large size and the carbon conductors themselves were of low resistance. I do not see, therefore, that the lamp of the patent in suit exhibits any advance in these respects over other incandescent lamps, shown and described in patents and publications long prior to the date of the application for the said patent, and prior to the year 1878.

12 Q. Please state whether or not in your opinion the lamp described and shown in the patent in suit would be a practically useful lamp, giving your reasons for any opinion that you may express.

A. In my last answer I have pointed out the defects which I conceive to exist in the lamp of the patent in suit, and have compared
these defects with those which existed in other lamps already
812 known and described in the art before 1878. This compari-
son seems to me to show that the lamp of the patent in suit
had the same defects of material and construction which were found in these early lamps. So far as I know, none of these lamps were ever put into practical use; and the reason for this is, as it seems to me, because of the defects which I have already pointed out. Inasmuch, therefore, as the lamp of the patent in suit seems to me to possess serious defects, and inasmuch as in my judgment these defects are the same in kind as those which prevented the earlier lamps referred to from coming into use, I think I am justified in the opinion

that this lamp of the complainant would not be a practically useful lamp.

13 Q. You have stated that the patent in suit discloses no advance in the art over what was well known prior to 1878. Please state what in your opinion was the advance in the art which marked the departure from the old and unsuccessful lamps toward the modern and successful incandescent lamp, and where you first find set forth the conditions upon which that departure was based?

A. To be successful, as it seems to me, an incandescent lamp must possess certain well-defined characteristics. In the first place, the carbon conductor must be of high resistance, so that the energy transmitted to it may contain the maximum of electro-motive force and the minimum of current; so that in this way the main conductors required to supply this energy to the lamp may be made as small as possible. The lamp should be capable of successful use in multiple arc upon the circuit, this being the only system of arrangement which is practicable for interior lighting. The carbon conductor should be united to wires of the minimum size, acting as conductors of the current into the lamp. Two advantages result from this arrangement; first, the expense of the conducting wires is reduced; and second, the lamp wires may be made of a metal, such as platinum, which has the same coefficient of expansion as
813 glass, and therefore is not liable to break away from the glass where it is sealed into it owing to changes in temperature. Moreover, the leading-in wires should be sealed into the glass by fusion of the glass itself. The carbon conductor should be inclosed in a globe of reasonable size and so thin that it may be sealed to the stem carrying the carbon conductor, also by fusion of the glass; and the globe should be thoroughly exhausted. It was the production of such a lamp, as I understand it, which constituted the true advance in the art which is characteristic of modern incandescent lighting. I find a description of such a lamp set forth for the first time in United States patent No. 223,898, issued to Thomas A. Edison, Jan. 27th, 1880.

14 Q. Referring now to the first claim of the patent in suit, state whether or not in your opinion there is any novel and useful invention described therein, giving your reasons?

A. The thing which seems to me to be the object of the first claim of the patent in suit is an incandescing conductor for an electric lamp made of a certain material, to wit, carbonized fibrous or textile material, and being of a particular form, to wit, of an arch or horseshoe shape. With reference to the expression "carbonized fibrous or textile material," I find that the specification speaks of "an incandescing conductor of carbon made from a vegetable fibrous material, in contradistinction to a similar conductor made from mineral or gas carbon." It also says, "in the practice of our invention we have made use of carbonized paper, and also wood carbon."

I do not, therefore, gather from the patent itself any information in regard to which of two possible constructions is intended. If the terms "fibrous or textile" are to be regarded as equivalent terms, then the word "textile" would seem to me to limit the term

"fibrous," so as to require the conductor to be made of a material which is textile as well as fibrous. If this construction be assumed (and it seems to me entirely reasonable) then in my opinion this would limit the material employed to carbonized paper, since this is the only material mentioned in the specification which
814 may be called textile even approximately; the other substance mentioned, to wit, wood carbon, certainly not being a textile material. Under this construction there appears to me to be no novelty in such a conductor, since carbonized textile material was already old in the art before 1878, and there would appear to me to be no novelty, in view of the state of the art at the time, in putting such carbonized textile material into a lamp. If, however, the expression "textile or fibrous" is to be regarded as an alternative expression, so that the said incandescent conductor may be either textile or fibrous, then it seems to me that, since carbonized fibrous material was already well known in the art in 1878 and had already been used as the incandescing conductor of an electric lamp, there is no novelty in again using it for the same purpose, as under this construction of the first claim would be the case.

With reference to the form of the carbon conductor, the references in evidence herein show not only the arch or horseshoe shape to be old in conductors for incandescent lamps, but they also show the use of carbon in the arch form in these lamps. Moreover, it seems evident to me that the shape of the conductor has necessarily nothing to do with the material of which it is made, the two things being entirely independent of each other. I cannot, therefore, see that, inasmuch as the form of the conductor is old both in metal and in carbon, and inasmuch as the material used for the conductor (that is the particular kind of carbon) is also old, and inasmuch as the form of the conductor is independent of the material of which it is made, there is any novel and useful invention accomplished by taking the old material and giving it a form which had been used for the same purpose, not only in metal, but also in carbon derived from other sources; in short in doing the thing which I understand to be the object of the first claim.

15 Q. Assuming that defendant's lamp is provided with an incandescing conductor made from carbonized bamboo, does such lamp in your opinion embody the invention set forth in the first
815 claim of the patent in suit, assuming that the proper construction of said claim is the one first stated by you in your last answer?

A. In my opinion it does not. Bamboo is not a material properly called textile, as I understand it, and I have never heard of its being used as such for textile purposes. Nor have I ever heard of its being treated successfully so as to convert it into a form in which it is separated into fibres capable of being used in the manufacture of paper or any textile fabric.

Adjourned to March 15th, 1889, at 10 a. m.

PHILADELPHIA, *March 15th*, 1889.

Met pursuant to adjournment.

Present: R. N. Dyer, Esq., for defendant, and L. E. Curtis, Esq., for complainant.

16 Q. Referring now to the second claim of the patent in suit, state whether or not in your opinion there is any novel and useful invention described therein, giving your reasons.

A. The second claim appears to me to be a combination claim. The elements of the combination are: first, "an incandescent conductor of carbonized fibrous material," and second, "a transparent hermetically sealed chamber in which the conductor is enclosed." The claim also speaks of an electric circuit in which the lamp is included and of which it forms a part; and, since this arrangement is necessarily true of all such electric lamps, it seems to me that these words are simply explanatory. This claim seems to me to differ from the first claim in respect to the material of which the incandescing conductor is made; the second claim requiring this conductor to be made of carbonized fibrous material while 816 the first claim requires it to be made of carbonized fibrous or textile material. In this respect, therefore, the second claim seems to me to be broader than the first. The second claim also differs from the first claim in the fact that nothing is said in it of the shape of the carbon conductor, and further in the fact that the said second claim requires the carbon conductor to be enclosed in a transparent hermetically sealed chamber: about which chamber nothing whatever is said in the first claim.

Two conditions appear to me to be possible in considering this claim. In the first place, if it be considered that such a combination between such an incandescent conductor and such a transparent hermetically sealed chamber is not a valid combination, then it seems to me that the fact abundantly established by the numerous references to patents and publications which are in evidence herein that incandescent lamps had been shown and described prior to 1878, which lamps consisted of a hermetically sealed chamber of glass and of an incandescent conductor of metal or of mineral carbon, would deprive the claim of all novelty; since it was well known in the art at the time that various metals, mineral carbon, wood carbon and other forms of carbon might all be used for producing electrical incandescence.

If, however, the combination of the second claim be regarded as a valid and operative combination, then it seems to me that we have described in the patents of De Moleyns, of Greener and Staite, of Shepard, of Roberts, and in the publication of Ladyguine, incandescing electric lamps consisting of a transparent hermetically sealed chamber enclosing the conductor made of carbonized fibrous material. Moreover, the said lamps are intended to be included in, and to form part of an electric circuit, as is true of the lamp referred to in the claim. It seems to me, therefore, that there is no novel and useful invention described in the second claim of the patent in suit; and I agree in this respect with the opinion which Professor Brackett has expressed in his deposition already given in this case.

817 17 Q. Referring now to the fourth claim of the patent in suit, state whether or not, in your opinion, there is any novel and useful invention described therein, giving your reasons?

A. The fourth claim of the patent in suit is also a combination claim, the elements of the combination being first, a glass hermetically sealed chamber, containing no carbon-consuming gas; second, an electric conductor hermetically sealed into the glass wall of the said chamber; and, third, an illuminating conductor made of carbonized fibrous or textile material and having the form of an arch or loop. Referring to the specification, I find that the patent contemplates as the first element of the said fourth claim a glass lamp chamber having a glass bottom plate secured by clamps and sealed by cement to the bottom of the said lamp chamber, the space within the said chamber being exhausted of air, and either left in this exhausted state or subsequently filled with a gas not capable of consuming the carbon. The second element is a conducting wire passing through the glass wall of the chamber and hermetically sealed therein. On referring to this specification, I find that the conductor referred to passes through an opening in the bottom plate of the lamp, this conductor being sealed air-tight into the opening with cement. The illuminating conductor which constitutes the third element of the said fourth claim is substantially the same as that which is described in the first claim. It consists of carbonized fibrous or textile material, and it has the shape of an arch or loop. With regard to the material, the same ambiguity of construction arises to which I have referred when considering the said first claim. Evidently material may be fibrous without being textile, but I do not know of any material which may be used as a textile material which is not fibrous. Hence, as I said in my last answer, the term "fibrous material" seems to me to be a broader term than the term "fibrous or textile material," and consequently it seems to me that by the addition of the word "textile" the patentees may have intended to limit the word "fibrous." At all events, the
818 same two constructions are applicable in this case which I supposed to be possible in the case of the first claim. The first of these constructions is an equivalent construction, and assumes that the patentees intended to use these two words in the same or in an equivalent sense, meaning thereby, as I understand it, that the property of value in the material was a property common to both fibrous and textile materials; as, for example, when we speak of a spongy or porous substance. The second of these constructions supposes the words "fibrous" and "textile" to be used in the alternative sense, so that a material which is fibrous and not textile would answer the requirements. I do not understand that the usefulness of a material from which to make the incandescent conductor of an electric lamp consists necessarily in the fact that it is fibrous in its structure; that is, that it consists of or contains fibres within its substance. I suppose that a carbon conductor for an electric lamp may be made of material which is not

fibrous, and that such a conductor might answer its purpose effectively.

With regard to the elements of the combination embodied in the said fourth claim it seems to me that the devices constituting the first and second of these elements were abundantly shown and described before eighteen hundred and seventy-eight, not only by these patentees themselves in their earlier patents, but also by De Moleyns, Greener and Straite, Straite, King, Shepard, Roberts, Konn, Kosloff, Woodward and Ladyguine, either in their patents or publications already referred to and herein in evidence. With reference to the third element the material is old in other forms and the form is old in other materials, as I have already pointed out in considering the first claim. Nor do I see that there are any advantages whatever of the form which is claimed which are depend*a*nt in any way upon the material employed; so that in my judgment the advantages of the form and the advantages of the material are entirely independent of each other. The said fourth claim would be substantially produced, as it
seems to me, by placing the carbon conductor of the
819 first claim in one of the old lamp chambers above referred
to, or by adding to the second claim the form of the conductor. If it should be held that the combination of the fourth claim is not a valid combination, then, since each of the three elements separately considered has long been well known and used in the art (possibly excepting the precise form in conjunction with the precise material of the third element, the same form in equivalent material and the same material in equivalent forms having long been so described and used), then there would not seem to me to be any useful novelty set forth in the said fourth claim. Moreover, it is difficult for me to see that there is any novel and useful invention in the said claim, even if the combination itself be held to be valid. The patents of Roberts and of Konn, for example, both seem to me to describe lamps containing the three elements of the said fourth claim or their substantial equivalents for the purposes of the invention. I agree with Professor Brackett that these lamps have circuit conductors passing air-tight into a glass lamp chamber, which glass lamp chamber is either exhausted or contains no carbon-consuming gas, and in which is contained a carbon conductor. This conductor in the Roberts lamp is straight in form, but is made of carbonized fibrous material; while, in the Konn lamp, this conductor has an arch shape and is made preferably of hard carbon. No change would have to be made in either lamp in order to exchange the carbon conductors, and the straight conductor of Roberts seems to me to have substantially the same advantages as the arch-shape conductor of Konn and of the patent in suit. For these reasons there does not seem to me to be any novel and useful invention described in the fourth claim of the patent in suit.

18 Q. Did you take into consideration in making your last answer that the illuminating chamber is stated in the fourth claim of the patent in suit to be "made wholly of glass."

A. I did. In my answer to the tenth question I considered
820 the relative advantages of closing the mouth of the lamp chamber with plates of metal or plates of glass, and I expressed the opinion in the said answer that a metal plate would be the full equivalent of a glass plate for the purposes of the invention described in the patent in suit. Moreover, as I have already pointed out, the use of both glass and metal plates for the purpose of closing the mouths of globes or receivers intended to contain gases or from which the air was to be exhausted by means of the air pump was well known in the art prior to eighteen hundred and seventy-eight. I find, too, in the patents to Staite an incandescent lamp having its mouth closed with a block of glass, and in the patent to Kosloff a block of porcelain seems to me to accomplish substantially the same function. In the patents of Konn and of Roberts the plates closing the lamp chamber are, I believe, of metal; but I do not see that they are not in every way the substantial*ly* equivalent of glass plate for the purpose. In the patent issued to Shepard a lamp is described, which consists of a globe of glass, having a stopper luted into it. I do not find that the patent itself distinctly states that this stopper must be of glass; but taking into account the state of the art and the well-known fact that it was a common practice to close the mouths of flasks and other similar glass vessels, like that used for the lamp chamber in this patent, with stoppers of glass, it seems to me clear that the stopper in the case of the Shepard lamp must have been made of glass. Taking the construction of the lamp as described in the patent of Shepard and shown in the drawing, it is much more probable in my judgment that the said stopper was made of glass than that it was made of metal.

19 Q. Assuming that the proper construction of the expression "fibrous or textile material," used in the fourth claim of the patent in suit, is that the material should be both fibrous and textile, and assuming that defendant's lamp is provided with an incandescent conductor made from carbonized bamboo, does such lamp, in your opinion, embody the invention set forth in the said claim?

821 A. It seems to me that it does not. As I have already stated, bamboo is not, in my judgment, a material which can properly be called "textile," having never, so far as I know, been used for textile purposes; either as such or after having been treated by any process. So far as my knowledge goes, bamboo has never been put into a form useful for textile purposes.

20 Q. Considering the structure of the patent in suit as illustrated in the drawings of the patent, would it be practically feasible, in your opinion, to seal the glass plate "Y" to the flange "X" by the fusion of the glass?

A. In my judgment it would not in consequence of the very considerable thickness both of the flange and of the glass plate.

21 Q. Would it be feasible, in your opinion, in such a lamp structure to fuse the glass plate upon the tubular conductors which are shown as passing therethrough?

A. I do not think that it would. It will be observed that the conductors required to carry the current into the lamp are necessarily quite large, and that the glass plate itself, through which these conductors pass, is quite thick. In order that the tubular conductors should be successfully sealed into the said glass plate by the fusion of the glass itself it would be necessary to employ a metal which was not only unoxidizable under the conditions employed in effecting the fusion, but also one whose coefficient of expansion is practically the same as that of the glass, so that during the changes of temperature to which the lamp is subjected when in use the glass and metal shall not be separated from each other in consequence of the differential expansion of the two substances and so cause a leakage into the chamber. Only one such metal is known which is capable of being used practically for this purpose, viz., platinum. But even this metal when used in large masses would be liable to separate from the glass into which it had been fused provided that its expansion should differ slightly from that of the glass (which I suppose to be generally the case) much more than when used 822 in the form of the small conducting wires which are required to carry the current into an incandescent lamp of high resistance.

22 Q. Please state whether or not in your opinion there is a sufficient description in the specification of the patent in suit as to the character of the fibrous or textile material to be used for the burner to enable others generally skilled in the art as it existed at the date of the application, viz., January 9, 1880, to produce a practically operative incandescent conductor without experiment?

A. The description in the specification of the patent in suit as to the character of the fibrous or textile material to be used for the incandescent conductor is not in my judgment sufficient to enable a person skilled in the art in January, 1880, to produce, without experiment, such an incandescent conductor which would be practically operative. In the first place the materials which are to be employed for producing such a conductor are referred to in the patent in a very indefinite way, being referred to generally either as "a vegetable fibrous material in contradistinction to a similar conductor made from mineral or gas carbon," or as "vegetable fibrous or textile material." Although there are many thousand distinct forms of vegetable fibrous material from which by carbonization such a conductor could be made, some of which are textile materials and some of which are not, yet the specification mentions only two substances specifically which the patentees have made use of in the practice of their invention, to wit, carbonized paper and wood carbon. But even these do not appear to me to be sufficiently definite and precise. For example it does not seem to me that a person skilled in the art could produce a successful incandescent conductor without experiment even if he was instructed to use paper and to carbonize it for the purpose. The word paper in its broad sense is a generic term and not a specific one. Papers are made of a great variety of materials in the first place, most of which are fibrous and some of which are textile. Commonly cotton or linen rags are pulped and converted into

paper. Frequently straw is so employed; and for cer-
823 tain qualities of paper pulp made by treating chemically
various kinds of wood is made use of. But not only may papers thus widely differ from each other in the kind of fibre which is made use of in their construction, but they may differ very widely in the character and the quantity of the materials which are mixed with the pulp for the purpose of loading the paper and so cheapening it. The cheaper class of papers, as I am informed, are very largely weighted with this kind of useless material, the substance more frequently made use of for the purpose being certain kinds of clay. Again, as I understand the matter, papers may differ very materially from each other in their structure, this difference depending, not upon the materials used in their construction, but upon differences in the process employed in making them. The resulting texture of the paper may be open or close and the paper itself may be more or less porous in consequence of the way in which it may have been made. So, after it comes from the paper machine it may be very heavily calendered, so as to render it more or less compact, and it may be sized, glazed, or otherwise subsequently treated to fit it for the special use for which it is intended in commerce. It seems quite evident to me that it would require experiment, even on the part of a person skilled in the art, to select out of all this vast number of papers so different in character and properties those which would be suitable on carbonization to produce a successful incandescent conductor. Indeed, it would be difficult, if not impossible, to obtain a paper which would perfectly fulfill the requirements necessary to produce a carbon completely suited to serve as the incandescent conductor of an electric lamp, and I understand that it is this difficulty which has led to the abandonment in practice of carbonized paper as the material for making such incandescent conductors. The most cursory examination of a sheet of paper when held up to the light would seem to indicate the incapacity of the process of paper-making to produce a material homogeneous and uniform throughout. When such a paper is carbonized it would be denser in certain portions of it and less
824 dense in others; and this want of uniformity in its texture
would cause a variation in its resistance in different portions of its length; this want of uniformity resulting in very irregular heating of the carbon conductor when subjected to the action of the current and a resulting speedy destruction of the conductor itself.

The unsuitableness of wood carbon in the broad sense of that term as the incandescing conductor of an electric lamp would seem to me to be even more marked than that of paper. The term "wood" is a generic term and refers to the material which constitutes the stems of most, if not all, vegetable structures. An examination of the structure of wood shows, as it seems to me, the entire unsuitableness of this substance in general to produce a carbon suitable for use as an incandescing conductor. Indeed, the structure, of almost all the woods which grow in our climate, and therefore which are familiar to us, is such as to completely unfit them

for such a purpose even to a greater degree than is the case with paper. These woods for the most part have the material arranged in them transversely as well as longitudinally. Moreover, the amount of woody matter for a given cross-section not only varies very much for different species of woods, but also varies very much from point to point in the same species. The consequence of this is that not only is it impossible to cut from these woods a piece having an equal amount of the solid woody matter in all the cross-sections of its length, but it is also impossible to produce a piece of wood carbon by carbonizing such a wood, which should be uniform in its structure and density throughout, so that it would not, when heated by the electric current, develope a higher temperature at some points of its length than others, and so be speedily destroyed. That uniformity in the carbon conductor throughout, which is necessary to secure uniform incandescence throughout its length, and which, therefore, is so essential in the modern incandescent lamp, is not, in my judgment, attainable by carbonizing any of the forms of wood which we commonly understand to be indicated by this
825 term. To determine this fact, which I understand to be now
well known and fully recognized, would have required, as it seems to me, even on the part of a person skilled in the art at the time of the application of the patent in suit, a vast amount of minute and laborious experiment.

Even if the term "wood" be not confined to those woods with which we are familiar in this vicinity, woods which are known as oxogenous, or outside growers, and be extended to include endogenous woods, or inside growers, it seems to me, still that extended experiment would have been necessary in January, 1880, to enable a person skilled in the art to produce a successful incandescent conductor for an electric lamp, even with the aid afforded by the patent in suit. The testimony of Mr. Edison, already given in this case, seems to me to establish this fact conclusively, since it shows that so competent an investigator and experimenter as he is had been obliged to examine many hundreds, or, perhaps, thousands, of wood materials, many of which were endogenous, in order to obtain a form of carbon from them which would answer the purposes of an incandescing conductor for an electric lamp. The bare statement of the patent in suit, therefore, that the material to be used for the production of the carbon conductor (which is the essential feature of an incandescent lamp) is vegetable fibrous material, seems to me to be utterly vague, indefinite and unsatisfactory, and does not seem to me to be such a full and complete description as would enable a person skilled in the art, as it existed at the time the said patent was applied for, to produce a practically operative incandescent conductor without experiment.

Adjourned to meet at the office of R. N. Dyer, Esq., 40 Wall street, New York, on Saturday, March 16, 1889, at 11 a. m.

826 New York, *March* 16, 1889.

Met pursuant to adjournment.

Present: R. N. Dyer, Esq., for defendant, and S. A. Duncan, Esq., for complainant; and the direct examination of Prof. Barker was continued, as follows:

23 Q. Are there in your opinion any kinds of paper and any kinds of wood which would be entirely useless for the making of incandescent conductors by carbonization?

A. In my judgment there are many kinds both of paper and of wood which would be practically useless for the purpose referred to. In the case of paper, for example, there are many sorts of paper whose structure is so open or so coarse, and whose structure is so irregular, as to entirely unfit them to make a successful incandescent conductor for an electric lamp. Moreover, it is evident that none of that large class of pa*pa*pers which have been weighted with extraneous materials, such as clay and the like, would answer the purpose. With regard to woods, the same general conclusion follows. The structure of many woods, and, indeed, of exogenous woods in general, is so open and irregular that a uniform carbon conductor could scarcely be made from them, and in the case of some of them could not be successfully made from them at all.

24 Q. Please state whether or not, in your opinion, there is a sufficient description in the specification of the patent in suit as to the method of preparing the fibrous or textile material for carbonization, and carbonizing it to enable others generally skilled in the art, as it existed at the date of the application, viz., January 9, 1880, to produce a practically operative and useful incandescing conductor without experiment?

Objected to as immaterial.

A. In my judgment, the description in the specification is quite insufficient for the purpose. Indeed, it says distinctly that

827 "No especial description of making the illuminating carbon conductors, described in the specification, and making the subject-matter of this improvement, is thought necessary, as any of the ordinary methods of forming the material to be carbonized to the desired shape and size, and carbonizing it while confined in retorts in powdered carbon, substantially according to the methods in practice before the date of this improvement, may be adopted in the practice thereof by any one skilled in the arts appertaining to the making of carbons for electric lighting or for other use in the arts."

This statement of the patent that any of the ordinary methods in practice before the date of the improvement therein contained would enable a person skilled in the art, and without experiment, to produce a practically operative and useful incandescent conductor without experiment does not seem to me to be the fact. In the first place, the method for forming the material to the desired shape and size would not only vary in its details, according to the character of the material operated on, but for a given material experiment would seem to be necessary, in order to determine the details of direction of the fibre, with reference to the said shape, which would give the best results. Moreover, the details of carbonization are even more important to a successful result than the details of forming to the desired shape. It is perfectly well known that the process of carbonizing the material while confined in retorts in powdered carbon, which is the process of the specification, will not result necessarily in the production of a successful incandescent conductor, but that various details of manipulation, of temperature, of the arrangement of the carbonizing vessel and the like, are necessary in order to success, these details being obtained only as the result of experiment.

25 Q. In making such a conductor from wood carbon is it in your opinion essential to the production of a useful and operative device that the material should be cut from the wood in one way 828 rather than in another, and, if so, do you find anything in the specification of the patent in suit to indicate how this is to be done?

A. It does seem to me that it might make all the difference between a useful and useless carbon for the purpose, whether the shape before carbonization were cut in one direction or in another out of the original material employed, the relation of the direction of the fibre to the structure being, I think, a factor of great importance in determining the practical usefulness of the incandescent conductor. I do not find anything in the specification of the patent in suit to indicate even that it is desirable that the material should be cut in one way rather than in another, and, therefore, nothing to indicate the direction of cutting which would be best for the intended purpose.

26 Q. What would be the effect of cutting the wood across the grain or fibres to produce a straight strip or of cutting the arch shape in any direction from the wood?

A. The structure of wood, as I have already stated, is quite different in a longitudinal direction parallel with the fibres than in a transverse direction. Moreover, the differences in contiguous parts are much greater transversely than longitudinally. Hence, if a straight strip were cut from the wood with its length parallel to the direction of the fibre, it would, in my judgment, be much more uniform in its density at different points of its length, and, therefore, would produce a much more uniform carbon conductor than if the said strip were cut with its length in the transverse direction, *i. e.*, were cut across the grain or fibres. Evidently if an arch shape were cut from the wood so that one portion of it were parallel to the fibres another portion of the arch would necessarily be cut transversely to these fibres. In consequence of this the structure would be very unlike in its different parts, would lack uniformity in different parts of its length and when carbonized would produce a carbon entirely unsuited to operate successfully as an incandescing conductor, since it would be very irregular in the amount of the conducting material contained in dif- 829 ferent cross-sections. When in use, therefore, it would heat very differently in its different parts and its life would be brief.

27 Q. What degree of usefulness, if any, would a carbon conductor have, made from a strip cut across the grain or fibre of wood and used either as a straight strip or bent into an arch form?

A. It would seem to me not to have any usefulness whatever.

28 Q. Referring to the original application for the patent in suit and to the patent as issued, please state whether or not in your opinion the same substantial invention is described and claimed in the original application as is described and claimed in the patent in suit.

A. I find in the specification of the original application the statement that

"Our present invention especially relates to the incandescent conductor; its object is to secure a cheap and effective apparatus and our improvement consists in the employment of an incandescent arc of carbon in the circuit as the light-giving medium."

With reference to the said incandescent arc of carbon in which the improvement described in the application is said to consist, the specification says:

"Our improved burner or incandescent arc consists of an arch-shaped or semi-cylindrical piece of carbon A, mounted in its clamps or supports in the usual well-known ways."

The specification further says:

"We have also used such arcs or burners of various shapes, such as pieces with their lower ends secured to their respective supports, and with their upper ends united so as to form an inverted V-shaped burner.

We have also used arcs of varying contours, that is, with rectangular bends instead of curvilinear ones; but prefer the arch shape as the shadow cast by such a burner is less than that produced by other forms of burners."

The first claim in the said application is for "incandescing arcs for electric lights made of carbon."

830 The second claim is "for incandescing arcs of carbon in combination with the circuit of an electric light."

The third claim is "for an incandescing arc of carbonized paper included in the circuit and a close transparent chamber in which the arc is enclosed."

The fourth claim is "for an incandescing arc made of carbonized fibrous or textile material."

It would seem from this that the invention which is set forth in the said application consists in a peculiar form or shape to be given to the carbon forming the conductor of an incandescent lamp, to wit, the shape of an arc; these arcs being of varying contours as the specification states.

The only reference, I believe, to the material which is to be used for the arc to be found in the specification is as follows:

"We have tried carbonized paper covered with powdered plumbago, wood carbon or charcoal and ordinary gas carbon."

This reference to the material seems to me to be entirely incidental, and to be inserted for the purpose of indicating in a general way the kinds of carbon which the patentees had used.

This conclusion that the invention of the application consisted in the use of incandescing arcs of carbon, and that the material is specifically unimportant would seem to be confirmed by the fact that the first two claims refer only to carbon arcs in general.

The patent in suit, as issued, however, states that the invention relates to the substance as well as to the form of the incandescing conductor, and that the substance of which this conductor is to be made is a vegetable fibrous material in contradistinction to a similar conductor made from mineral or gas carbon. The reference to the kind of carbon in the application appears to me to have been changed; so that it reads, in the patent as issued, "we have made use of carbonized paper and also wood carbon."

It seems to me, therefore, that the invention which has been described and claimed in the patent in suit is not the same 831 substantial invention which is described and claimed in the original application, the said invention having been broadened so as to include the specific material as well as the form of the conductor in its progress through the Patent Office.

Moreover, the specific materials to be used for the purpose of forming the arc have been greatly extended in the patent as issued, as compared to the application. The statement of the application that "carbonized paper covered with powdered plumbago, wood carbon or charcoal, and ordinary gas carbon," had been tried, appears to me to indicate that these materials had been found the equivalents of each other for the purposes of the invention. But in the patent as issued the omission of the words "covered with powdered plumbago" seems to me to extend the material beyond its original scope. So, too, in the application "wood carbon or charcoal" are referred to in equivalent terms, as it seems to me. In the patent as issued, the omission of the word "charcoal" appears to me to extend the material to all forms of wood carbon, whether charcoal or not, and thus to broaden the range of material to be employed. Again I find that in the patent as issued the words "ordinary gas carbon" are not only omitted from the list of materials mentioned in the application, but the substance to be used for the incandescent conductor is stated to be carbon from vegetable fibrous material in contradistinction to a similar conductor made from mineral or gas carbon.

29 Q. The opinion has been expressed by complainant's expert that the reference to carbonized paper in the third claim of the original application, and the reference to carbonized fibrous or textile material in the fourth claim of said application indicate a preference for a specific kind of carbon. Please state what your views are upon this subject.

A. I do not see anything in the language used which seems to me to justify such a conclusion, as I understand the matter. I believe it is the custom frequently to restate the invention of a patent in different forms in its various claims, and it seems to me that this is a case of the sort, the third and fourth claims being narrower 832 than the first and second, and claiming, not broadly, arcs of carbon but arcs of carbonized paper or carbonized fibrous or textile material specifically; and this, as it seems to me, without indicating any preference for either of the forms mentioned.

30 Q. I call your attention to the fact that in the original application "wood carbon or charcoal" is stated as one of the materials used, while in the patent as issued this is replaced by the words "wood carbon." Do you attach any significance to this change?

A. The significance of this change seems to me to depend upon the fact that subsequent to the filing of the application it was ascertained that incandescing conductors for electric lamps could be successfully made from wood carbon while they could not be successfully made from charcoal, and hence, therefore, it became necessary either to differentiate between wood carbon and charcoal, or to drop the word "charcoal" altogether. The latter is what seems to have been done.

31 Q. Do you agree with the opinion expressed by complainant's expert, Mr. Pope, in his answer to Cross-Q. 130, that in the original specification "wood carbon" is used as an alternative term for "charcoal"?

A. I do; these terms seeming to me to be equivalent terms as there used.

32 Q. What character of material would you understand to be meant by the term "wood carbon or charcoal," as used in the original application?

A. Generally, that material which is ordinarily called by the name "charcoal" and which is produced by carbonizing any of the familiar varieties of wood by any of the well-known processes.

33 Q. What do you understand is meant by the expression used in the original specification: "Carbonized paper covered with powdered plumbago"?

A. It seems to me that it means paper which has been carbonized and which is covered with plumbago. As to the process by which it was made, the specification does not appear to enable me to determine. It may have been made either by covering 833 the paper with powdered plumbago and then carbonizing it, or it may have been made by carbonizing the paper first and then covering it with powdered plumbago. It is possible, too, as it seems to me, that the carbonization may have been attempted electrically, the powdered plumbago being used to facilitate this operation by rendering the surface conducting.

33½ Q. Was there anything known in the art at the date of the application for the patent in suit which would be described by the words "carbonized paper covered with powdered plumbago"?

A. Not to my knowledge.

34 Q. Assuming that the words "carbonized paper covered with powdered plumbago" mean that the paper—say blotting paper—is to be taken and rubbed with the powdered plumbago, and is then to be connected with a source of electric current and an attempt made to carbonize it by passing a current through it, would such an operation, in your opinion, be practically useful or operative for the manufacture of incandescing conductors or burners for electric lamps?

A. Certainly not. Even if by rendering the surface conducting by covering it with plumbago, some sort of carbonization of the paper could be affected by means of a current, this carbonization would be exceedingly incomplete and unsatisfactory, and the product itself would be worthless in my judgment for an incandescing lamp conductor.

35 Q. Would it be feasible to make a useful or operative incandescing conductor by carbonizing by passing the electric current through paper covered with plumbago, if such paper were enclosed in a reservoir containing hydrocarbon gas or hydrogen or nitrogen, the reservoir being of glass and sealed up and the metallic conductors to which the paper was affixed passed through to the interior of the reservoir in which the gas is contained?

A. It would not in my judgment. My last answer supposed the
carbonization to be effected without access of air, and I do
834 not see that the present question involves any other condi-
tion that would be likely to modify the result.

36 Q. I call your attention to the fact that the expression "carbonized paper covered with powdered plumbago" of the original specification has been changed to "carbonized paper" in the patent in suit, and that the original specification gives no description of the method of carbonizing other than is to be inferred from the words just quoted, while the patent in suit states that the material is to be carbonized "while confined in retorts in powdered carbon," assuming that the original specification intended that the paper should be carbonized by passing an electric current through it after it had been covered with powdered plumbago, what significance do you attach to the changes indicated between the original application and the patent as issued?

A. Inasmuch as I have already expressed the opinion that the process assumed in the question for preparing the carbonized paper referred to in the application is not a practically operative process, and the product of it worthless as an incandescing conductor; and inasmuch as the process of the patent of carbonizing the material while confined in retorts is in my judgment a practically operative one, it seems to me that the change referred to in the question is a substitution of a process capable of successful commercial application for a practically inoperative process of no value whatever as a method for making a useful incandescing conductor. In short, the significance of this change under the assumptions of the question seems to me to lie in the fact that by making it, a valuable process is substituted for one which is practically worthless.

37 Q. I call your attention to the opinions expressed by Professor Brackett in answer to questions 25, 26 and 27; do you agree with him in these opinions?

A. I do. The significance of these changes, in my judgment, lies in the fact that the patent in suit is thereby extended to include structures quite different from those contemplated by the patentees
at the time of filing their application. The progress of the
835 art had shown the defects of the patentees' lamp as originally
constructed. It had also shown what requirements were neces-

sary in a lamp in order that it might successfully accomplish the purposes intended. To change the application in this way seems to me to be an attempt to include the newer and improved construction under a form of words applicable to the older constructions of the patentees, though, as it seems to me, in quite a different sense.

In the United States patents 223,898 and 227,229, issued to Thomas A. Edison January 27th and May 4th, 1880, the well-known form of lamp which has proved commercially successful is shown for the first time. This lamp appears to me to be free from the serious defects of the patentees' lamp. Its parts were sealed together by the fusion of the glass. The only method of sealing by which a vacuum can be successfully maintained. The leading-in wires were of small size and were also sealed into the glass by fusion. The entire lamp seems to me to constitute a radically new idea in incandescent lighting. In this lamp there is no joint filled with a cementing material; but the parts are united into a single complete whole by fusion so that the lamp chamber is, in fact, composed wholly of glass. That such a lamp so radically new and different from any previously known should be claimed to be brought by this change within the scope of the patent in suit as issued seems to me to show very clearly the significance of the changes referred to in the question.

38 Q. I call your attention to the opinions expressed by Professor Brackett in answer to questions 29 and 30. Do you agree with these opinions?

A. I do. The significance of the changes referred to lies in the fact, I think, that they are of the same nature so far as their effect is concerned as those which have been already mentioned; these changes being evidently intended to widen the scope of the application so as to include methods of introducing and sealing the leading-in conductors which subsequent experience had shown to be necessary. I also agree with Professor Brackett in the opinion that the structure shown in the drawings of the patent in suit is not adapted to have the electrodes sealed into the glass by any of the well-known methods of sealing metal electrodes to glass previous to the filing of the application. 836

39 Q. Do you agree with the statement contained in answer 31 of Professor Brackett's deposition with regard to the manufacture of commercial incandescent electric lamps provided with carbons made from carbonized non-fibrous material?

A. I do, and I have such lamps in my own collection.

40 Q. The opinion has been expressed in substance by complainant's expert that the mere mention of carbonized paper in the specification of the original application for the patent in suit forms a definite indication that the inventors intended to employ a fibrous material reduced to size in at least one dimension before carbonization and that the carbonization of such a material would produce a carbon possessing valuable qualities for incandescent lighting. Please state whether or not you concur in this view.

A. I do not concur in it; I do not find in the application referred to any expression whatever which seems to me to justify such

a conclusion. The mere mention of carbonized paper in the specification of this application would not seem to me to justify so radical a conclusion. The object of using paper seems to have been solely to obtain readily a fibrous material. The said specification speaks of "carbonized paper covered with plumbago," and it seems to me that if the paper here referred to is covered with plumbago for the purpose of carbonization by the current that its thickness must be determined by the current which is to be employed in carbonizing it and moreover it seems to me that the simple mention of "carbonized paper covered with plumbago" is not sufficient to enable a person skilled in the art at the time to produce without experiment a practically operative incandescing conductors. The thickness of the carbon conductor might, as it seems to me,
837 require alterations by cutting or otherwise in the thickness
as well as the length and breadth of the material employed. If the paper used were thin it might be necessary to cement several layers of it together, and if it were thick it might be necessary to file it down. But of all this nothing is said in the specification. Indeed, to determine the proper size of the material before carbonization required to produce a proper size of carbon conductor would also require experiment, since the relation of the two is nowhere alluded to in the specification.

Hotel Lafayette,
Philadelphia, *March 20th*, 1889.

Met pursuant to arrangement of counsel.

Present: Walter K. Griffin, Esq., for defendant, and L. E. Curtis, Esq., for complainant; and the examination of Professor Barker was continued as follows:

Questions by Mr. Griffin:

42 Q. The opinion is expressed by complainant's expert, Mr. Pope, in answer to cross-questions 130 and 166, that omitting the reference to carbonized paper in the original application for the patent in suit there would be no sufficient description in the specification of the carbon having certain peculiar and valuable qualities which he thinks as applied to incandescent lighting, is the invention of the patentees, but that the mere mention of carbonized paper in the specification of the original application would be sufficient to enable any one following the specification to obtain a product having these certain valuable properties or qualities without any further experimentation. Do you agree with him in this opinion?

A. It seems to me that this is an extreme view of the matter, and one that is wholly unwarranted by the language of the speci-
838 fication. In the first place, as I have before stated, the
specification of the original application for the patent in suit does not mention carbonized paper *per se*, but "carbonized paper covered with powdered plumbago." Whether results of any usefulness whatever would be secured by the following of such direction as is contained in the statement "we have tried carbonized paper covered with powdered plumbago" would depend upon how

that direction is taken. It has no certain definite meaning of itself. If it means that the paper covered with powdered plumbago is to be carbonized by the current, the result would undoubtedly be useless and would not have the properties or qualities which Mr. Pope thinks necessary to the invention. If the direction is to be taken as meaning to cover the paper before or after carbonization with the plumbago, it is evident that, to whatever extent the plumbago is applied to the material, to that extent will the plumbago become a more important factor and the paper carbon a less importan factor in the resulting burner. The plumbago could be applied t such an extent, either before or after carbonization of the paper, that the paper carbon would become an unimportant factor and would act principally as a core to assist in sustaining the plumbago, and such a carbon conductor I take it would not have the peculiar properties and qualities which Mr. Pope thinks are essential to the invention. If a person took the direction to mean to carbonize by the current it would certainly require experimentation for him to ascertain that a suitable carbon conductor could not be made i that way; then if he thought it meant to cover the material wit plumbago either before or after carbonization, he would have t find out by experiment how to do that, and since the specification does not tell him how to do it, or to what extent to apply the plumbago, and does not tell him even the characteristics which it is desired to obtain, or whether the desired characteristics are those to be found in the plumbago or in the paper carbon, he is left entirely without direction either as to procedure or product, and he 839 must grope around until he not only finds the proper qualities or properties for his product, but also finds how to produce them.

Again, the original specification speaks of three materials for the arch-shape burners, viz., the carbonized paper covered with powdered plumbago, the wood carbon or charcoal and the gas-retort carbon. These apparently are mentioned indifferently an with equal force and would serve to mislead the constructor, attempting to follow the specification, as to what the desired properties or qualities for such a burner would be. In addition, I take it, from the fact that paper is such a comprehensive term and that so many materials included by that term would be useless, that the simple direction to use carbonized paper would only serve to point out a class of material upon which experiment would be necessary in order to obtain a paper carbon.

43 Q. I call your attention to the opinions expressed by defendant's expert, Professor Brackett, in his answers to questions 33 to 37 inclusive. Do you agree with him in those opinions?

A. I do. It does not seem to me that the carbon burner of the patent in suit would have the advantage of contracting and expanding between fixed terminals without breaking, which advantage has been incorporated by description in the patent in suit as issued but was not mentioned in the original specification. Such an advantage does exist in the modern incandescent lamps which have exceedingly small and flexible carbon conductors, which by

reason of their great flexibility take up the contraction and expansion in their length by changing in shape and without straining the connections with fixed terminals. This is an advantage due to flexibility rather than to the shape of the carbon conductors, the loop shape being employed principally to give greater length of conductor within the lamp. The addition of this matter of description to the patent in suit would seem to be intended to apply to the shape of the burner of the patent in suit, an advantage which it does not have, but which is possessed by the in-
840 candescent conductors of modern and successful lamps by reason of the flexibility of their conductors.

44 Q. What kind of a lamp burner do you understand is described by the following statement contained in the patent in suit: "We have also used such conductors or burners of various shapes, such as pieces with their lower ends secured to their respective supports and having their upper ends united so as to form an inverted V-shaped burner"?

A. I understand this to mean what is known as a "semi-incandescent lamp"—that is, a lamp having two carbon conductors brought into contact, a light being produced by the incandescence of the pieces of the carbon at or near the points of contact where the resistance is greatest. The two '78 patents of the patentees, viz: 205,144 and 210,809 describe lamps of this character—also the patent of Shepard.

45 Q. Would carbon pieces made from a carbonized fibrous or textile material have any advantages over a hard carbon for such a semi-incandescent lamp?

A. The hard or mineral carbon would in my opinion be superior for such a lamp.

46 Q. Would there be any difficulty in making a carbon burner of the size and shape as that shown in the patent in suit from hard carbon, such as from Carre's mixture?

A. I can see no difficulty in doing so.

47 Q. What do you understand by the statement contained in Konn's patent No. 3809 of 1872, that the carbon conductors "are preferably graphite"?

A. I would understand from that expression that the patentee intended to avail himself of any of the forms of carbons which were known to be suitable for electric light such as carbons of wood and various other fibrous material such as hemp, flax, cotton and paper.

48 Q. Was carbon obtained from bamboo known at the date of the application for the patent in suit, viz: January 9, 1880, as an equivalent for carbon from paper or for the ordinary wood carbon or charcoal?

A. Not to my knowledge for any purpose whatever.

49 Q. Have you read and do you understand French let-
841 ters patent No. 113,706 of July 12, 1876, issued to Octave Gauduin and the certificates of addition thereto dated April 7, 1877, and June 12, 1877, respectively? If so, please describe such

matters contained therein as in your opinion are more particularly material to the questions herein at issue?

A. I have read the said letters patent and the certificates of addition thereto and believe that I understand them.

I find that the object of the invention which is set forth in the original patent is the production of various physical and chemical articles such as crucibles, pencils for producing the electric light, etc., which the patent states should be made of chemically pure carbon. This object the inventor obtains by decomposing in close vessels various carbonaceous materials such as tar, resins, bitumens and the like, thus producing a very pure coke which is mixed after pulverization with tar, pitch or similar material to a plastic mass and is then forced through a die, thus forming said pencils for the electric light which are subsequently carbonized at a high temperature.

The first certificate of addition describes a multiplication of this process which enables the inventor to give to the carbon the definite form in which it is desired to preserve it and which simplifies considerably the manufacture. The process here described consists substantially in shaping the crucibles, vases and pencils for electric light or electro-chemical purposes, etc., out of dry and properly selected wood by any method suitable to be used in working wood. The object thus shaped in wood is then converted into a hard and compact carbon preserving the original form by suitably drying it, impregnating it with tar, bitumen, sugar, caramel, etc., and heating it, at first slowly and finally to a high temperature in a reducing atmosphere. To especially purify the carbon the inventor treats it during the intermediate stage with acids, alkali-s, etc. He further states that he has also manufactured articles in carbon with cotton, hemp, linen and cellulose impregnated in the same way with 842 tar or other similar material and shaped in such a way as to give to it the form desired, treating it subsequently in the same way as in the case of the wood already mentioned.

In the second certificate of addition dated June 12, 1877, Gauduin describes the particular form of tubular furnace by means of which the said crucibles, electric light pencils, etc., can be baked continuously at a high temperature.

50 Q. In view of the Gauduin patent and in particular in view of the certificate of addition of April 7, 1877, have you any further statement to add to your previous direct testimony as to the novelty of the use of a vegetable fibrous carbon or a vegetable textile carbon as an incandescent conductor for an electric lamp prior to the year 1878?

A. It seems to me that we have described in said certificate of addition electric light conductors produced by forming the material to be carbonized, to wit, vegetable fibrous material in the form of wood to the desired shape and size and then carbonizing it in closed vessels. It seems to me further that we have described the manufacture of objects in carbon by carbonizing various forms of textile material such as cotton, hemp, linen, and cellulose of any desired kind, shaped in the form desired by mixing it with tar or other similar material and then carbonizing it.

The patent itself does not state specifically whether the said carbon pencils are to be used for arc or for incandescent lighting, but inasmuch as both forms of lighting were well known in the art at the time, I see no reason for supposing that the inventor intended to restrict their use to either of these modes of lighting. Indeed, to my knowledge the said Gauduin pencils were made of various sizes within a considerable range; some of them being not over a millimetre or two in diameter, as I recollect them, and therefore adapted only to the production of light by incandescence.

Further, it does not seem to me to have required invention, in view of the state of the art in 1878, to substitute the carbon conductor thus made by the Gauduin process from vegetable fibrous 843 material put into the desired shape before carbonization for the straight or curved pencils of mineral carbon which had been already used in the incandescent lamps to which I have already referred; such, for example, as that of Kosloff and Konn; or that it would have required invention at that date to substitute the said Gauduin pencils for the pencils of mineral carbon described by the patentees of the patent in suit as used in their prior patents already referred to in this case.

Defendant's counsel offer in evidence letters patent of the Republic of France dated July 12, 1876, and certificates of addition thereto dated April 7, 1877, and June 12, 1877, together with translations of the same as exhibits on behalf of defendant and the same are marked as follows:

(40.) Defendant's Exhibit Gauduin Patents of 1876 and 1877. The stipulation entered into on March 13, 1889, as to the defendant's patents and publications is extended to said Gauduin exhibit.

Cross-examination of Prof. Barker by Mr. Curtis:

51 X Q. Do you mean by your answer to question 14 that you consider any of the "references in evidence herein" to be direct anticipations of the first claim of the patent in suit?

A. I meant to be understood as expressing the opinion that the references taken together showed direct anticipation rather than the opinion that any one of them showed such a complete anticipation.

52 X Q. By "the references in evidence herein" you mean the patents and publications put in evidence by the defendant at the commencement of your deposition?

A. Yes; I intended to be so understood.

53 X Q. Do you regard either one of these patents or publications as a direct anticipation of the first claim of the patent in suit?

A. It seems to me that in two of these references at least 844 devices are described which are the substantial equivalents of the device which forms the subject of the first claim. In the English patent to Roberts, I find described an incandescent conductor for an electric lamp made of carbonized fibrous material. In the specification I do not find any statement as to the shape of this conductor, but in the drawing attached thereto it is shown as having straight sides. Inasmuch as the advantages set forth in the patent in suit as belonging to the arch form of incandescent conductor seem to me to be secured to the same extent by the form of the said conductor shown in the Roberts patent, I think the opinion justified that for the purposes of invention the conductor of Roberts is a substantial equivalent for the conductor described in the first claim of the patent in suit.

In the English patent to Konn, No. 3809, of 1872, I find described an incandescing conductor for an electric lamp, which, as to form, appears to me to be of an arch or horseshoe shape, and as to material, may be made, I think, of any substances suitable for the purpose which were known in the art at the time the said patent was applied for. This conclusion seems to be justified by the fact stated in the specification that the incandescing conductors employed are to be made "preferably of graphite." This clearly indicates to me that Konn was fully aware that carbon in other forms was suitable for the purpose and that these other forms had already been known and used as incandescing conductors for electric lamps. Inasmuch as Sidot had described two or three years before a process for pro*pro*curing forms of carbon by carbonizing fibrous or textile material, which forms of carbon were characterized by their great conductivity of heat and electricity, it seems to me fair to assume this fact as known to Konn as a part of the knowledge of the art at the time, as it certainly was a part of the common knowledge of those skilled in the art in 1872. Konn's statement therefore seems to me equivalent to saying that while graphite had the preference in his mind as the material for a conductor, he did not intend
845 to limit it to this material, but that any material might be
used which was a well-known equivalent of graphite for the purpose at the time.

54 X Q. Taking everything into consideration, which of these two English patents do you regard as the most complete and satisfactory anticipation of the claim referred to?

A. It does not seem possible to me to discriminate between them in this respect.

55 X Q. Then do you consider the two as equally complete and satisfactory anticipations?

A. It seems to me that they are for the purposes of the invention of the first claim.

56 X Q. In which of the prior patents and publications referred to in your answer to question 16, do you find what seems to you to be the most complete and satisfactory description of the invention referred to in the second claim of the patent in suit?

A. In the English patents issued to Shepard and to Roberts and in the publication of Ladyguine I find described the combination of an electric circuit and an incandescing conductor of carbonized fibrous material, and a transparent, hermetically sealed chamber enclosing the said conductor, which I understand to be the combination referred to in the second claim. It further seems to me that for the purposes of the said second claim these said three references are equally important and show substantially the same combination. The said three references seem to me to describe the combination referred to more completely than any of the other references.

57 X Q. Are you able to select either one of the three as containing, in your opinion, a better description of the combination referred to than either of the others?

A. I do not think that I am.

58 X Q. Did you mean by your answer to question 17 that you regarded either of the prior patents or publications there referred to when taken by itself as containing a complete description of the invention described in the fourth claim of the patent in suit?

846 A. In the said answer I stated that:

"The patents of Roberts and of Konn, for example, both seem to me to describe lamps containing the three elements of the said fourth claim or their substantial equivalents for the purposes of the invention."

The said fourth claim, in my judgment, would be substantially produced by placing the carbon conductor of the first claim in one of the old lamp chambers shown and described for this purpose before 1878; or by adding to the second claim the form of the conductor. With reference to the elements of this claim the statement of Greener and Staite, made in 1846, seems to me important. In their patent the inventors say:

"We think it unnecessary to describe either how the air-tight vessel which is to enclose the illuminating bodies should be mounted or how the electric currents are to be conveyed to them from the voltaic battery or the magnetic machine employed, because there are many well-known modes of doing so, and we do not claim to have invented anything new in this respect. We desire further to be understood that we lay no claim to the employment of carbon, platinum, or like difficult fusible metal enclosed within air-tight vessels as a medium for the development and exhibition of electric lighting or the suitableness of both bodies for the purpose when so enclosed (subject to the difficulties aforesaid) being long well known."

Taking into consideration what I have said in previous cross-answers it seems to me that the patents to Roberts, Shepard and Konn show and describe the elements in combination substantially which are the subject of the said 4th claim; but I did not intend to say that I regarded either of these references as containing a complete literal description of the invention set forth in the 4th claim.

59 X Q. Do you then regard either of the three patents just referred to as containing in itself, without reference to the others, a description of the combination referred to in the 4th claim of the patent in suit?

A. It seems to me that in neither of the three patents re-
847 ferred to, taken alone, is there a complete literal description
of the elements in combination which is referred to in the
4th claim.

60 X Q. Which one of these patents approaches nearest, in your

opinion, to a complete and satisfactory description of the combination referred to in the 4th claim?

A. That would depend, as it seems to me, upon the relative importance to be assigned to the various elements of the combination and to the departures, if any, from the literal description given in the claim. In some respects the lamp of the Shepard patent meets most fully the requirements. In other respects these are met most fully by the lamp of the Konn patent. In still other respects the lamp of the Roberts patent has the advantage.

61 X Q. Which one of all the prior patents and publications put in evidence by the defendant would you select for the purpose of anticipating the 4th claim of the patent in the suit, if you were confined to one of the said patents and publications for that purpose?

A. It has always seemed to me that the English patents to Roberts to Shepard and to Konn and the publication of Ladyguine exhibit as clearly as any of the references in this case the invention described in the 4th claim; while none of these references describe literally the precise invention thus claimed, it seems to me that taken together they do describe this invention. Regarding the departures in the individual cases as of equal importance it would seem to me impossible to say that any one of these references described the invention in the literal sense more fully than the others. It is extremely difficult to determine in which case the advantages preponderate. But as I look at the matter at present it seems to me that the English patent to Shepard is on the whole to be preferred.

62 X Q. In your answer to question 9 you say:

"I find *that* in the state of the art before the date of the patent in suit the use of both mineral carbon and of carbon from vegetable fibrous material as the incandescing conductor of an electric lamp.

848 I find further that this carbonized fibrous material was used in the said incandescent lamps or was described for such use either in the form of straight pencils or in the form of arch or equivalent shapes."

Did you in these statements refer to the state of the art as shown in the prior patents and publications put in evidence by the defendant?

A. I did.

63 X Q. In which of the said prior patent- and publications do you find the most complete and satisfactory description of the use of "carbon from vegetable fibrous material as the incandescing conductor of an electric lamp"?

A. I find that the use of carbon from vegetable fibrous material as the incandescing conductor of an electric lamp is described in the English patents granted to Greener & Staite, to Shepard, to Roberts and to Konn, by implication, also in the publication of Ladyguine in the "Journal of the Society of Arts." It seems to me that the descriptions given in the patents of Shepard & Roberts, and in the publication of Ladyguine are equally complete and satisfactory upon this specific point.

64 X Q. In which of the prior patents or publications do you find a description of the use of carbonized fibrous material in incandescent lamps in the form of arch or equivalent shapes?

A. The reference which I had in mind is the English patent to Konn, No. 3809, of 1872, when taken in connection with his English patent No. 91 of 1873. The former describes a carbon incandescing conductor in the arch or inverted V form; while the latter, which uses the incandescent carbon for heating purposes states that this conductor may be used in other shapes. The expression "preferably of graphite," as I have already stated, seems to me to imply that carbon of other forms known to be equivalents for this purpose may be used.

65 X Q. Is that the best description you find in the prior patents or publications of such use?

A. I believe that it is.

849 66 X Q. Was the process of carbonization well known in the arts prior to 1880?

A. Broadly speaking, I think that it was. By this I mean that it was known that the proportion of fixed carbon in organic substances in general could be increased by heating them to a high temperature.

67 X Q. The process consisted of exposing the material to be carbonized to a high temperature in a closed vessel or chamber so as to exclude the air, did it not?

A. Practically I think that it did.

68 X Q. Is a cotton thread a fibrous or textile material?

A. I believe it is usually so regarded.

69 X Q. Have you any doubt in regard to it?

A. I think that I should so regard it.

70 X Q. Would a cotton thread carbonized by heating it to a high temperature in a closed vessel be a practically operative incandescent conductor?

A. Not necessarily, I think.

71 X Q. Do you think some further description than this would be necessary in order to enable you to say whether such a conductor would be practically operative or not?

A. While I should regard instructions to use a cotton thread for the purpose of making an incandescing conductor as much more specific than instructions to make such a conductor from fibrous or textile material, yet it seems to me that in the absence of any other directions some experiment might be necessary in order to make a practically operative incandescent conductor from a cotton thread.

72 X Q. What further directions would be necessary, taking into consideration the prior patents and publications with regard to carbonization and the general state of the art with reference to that subject as known prior to 1880?

A. Perhaps no further directions would be necessary.

73 X Q. What is your opinion in regard to it?

A. While I do not think that simply to carbonize a cotton
850 thread would necessarily make a practically operative incandescent conductor, yet I do not wish to be understood as ex-

pressing the opinion that it would not be possible to carbonize a cotton thread so as to produce such result. Indeed, my opinion is that this might be done.

Adjourned till Thursday, the 21st inst., at 2 p. m.

Resumed pursuant to adjournment.

74 X Q. Can't you give me a more definite opinion as to whether any further directions than those set forth in cross-question 70, would or would not be necessary for making a practically operative incandescent conductor?

A. I do not think that I can give a more definite opinion than that which is expressed in the last sentence of my last answer.

75 X Q. Why do you entertain any doubt on the subject?

A. I do not entertain any doubt on the subject.

76 X Q. Then do you think that such directions would be adequate for the purpose both with respect to the proper selection and preparation of material and with respect to the proper method to be employed for carbonization?

A. I think that in all probability a practically operative incandescent conductor might be made from a cotton thread carbonized by heating it to a high temperature in a closed vessel without further directions.

77 X Q. Do you mean to express any doubt as to whether a cotton thread so carbonized, would be a practically operative incandescent conductor, assuming only that such a thread were selected and it were prepared and carbonized in such a manner as would be done by a person skilled in the art as it stood prior to 1880, without experiment?

851 A. I mean simply to say that in my judgment a practically operative incandescent conductor could in all probability be made from a cotton thread carbonized by heating it to a high temperature in a closed vessel by a person skilled in the art prior to 1880, without experiment.

78 X Q. Have you any doubt in regard to it?

A. I don't understand the question. I stated in my last answer that in my judgment a certain thing could be done. I do not see how I can answer the question, therefore, except by saying that I have no doubt that in my judgment this thing could be done.

79 X Q. There are a great many different kinds of cotton thread, are there not?

A. I do not exactly understand what is referred to by the word "kind."

80 X Q. Are there not different sizes of cotton thread, thread dyed and undyed, glazed and unglazed, some which are twisted harder then others, and thread made of different numbers of strands and different kinds of cotton?

A. I believe that there are.

81 X Q. Are not various kinds of cotton thread filled with various dyes and glazed with various substances which would unfit them for use in making practically operative incandescent conductors?

A. I do not think so. In the first place the amount of dyeing or glazing material is very trifling, I believe, as compared with the whole mass of the thread. In the second place, such dyeing and glazing material being for the most part organic would be carbonized when the thread was. And, in the third place, I should suppose that a person skilled in the art would exercise some judgment in the selection of the cotton thread suitable for the purpose.

82 X Q. Would all cotton threads be suitable for the purpose so far as their structure is concerned? I mean with reference to the kind of cotton fibre employed in making them the number of strands, the tightness or looseness of the twist and the uniformity of gauge.

852 A. I should hardly like to say that all cotton threads would be suitable for the purpose, but I think it would be easy to select a cotton thread which would be so suitable.

83 X Q. In this also do you think that a person skilled in the art as it stood in 1880 would be able to exercise sufficient judgment to select a thread suitable for the purpose without experiment?

A. It seems to me that he might.

84 X Q. What kind of a thread do you think he would select as suitable for the purpose and what kind do you think he would reject as unsuitable?

A. It seems to me that such a person would probably select a thread uniform in size and made of pure material.

85 X Q. Having selected a proper thread do you think that such person would have been able to carbonize it properly without experiment so as to produce a practically operative incandescent conductor?

A. It seems to me that he might.

Cross-examination closed.

GEORGE F. BARKER.

Affirmed to before me,

WILLIAM T. FARNHAM,
Special Examiner.

Adjourned till Saturday the 23d inst., to meet at the office of defendant's counsel 40 Wall street, New York, at 11 a. m.

NEW YORK, *March* 23, 1889.

Met pursuant to adjournment.

Present: R. N. Dyer, Esq., for defendant, and R. H. Duncan, Esq., for complainant.

The witness, Professor GEORGE F. BARKER, being recalled by the defendant and reaffirmed, deposes and says in answer to questions by defendant's counsel:

853 1 Q. Are you acquainted with the construction of Geissler tubes; if so, please state how they are constructed, what they are used for, and how long they have been known?

A. I am acquainted with the construction of Geissler tubes; have

had many of them in my collection of apparatus, and have made many experiments with them. Soon after the perfection of the induction coil when it became possible to use this coil for the production of the electric discharge of gases more or less rarified, a glass-blower of Bonn under the direction of Professor Plücker undertook to produce tubes of various sizes and forms made of glass and permanently exhausted and sealed by fusion, for the purpose of replacing the cumbrous apparatus made jointly of glass and metal which had hitherto been used for passing the spark through gases. In consequence of the fact that the name of the said glass-blower was Geissler the tubes thus made by him or subsequently made by others upon the same principle are called Geissler tubes. These tubes being made of thin glass, and having the various parts sealed by fusion, were found to maintain a better vacuum than had been possible in the older forms of air-pump receivers the parts of which were separated by ground joints, usually having some fatty substance as tallow applied to their surfaces. This fact, together with the novel and beautiful effects produced in these tubes by the skill of the glass-blower, caused them to come extensively into use for experimental purposes. The current from the induction coil—a current therefore of very high tension—was conducted into the said tubes through small wires of platinum sealed into the glass by fusion. The electric discharge took place within the tube between the wire terminals and passed through a distance varying from a few inches to several feet according to the size of the tube, and the character of the induction coil used. The exhaustion produced in these tubes was various depending upon the conditions to be attained, but was never very high since a high vacuum increased the resistance and thereby diminished the brightness of the tube. I do not recall the year when these tubes were first introduced
854 by Geissler, but they have been familiar to me for twenty years or more.

2 Q. Please state, whether or not, in your opinion, the Geissler tube construction of chamber was, or is, or has at any time been known as a substitute or equivalent for the enclosing chamber of electric lamps like that shown and described in the patent in suit.

A. Not to my knowledge. There does not seem to me to be anything in common between the two except in the most general sense; and the one, therefore, would not seem to me likely to suggest the other as an equivalent for it. Indeed, prior to the description by Mr. Edison of his incandescent lamp there does not seem to me to have existed any form of incandescent lamp for the inclosing chamber of which the Geissler tube construction of chamber could properly be said to be a substitute or equivalent. So far as I know, no person had up to that time suggested the Geissler construction as applicable to incandescent lamps.

3 Q. Please state whether or not, in your opinion, the Geissler tube construction of chamber is applicable to or useful in the construction of lamps such as that described and shown in the patent in suit, or of any incandescent lamps that were known prior to the

publication of Mr. Edison's lamp construction in December, 1879, giving your reasons for any opinion you may express.

A. In my opinion the Geissler tube construction of chamber would not be applicable to or useful in any of the incandescent lamps referred to in the question, except those of Mr. Edison. The earlier forms of incandescent lamp—a form closely followed by the lamp of the patent in suit—seem to have been constructed upon the same general principle as that well known at the time for arc lamps, to wit, the principle of a somewhat elaborate and complicated structure which would allow of the replacement of the carbon conductor when necessary. Hence the lamp chamber was made thick and heavy, and it was closed by a plate fitted tightly to its opening but yet removable at will. Through openings in this plate, or its equivalent, passed the
855 wires or rods necessary to convey the current into the
apparatus. Since the incandescent conductor in these lamps was uniformly, I believe, of low resistance—about one ohm—it was necessary to make the conductors which carried the current into the lamp of large size and to contrive some method of making the joint air tight at the point where they passed through the said plate. I do not see that any material advantage would have been secured to a lamp of this kind by adopting the construction of the Geissler tube chamber. Evidently, I think, the necessity existing in all these lamps of renewing the carbons from time to time (and this quite frequently) would have prevented the joining of the glass parts of the lamp chamber by fusion of the glass, as is done in the Geissler tube, from being of any advantage to the incandescent lamp itself. And, further, because of the low resistance of the incandescent conductors employed in these lamps and the consequent large amount of current which it was necessary to convey into them for the production of the light necessitating the use of large leading-in wires, it does not seem to me that the method of sealing these leading-in wires into the glass, as in the Geissler tube construction, would have been of any material use; and this because, in the first place, these leading-in conductors must be of platinum—a poorly conducting metal—in order to be sealed into the glass at all. And in the second place, it would not be possible to maintain air tight the junction between the glass and the metal, in my judgment, for the reason that the heat conducted by the platinum to this junction would be liable to crack the joint by the differential expansion between the metal and the glass; even supposing that glass and platinum of the same coefficient of expansion precisely were employed, a thing extremely difficult to do at all times upon a commercial scale.

Because, therefore, the old lamps which have been referred to in the question, like the lamp of the patent in suit, required to be taken apart in order to renew the carbon, because these lamps
856 were substantial structures and could not be sacrificed when-
ever the incandescent conductor needed renewal, and because, further, these lamps were of so low resistance as to require leading-in conductors of large size, which could not be satisfactorily and

permanently sealed into glass, first, because of the large size of these conductors themselves, and second, because of the undue heating which would result, it seems to me that I am entitled to say that the Geissler tube construction of chamber would not be applicable or useful in any of the said lamps.

When, however, Mr. Edison conceived for the first time the idea of making an incandescent lamp with a thread or filament of carbon of high resistance he made, in my judgment, a radically new departure in incandescent lamps. By making the said filament long and of small cross-section, he obtained an incandescent conductor of great flexibility which could readily accommodate itself without injury to the extreme changes of temperature to which it must be subjected. But what was more, he succeeded in conveying to the lamp in this way the necessary electric energy required to give the light in the form of a maximum of tension and a minimum of current; so that the leading-in wires of platinum could be made of small size and could be readily sealed into the glass satisfactorily and permanently. In this way, too, Mr. Edison succeeded in increasing very greatly the duration of the incandescing conductor; so that, by enclosing it in a comparatively simple lamp chamber, sealed by fusion of the glass, he produced a lamp entirely different in its fundamental features from those which had, up to that time, been used for lighting by incandescence, and a lamp in which, as it seems to me, the Geissler tube construction could be made use of for the first time to material advantage.

4 Q. You have stated in substance that it was not until a radically new departure had been made in electric lighting that the principles involved in the construction of the Geissler tube chamber were applicable to or useful in the construction of incandescent electric lamps. Please state where you find the new departure you refer to first disclosed? 857

A. The radically new departure referred to is first found, as I have already stated, in the incandescent lamp described by Mr. Edison in his patent No. 223,898, issued January 27th, 1880, and a popular description of which appeared in the "New York Herald" for December 21st, 1879. The principle of this lamp consists in the use of a hair-like incandescing conductor of high resistance, which can be brought to incandescence by a minimum of current, and can be enclosed in a simple glass chamber.

Cross-examination by L. E. Curtis, Esq.:

5 X Q. In your answer to question 3 you say that the old lamps to which you refer required leading-in conductors of large size, which could not be satisfactorily and permanently sealed into glass. How large platinum wires can, in your opinion, be satisfactorily and permanently sealed into glass?

A. That would require experiment to determine, as it seems to me. I do not remember to have seen platinum wires so sealed which were larger than a millimetre in diameter.

6 X Q. Do you think that a wire a millimetre in diameter is the

largest wire that could be so sealed in regular commercial work in making incandescent lamps?

A. I have never seen wire larger than this used in incandescent-lamp construction, and never as large as this, except in a single case. I should suppose that, if larger wire than this were used for the purpose, the seal would not be permanent.

7 X Q. Are you prepared to say that the seal would not be permanent if wires two millimetres in diameter were used?

A. I cannot say what the fact would be from experimental knowledge, but my judgment would be that under considerable ranges of temperature such a seal would not be permanent.

858 8 X Q. In your answer to question 3 you say that Mr. Edison succeeded in conveying to the lamp the necessary electric energy required in the form of a maximum of tension and a minimum of current. What is the greatest current strength which you would regard as coming within the minimum of current to which you here refer? Would ten amperes, for instance, come within your understanding of a minimum of current?

A. That would depend, as it seems to me, upon the use to which such current is to be applied. For some uses I should regard ten amperes as a minimum of current and for others not. What I meant to have understood in my answer referred to is simply this fact, that granting the total energy supplied to a lamp to be represented by the product of the tension, by the current strength lamps may radically differ from each other, even when they consume the same amount of energy to produce the same amount of light according as they require a large current delivered under small tension or a small current delivered under high tension. Thus, for example, incandescent lamps, like that of the patent in suit, and older lamps of essentially similar construction, being of low resistance, require, as it seems to me, a maximum of current with a minimum of tension for the same total output. While the lamps first described by Mr. Edison, and which, as I have said, seem to me to constitute a radical departure in incandescent lamps, differ substantially and materially from the older type of incandescent lamps in being at the other extreme of the scale and in requiring in consequence of their high resistance the maximum amount of tension and the minimum amount of current for the same output. If, for example, two incandescent lamps require each the same amount of energy to give their normal candle power, say sixteen candles, and if this energy be assumed as three watts per candle the total energy for each lamp would be the same, to wit, forty-eight watts. Now one of these lamps may be of high resistance and require say ninety-six volts of tension to operate it; in which case the current required would be half an ampere. The other lamp may be of low resistance and require only one volt of tension to operate it, in which case the current required would be forty-eight amperes. With reference therefore to the same total energy expended in these two lamps, I should say that the former was a lamp in which the maximum of tension and the minimum of current was employed, while the latter re- 859 quired a maximum current to a minimum tension; using these terms relatively of course. Since the size of the conductor varies as the square of the current strength it is obviously of the greatest advantage to convey the energy to the lamp in the form of tension and not in the form of current, and hence the lamp in which this was first done by Mr. Edison seemed to me to constitute a radical departure in incandescent lighting.

9 X Q. Would a lamp requiring less volts of tension than amperes of current not be within the scope of the alleged improvement made by Mr. Edison and defined in your answer to question 3, even if the leading-in wires were made of platinum and sealed into the glass and the seal was permanent?

Objected to as immaterial, irrelevant, the scope of Mr. Edison's patent not being in controversy here.

A. I should hardly call such a lamp a lamp in which for a given total consumption of energy required a maximum of tension and a minimum of current. Whether such a lamp would be within the scope of Mr. Edison's patented invention I am not prepared to say.

10 X Q. What was the least current strength you assumed in your answer to question 3 would be required by the old lamps to which you there referred?

A. I have never seen any results of experimental tests to determine the amount of energy which must be expended upon the lamp of the patent in suit, or of the older incandescent lamps in order to produce a given candle power, and I do not know
860 that any such tests have ever been made. These lamps, so
far as I have been able to ascertain, were not only of very low efficiency, but also of very low resistance, thus regaining the energy to be supplied to them in the form of current. Assuming the resistance of the lamp of the old construction to be an ohm, and the efficiency to be not below ten watts per candle, which, in the absence of any exact data, seems to be reasonable, I should suppose that the minimum current required by such a lamp might be about three amperes per candle.

11 X Q. What is the maximum current which you have assumed could be used with an incandescent lamp having platinum leading-in wires sealed into the glass and keep the joint permanently tight under the conditions ordinarily obtaining in the use of incandescent lamps?

A. I did not have in mind in answering question 3 any precise number of amperes either as a minimum current for the older forms of lamps or as a maximum for the present forms. My last answer must therefore be regarded as fair an estimate as I can make upon the data assumed. As to the maximum current which it would be safe to use with an incandescent lamp of the construction stated in the question it seems to me that this would be the current which a platinum wire of a millimetre in diameter could carry without undue heating; the size of wire which I supposed, in my sixth cross-answer, was the maximum permissible. I have not the data here to calculate what this current would be, but the calculation when made would give, as it seems to me, what the question calls for.

12 X Q. Is that the best answer you can give?

A. It is, under the circumstances.

GEORGE F. BARKER.

Affirmed to before me,

[L. S.] WILLIAM T. FARNHAM,
Notary Public and Special Examiner.

It is stipulated and agreed that such of defendant's witnesses as have not already signed their *depositories* may sign them *nunc pro tunc* at any time within ten days.

861 40 WALL STREET, NEW YORK, *March* 19, 1889.

Mr. Curtis appears for the plaintiff; Mr. Griffin for the defendant.

WILLIAM P. WILSON, being duly sworn and examined as a witness in behalf of the defendant, testified as follows:

Direct examination by Mr. GRIFFIN:

1 Q. What is your name, age, residence and occupation?

A. William P. Wilson; age, 44; residence, Philadelphia; occupation, professor of the anatomy and physiology of plants.

2 Q. State your experience and qualifications for knowledge as to the intimate structure of vegetable matter.

A. I have been studying botany, which includes plant structures, or the anatomy of plants, since 1865. In 1874 I was appointed to a position in Harvard university, where it was my special work to care for the students in the anatomy of plants. In 1878, wishing to broaden my knowledge on the anatomy and physiology of plants, I went to Europe, and spent the greater part of five years in the universities of Göetingen, Berlin and Tübingen, in Germany, and Naples, in Italy, studying especially the tropical plants, so far as they could be cultivated in Italy. Since that time I have been actively engaged especially in the microscopic examination and study of vegetable tissues for the purposes of my profession. At the present time I am officially connected with the University of Pennsylvania, in Philadelphia.

3 Q. What special preparation, if any, have you made for the purposes of this examination?

A. I have visited the Edison Electrical Company's factories, examined the bamboo in all its stages and in its different conditions as brought from Japan; and have looked over the various 862 processes of manufacture of the part which is carbonized for the incandescent light. I have taken material to my own laboratory, and given it the most careful microscopic and chemical examination—in this way being able to make comparisons between this and many other substances. I have also made special examinations of numerous exogenous and of numerous endogenous woods and fibrous structures, with special reference to their carbonization for electric conductors.

4 Q. Are you acquainted generally with the principles of electrical science?

A. In a general manner, yes. I have made no special study for a number of years of the phenomena of electricity, or of electric science as it has grown up; but formerly, when interested in the study of certain currents which were discovered to exist in plants, I made some special studies of electrical resistance and of kindred subjects—I mean with special reference to plant structure.

5 Q. Using the word "fibrous" in its ordinary broad signification, as that which contains or consists of fibres, what proportion of vegetable substances are fibrous, and what classes of vegetable substances, if any, are devoid of fibre?

A. If one uses the term "vegetable fibrous substances" in its broadest sense it practically includes all vegetable growths, the number which are not fibrous being so small and of such an inconspicuous character that no ordinary person would think of them. I believe, taking the plant kingdom as a whole, there are but two or three very small groups which are not fibrous, such as the algæ and the fungi; but the group called "fungi" must be qualified to a certain extent, as even in this so-called family there occur numerous structures which might be called fibrous. I want to make one modifying statement. I do not mean to say that the number of individuals is small, for, in the algæ, they are extremely numerous, but largely microscopic, and the same may be said of the fungi—a larger part of which are microscopic and unicellular in structure.

863 6 Q. In the families of the algæ and fungi you have mentioned as being non-fibrous, what is the proportion of the solid matter, or residue, as compared with the watery tissue which would evaporate on heating?

A. If you mean the solid matter which would remain upon incineration, then, in many of the algæ, and also of the fungi, much the greater part would pass off in the form of vapor or water, and in many cases the percentage would run as high as from seventy-five to ninety-seven and a half per cent. of water.

7 Q. In the broad and ordinary sense of the words, is there, then, any substantial difference in the defining or limiting meaning of the expressions "fibrous vegetable material," as compared with the expression "vegetable material"?

A. In the general sense fibrous vegetable material would be taken to include all vegetable growths, the groups which are not fibrous being so inconspicuous, and the group of the families which are not fibrous playing no conspicuous part in the general vegetation of the earth.

8 Q. What, to your knowledge, is the great natural storehouse, or source of origin, of carbon or carbonaceous material?

A. I should say that it was the vegetable world.

9 Q. What class of vegetable tissue, as a rule, contains the largest

percentage of carbon, or of carbonaceous matter, in proportion to its original weight?

A. The exogenous plants would contain more carbon in proportion to their weight than the endogenous plants.

10 Q. Please describe, with as much brevity as is consistent with clearness, the general characteristics of the various tissues or fibres of an exogenous stem, so that the same may be understood, without unnecessary use of technical botanical terms?

A. The character of exogenous stems, of course, varies with each stem, and with the age or growth of the stem under consideration. In order to facilitate such description I have prepared a few plates and diagrams which I should like to introduce into
864 the evidence. Nearly all of our ordinary plants, forest trees
and common shrubbery, which naturally grow in this climate, belong to the exogenous group. In brief, the description of an exogenous stem may be the following: If one takes a cross-section of any ordinary exogenous stem there will always be a central zone of loosely arranged more or less spherical cells called the pith. In a circle surrounding this central pith will be found the so-called woody zone. On the exterior of this woody zone, around its whole circumference, is the growing or cambium layer. Exterior to the growing layer is found the bark or rind. The cambium or growing layer forms each year in our exogenous growths a layer of wood on its interior and a layer of the bark or rind on its exterior; thus the wood becomes thicker each year by this addition. This newly added wood is called the annular ring; the bark or rind is more or less complex, having in many growths one or more layers which are capable of adding to its thickness. In the early stages of the growth of any exogenous stem the cells which make up its primary form are all rounded and more or less spherical like the pith in the centre. All subsequent modifications into the wood and into the various modified cellular structures of the rind are modifications of this original so-called fundamental tissue; so that whether the product is ultimately called a fibre or a duct or a tube or a vessel, it all originates from the one form of round-celled tissue. Plate No. 1 shows a typical transverse section of an exogenous stem, and plate No. 2 a vertical section of the same very highly magnified. In plate No. 2 the row of cells marked *p* shows the fundamental form of cells. The various vessels or tubes lettered from *a* to *k*, which are found in woody structures proceeding from the centre towards the circumference, are made up of modifications from the original fundamental tissue called pith, either by growth of the original cells, or by the breaking down of the intermediate wall or partitions of certain of the cells, or by the perforation or thickening or marking of the original walls of the cell either before or after they have
865 coalesced to form a tube form. Thus we have in plate No. 2,
beginning on the left, *p* the original parenchyma or fundamental cell; *a*, an annular vessel made up of numerous original cells, the intervening walls having disappeared so as to form a tube, a portion of the walls having become thickened into ring-like interior protuberances; *b* is a similar vessel, only having different mark-

ings; *c* is another vessel which differs only in its markings; *d* represents a group of ordinary wood cells in which the walls have not been obliterated but have become much thickened and filled often with starchy or other materials; *f* represents a large dotted duct formed out of the original cells which have coalesced to make a tube, the walls of which have become thickened in dots or small circular rings. Next to this succeeds the growing layer, where the fundamental cell is again visible, these cells on the woody or inner side developing into the various tubes and cells described, and on the bark or rind side into the ducts or vessels which are peculiar to bark, and which are shown at *h, i, j* and *k*. The comparative size of these various cells, tubes, ducts and vessels, the thickness of their walls, their length, the nature of their contents, the peculiarity of their markings and their relative position, all vary in each exogenous wood, and give to that wood its recognized characteristics. In the same wood, at different ages, similar differences may be found. At one period of growth one tissue predominates which at another period almost disappears or becomes so altered or filled with foreign substances as to become almost unrecognizable. The differences between these various vessels and fibers when viewed under the microscope are as fundamental and widely divergent as it is possible to imagine. The minute characteristics of the vessels or fibers in one wood do not necessarily appear in what might be popularly termed similar fibres or vessels in another wood. The only visible differences of one wood from another have their counterpart and analogy in the microscopical differences of the cells or fibrous structure of the woods; and these differences can
866 only be ascertained by microscopical observation and study.

One peculiarity of exogenous stems is shown better in transverse section in plate No. 1 than in plate No. 2. From the central pith or fundamental cells of exogenous stems there run what are called medullary rays towards the circumference through the wood into the bark. In young wood these medullary rays are composed of the fundamental tissue; and this characteristic is preserved by the cells of the medullary rays however old the wood may be. That is to say, the cells of the medullary rays do not develop into ducts, vessels and tubes, but always retain their original character. In young stems the medullary rays form a means of communication for the sap or watery elements, enabling them to circulate from the growing portion to the pith. In older wood the cells of the medullary rays become so thickened and compressed that they are practically dead. The number of these medullary rays is extremely great, although varying in different exogenous stems. The cells of the rays as a rule run horizontally as to their longer diameter.

The various vessels, ducts, tubes and fibres of the wood proper are harsh and unyielding and have no commercial value for textile purposes when used alone. When treated by various acids or alkalis or by steaming processes, they may be reduced to a condition of pulp, in which it is possible to employ them in the manufacture of a common variety of paper.

The bark or rind, &c., may be separated into the epidermis, which is the outside portion and generally composed of round-celled tissues, the walls of which are generally very much thickened, and beneath which is a corky layer of prismatic cells. Beneath these are layers belonging to the living, growing round-celled tissues. Further in the interior come very much elongated cells with thickened walls, grouped more or less together in bundles, called bast cells, together with a few tubes, generally called sieve tubes from the fact that the horizontal walls or divisions of these tubes are perforated so as to somewhat resemble a sieve.

867 11 Q. What portion of the exogenous stems has it been and is it, customary to use for purposes of carbonization generally?

A. The only portion which can be successfully used for carbonization is the wood.

12 Q. What would be the effect of trying to carbonize an ordinary *o*xogenous stem having the bark upon the stem?

A. The cambium, or growing layer which separates the bark on the one hand, and the newly formed wood on the other, is mainly a pulpy mass, made up of thin-walled cells filled with fluid. The bark would at once separate from the woody portion. In the woody portion would be found most of the carbon, the bark containing very little. The bark is much looser than the woody tissue, less coherent, less compact, less adherent, more easily separated, and on carbonization would be apt to break up, having little coherence, and containing so large a percentage of water. As is well known, for all purposes of carbonization in the general use of *o*xogenous woods, the bark is stripped off the wood, and unless in the green trees, or in trunks of the raw material, the bark is not found. The bark has little or no use as a timber or wood; and so far as I know, the bark is never used for the purposes of carbonization.

13 Q. In attempting to carbonize green willow twigs, for example, what would be the effect of any process of carbonization known to you, upon the bark of the green twig?

A. The bark of the green willow twig, under the process of carbonization, would mostly disappear; but whatever was left would separate from the woody portion, warping away from it.

14 Q. What would be the character of the resultant carbon obtained from such a stem as a green *ye*llow twig?

A. In consequence of the water character of the bark, it would be an extremely spongy mass, the round-celled tissue almost wholly disappearing. In fact, the entire twig, wood and bark, of a growing willow twig would almost disappear, so great being the
868 proportion of watery material to solid substance—the cells
generally being very thin and immature, and only partially formed.

15 Q. What would be the effect, to your knowledge, of an attempt to pass an electric current along a filament or conductor of carbon made from a live green willow twig?

A. The thin-walled cells which had been left from the carbonization would be rapidly consumed by the current—there being always a greater resistance at points where these thin-walled cells occur.

16 Q. Have you prepared microscopic drawings of any exogenous stems in longitudinal and transverse section, to illustrate the characteristics of such woods when cut to size of the ordinary filament, such as used in the Edison incandescent lamp? If so, please present and describe the same?

A. I have cut and prepared such specimens from such woods as I thought would be poorest, and from such woods as I thought would be best for electrical conductors. The drawings I have taken from filaments of the wood, as nearly as possible approximating the size of the ordinary Edison filament—the drawing showing the appearance of the same magnified about 150 diameters. Plate No. 3 shows such a magnified filament taken from common whitewood (*Liriodendron tulipifera*), otherwise known as the tulip tree, and sometimes called the white poplar. The cross-section of the filament shows four medullary rays of short fundamental tissue. Between these lines of fundamental tissue are numerous openings, some larger and some smaller. These openings represent the cut ends of various vessels, ducts, and large wood cells, the markings of which will be seen in the longitudinal section. A A shows the medullary rays; B B some of the open vessels; and C C indicate some of the woody fibres. It will be readily seen that the medullary rays A A in the longitudinal section are cut across at right angles to the lines of their longer axes, a very great number of cells being cut across in each ray. In the portion of the filament shown in the 869 plate, a dozen to fourteen medullary rays are shown cut across, and as this only presents one surface of the filament, a much larger number are cut across and not shown; in addition to which it must be remembered that the microscopic section shows only a very short length of the filament. In an ordinary filament of three or four inches in length, the number of medullary rays cut into would number many hundreds, and each ray would be composed of a very large number of original cells. It will also be seen that there are numerous large vessels running parallel with the filament, making a very open tissue. The woody fibres, it will be also noticed, are caused to diverge from their parallel course in proportion to the width of the vessels B B and the size of the medullary rays A A. Where the vessels or the medullary rays separate the woody fibres the coherence of the fibres is very slight.

17 Q. Is the whitewood as represented by you in plate No. 3 a representative specimen of the ordinary exogenous woods?

A. It is a representative of one of the so-called softer woods. Such woods would present great ease of cutting and making to the required form, and, as well known, such woods are commonly prepared by carpenters for such purposes in preference to the harder woods which offer greater difficulty of manipulation.

18 Q. Please present a similar plate representing a magnified picture of a filament of willow.

A. Plate No. 4 represents such a filament, magnified about 150 diameters, in longitudinal and cross section. It will be noticed that in the willow filament the vessels are even larger and looser than in the filament of whitewood. In the filament as shown very few of the medullary rays are shown cut into. This happens because the filament is not a perfect tangential section.

19 Q. Please present a similar microscopic drawing of one of the harder woods?

A. Plate No. 5 represents such a filament, made of rock elm, one of the most valuable of known exogenous woods of our clime. It will be noticed that the wood fibre is very greatly turned 870 aside and caused to diverge from a parallel course, by the medullary rays, which are very large, and are composed of a large number of small cells. It will also be noticed that the edge of the filament is broken as regards certain fibres. This is the inevitable consequence of cutting a filament of such a wood, in which the fibres are sinuous.

20 Q. Is the rock-elm section as presented by you a typical section of the harder, close-grained exogenous woods?

A. It is. I specially selected this specimen for its hardness, and because it presented the best or the nearest analogue to bamboo stem, as used by Mr. Edison, known to me in exogenous woods, so far as the length and closeness of the fibre is concerned. It is an extremely favorable specimen in this respect of the general character of exogenous fibres, which are by no means so long or so close. The general exogenous woods would run between the specimen of white wood, representing the softer woods, and the rock elm, representing the hardest and closest-grained woods. I may state that in selecting the rock elm from which to make my station, I obtained the assistance of the first expert in the State of Pennsylvania in the selection of a most favorable specimen. I have a specimen with me of the rock elm, into which a wedge was driven some two years ago, and which will be seen preserves the tightness of hold upon the wedge up to the present day, the intricate interlacing of the tissue causing such tension as, notwithstanding shrinkage from changes of temperature, moisture, etc., still retains a firm hold upon the wedge.

"Said specimen is offered in evidence, and marked 'Defendant's Exhibit Wilson Rock Elm Specimen, March 19th, 1889.'"

21 Q. State from your experience what would be the effect of carbonizing exogenous woods of the various types presented by you, and especially what would be the effect of attempting to carbonize filaments of such woods for use in the Edison incandescent lamps?

871 A. The carbonization of specimens of willow and of white wood would result in rather a spongy heterogeneous carbon, for the following reasons: The medullary rays being made up of very thin walled cells, would partially disappear; the larger parallel vessels and ducts would leave open spaces from one end of the filament to the other, thus giving a very open, spongy mass; and the fibrous part of such filament would be very loosely attached together after the destruction of the connective tissue—the medullary rays.

22 Q. Would there be any uniformity of conductivity of an electric current in a filament formed of such wood?

A. The conductivity would vary in proportion as the texture of the carbon varied, which would be extremely great, there being the greatest differences between the vessel and the medullary rays. The willow and the white wood, in this respect, are almost identical.

23 Q. Please answer similarly as to the rock elm, taking that as a sample of the hardest exogenous woods most suitable for manufacture into a filament for an electric incandescent lamp?

A. A filament made from rock elm, on account of the interlacing of the fibres, is extremely tough and tenacious before carbonization; but the very qualities which make it tough and tenacious before carbonization will make it extremely friable after carbonization. The fibres interlacing are cut at short intervals, and under great tension. Upon carbonization this tension is relieved, and these short fibres would naturally fall apart. In addition, the large number of medullary rays, as shown in plate No. 5, would render the conductivity extremely varying. Long close woody fibres would be excellent conductors; but where turned aside for a medullary ray, the resistance would be greatly increased; such resistance would naturally cause an increased degree of heat; and the thinner-walled cells making up the medullary rays would burn away first; thus, in a very short time, destroying the filament. Thus, a filament which before carbonization is one of the very toughest which can be made out of any of our exogenous woods, becomes after carbonization extremely friable, and an extremely poor conductor for an incandescent lamp. 872

24 Q. Please answer the same questions as to the large class of resinous or hard woods of exogenous character.

A. Such woods are extremely durable for purposes of carpenter's work by reason of their resinous character, which resin would be volatilized and dissipated under carbonization; the residue of the woody carbonaceous matter would then be light and spongy, the more so by reason of the evaporation of the large amount of resin contained in the large cells. The weight of these woods as ordinarily used is due to the enormous amount of resin contained in the cells, which are filled up solid with the resin. If this resin is dissolved or evaporated out, the residue of the woody tissue is no greater than in other woods already mentioned of exceedingly low specific gravity. The resultant carbon therefore would be of the same class so far as their electrical qualities are concerned.

25 Q. I call your attention to the following statement in the patent in suit: "The advantages resulting from the manufacture of the carbon from vegetable fibres or textile material, instead of mineral, or gas carbon, are many. Among them may be mentioned the convenience afforded for cutting and making the conductor in the desired form and size, the purity and the equality of the carbon obtained, its susceptibility to tempering, both as to har-ness and resistance, and its toughness and durability." Please state whether to your knowledge these advantages are found in vegetable fibrous

material of exogenous growth—first, as to the convenience of cutting and making the conductor in the desired form and size.

A. It is true that great numbers of vegetable tissues could be very easily and readily cut, but equally true that such of these tissues as can be readily cut would be generally worthless for electrical purposes. As for illustration, the white wood (plate No. 3), and the willow (plate No. 4), both of which woods are very soft 873 because they are filled with large ducts and vessels containing air, between which is interposed much of the fundamental tissue. This fundamental tissue allows the vessels, ducts, and woody cells to be very readily separated. It also renders the filament after carbonization equally friable and spongy, and therefore comparatively worthless for incandescent purposes as shown by experience. It may be stated that even in such woods it is perfectly impossible to get a smooth exterior, because in forming even so small a conductor as a filament, a large number of medullary rays are cut across or broken into, and also numbers of vessels and ducts of considerable diameter open up on the surface of such filament, often only partially parallel to it. For example, in plate No. 3 it will be seen that three of the medullary rays are cut across on the outer edge of the one portion of the surface shown in the plate; and on plate 4 a large duct at B comes just at the outer margin of a filament; and on carbonization this duct would allow the extremely thin surface of the filament to collapse, forming a rough edge.

In the harder woods, such as the rock elm, the fibres interlacing and crossing each other, as can be seen in the specimen with the wedge in it, which I have presented, present a material which is almost impossible to cut into straight even filaments; but when cut, as previously stated, there would be so many cross-fibres and cross-cuttings of interlacing fibres that the filament would have almost no adherence after carbonization. In very many woods (as for example in the specimen of curly maple which I present as a part of this my answer) the fibres are so wavy that they would almost be cut at right angles in short distances in any filament, so that even before carbonization there would be no coherence of the fibres. It would be like cutting a filament at right angles with the ordinary grain. Thus it will be seen that the very quality of toughness, apparently so desirable, becomes the main reason of the electrical destruction or inefficiency of the filament.

Next, as to the purity and equality of the carbon obtained. 874 The equality of the carbon, as opposed to the purity, must mean equality of structure, the lack of which is the distinguishing characteristic of ordinary vegetable carbon. The varying sizes and proportions of cells, ducts, tubes and fibres, the different thicknesses of the cell walls, the interlacing and crossing of the medullary rays, fibres and ducts, and the differing density of each portion of the wood, all tend to render the resultant carbon extremely heterogen-ous. The purity of the carbon also varies very greatly with the character of the vegetable structure. In the willow we have as a result of carbonization probably one of the purest carbons. A very careful analysis, made expressly for this examination, enables me to state that 100 parts of ordinary white willow contain only .42 of one per cent. of ash or foreign matter. It is for this reason that the willow charcoals are generally selected for the manufacture of gunpowder—on account of their extreme purity. In other words, the ash constituents are very much greater, consisting of salts of silica, potash and other mineral substances, varying with each wood. It will be noticed that the purest forms of carbon are obtained from such woods as willow, which are the least adapted for electrical use in an incandescent lamp. The woods of harder fibre contain more impurities in the form of residue ash, and owe more or less of their hardness in many cases to the presence of foreign matter. As an extreme instance of this it may be mentioned that certain woody substances contain so much silica that they have been used as edge tools or swords.

As to the question of tempering vegetable fibrous material, so far as it relates to its electrical resistance, I have had no experience, and therefore cannot state.

As to the question of toughness and durability, it has already been incidentally treated by me in my discussion of the heterogeneous nature of the wood tissues. All the exogenous woods known to me would make carbons which are by no means tough or compact. If, by durability is meant durability as an incandescent burner, the
presence of medullary rays, the interlacing of the fibres, and
875 the other characteristics of exogenous stems mentioned by
me, would, in my opinion, tend to produce a great variation of strength of the electric current in different parts of the carbon conductor, and so an unequal strain upon these different parts, and the speedy destruction of one part and the consequent disintegration of the filament.

26 Q. Assuming that a substantial equality of resistance is necessary in a carbon filament for use in an electric lamp, do the fibres in exogenous woods present such an equality, or, by reason of their existence, increase or aid such an equality in a carbon conductor?

A. I should think that from the nature of the general structure in exogenous woods, they would not aid such uniformity of conduction. The presence of fibrous ducts or cells implies a difference of structure, and consequently a difference of electrical conductivity. Even were the entire tissue fibrous, the existence of separate or differing fibres implies a difference of structure, and consequently to the extent of such difference, a variation of electrical conductivity. Each fibre has its wall or boundary line, and is separated more or less appreciably from its neighboring fibre which implies a variation of density, and consequently a variation of electrical conductivity. Fibres are also more or less infiltrated in their cell walls with different substances, so as not to be uniform one with the other in these respects; and according to such difference there will be a consequent difference of density, and so of electrical conductivity.

27 Q. Turning to endogenous stems, please describe their generic character.

A. Plate No. 6 (which is a cross-section of common Indian corn) is a typical illustration of an ordinary endogenous stem. The great mass of cells shown in such section is made up of round-celled, fundamental tissue F; among which are scattered numbers of what are termed fibre-vascular bundles, *g*; such fibro-vascular bundles are composed of spiral ducts C; and annular or ringed vessels, D; and a mass of surrounding small-celled tissue E, made up of bast cells, with more or less woody fibre. These bundles are called 876 fibro-vascular bundles, because in them are united on the one hand the elongated cells, which are the true fibrous cells, and the very much elongated and variously marked vessels. Towards the circumference of the stem it will be seen that the bundles become more numerous. At A and B are shown the epidermal layers. In endogenous stems there is no true bark. The increase in growth is formed by fibro-vascular bundles becoming interpolated in the fundamental tissue between the already existing bundles. Such stems do not increase in diameter, but are formed of the original size from the terminal bud. They grow harder and firmer according to the increasing number of fibro-vascular bundles, or various changes in the bundles and tissues already existing. This increase of fibro-vascular bundles is not continuous, but terminates at a period varying in different plants.

Plate No. 6 is a farly typical example of the ordinary endogenous structure. It will be easily seen that in cutting a vertical section it would depend entirely upon where the section was made, whether any of the fibro-vascular bundles were included in the surface of the section or not. The majority of the tissue in such section would be the short round-celled fundamental tissue, with here and there a portion of the fibro-vascular bundle shown in long and nearly parallel lines. The fundamental tissue is less prevalent towards the circumference than at the centre, in consequence of the greater number of fibro-vascular bundles.

28 Q. What would be the character of the carbon resulting from the carbonization of the ordinary endogenous stem?

A. In the great majority of endogenous stems the fundamental tissue largely exceeds in bulk that of the bundles; and any filament for electrical purposes cut from such stem would necessarily include one or more of the bundles, and a mass of the interwoven fundamental tissue. Upon carbonization such fundamental tissue, being thinner walled and with much less substance, would present naturally much less carbon; and form an open spongy mass between the fibro-vascular bundles. 877 The bundles also would vary very much in density in proportion as they neared the centre of the stem or the circumference, those in the centre of the stem being more vascular (that is to say, having larger air space) than those near the circumference, which would be made of a more compact fibre. These large air spaces would offer great irregularity of conductivity in different portions of the cross-section of a filament. Such filament carbonized from any ordinary endogen would lack necessarily compactness, as the mass of it would be made up of these round-celled fundamental tissue. The surface of it would be very rough, and would present a perfect honey-combed appearance, except where the fibro-vascular bundles happened to lie on the surface. As I understand it, this honey-combed character of the outside of the filament would tend to the rapid destruction of the filament by the electric current. In addition, the variations of thickness in the cell walls of the fundamental tissue present great differences of electrical resistance, especially as compared with the resistance of the fibro-vascular bundles. Consequently, the surrounding fundamental tissue, where resistance is greatest, soon burns out, and the life of the filament is destroyed. This I know from microscopic examination of short-lived filaments that have been subjected to the electric current. The microscope showed me that the fundamental cells in such filaments had been destroyed, or had become of so spongy a character that the walls might be said to have melted away and disappeared. They had the appearance of having melted up at the edges. Of course this was a destruction of a large portion of the cross-section of the filament and would throw the entire strain of the current upon the remaining small portion of the filament, tending to the speedy destruction of the filament. This would be the necessary consequence with nearly all endogenous stems known to me.

29 Q. Please describe the structure of the bamboo stem, 878 and state what differences, if any, there are in the structure of that stem and the ordinary endogenous stem already described by you?

A. For the purposes of this examination I have made a special study of bamboo stems, in addition to the general prior knowledge that I had on the subject. I present three plates, Nos. 7, 8 and 9, made from microscopical sections prepared by me. No. 8 is the cross-section of the ordinary adult bamboo stem; No. 9 is a longitudinal and cross section of an actual filament of the Edison lamp, obtained by me at the Edison lamp factory. The difference found to exist between an ordinary endogenous stem in cross-section and that of the bamboo may be briefly stated to be the following: The fibro-vascular bundles, taking on equal surfaces, are greatly increased in number in the bamboo. This is especially so as one approaches the outer margin of the stem. The fibro-vascular bundles as they approach the circumference lose a part of the woody tissue, which is replaced by bast, so that the bundles near the circumference are almost wholly made up of bast. Again, the round-celled fundamental tissue, which made up most of the surface in the section of corn, becomes greatly reduced between the bundles of the bamboo. This reduction goes still further as one approaches the circumference of the stem, until between many of the bundles, which are almost wholly bast, there is but one layer of cells of the fundamental tissue, and in many cases the bundles are not separated by any of the original parenchyma or round-celled tissue; but a still further change takes place in the fundamental tissue which exists between the bundles. The walls have become very much thickened, thus resembling the bast cells which it separates. The inner layers of the epidermis have also become transformed into bast. In the old stem of the bamboo we have, therefore, a zone extending completely around the stem, near the outer margin, which is almost made up of solid bast cells. Again, the bast cells, which in the corn or in most endogens are hollow, with quite large openings, in the bamboo becomes closed and nearly solid.

This gives practically a zone near the circumference of the
879 stem of the bamboo, which is made up of almost solid bast
cells. These bast cells are shown well in the cross-section at A of the filament on plate No. 9, in which it will be observed that the cell walls have become so thickened that each cell may be said to be almost absolutely solid, the slight ring marked at the centre being the only trace of an opening. It will also be observed that the bast cells are close approximately one to the other—so close, indeed, that they may be said to form practically a solid rod or mass. This bast zone of which I have spoken is shown in the diagram in plate No. 8 as A A.

30 Q. What difference, if any, exists between the adult bamboo stem and the young green bamboo stem?

A. Plate No. 7 is a cross-section of a green bamboo stem cut by me, the stem being only six weeks old. Here the bundles are separated by a much wider layer of the fundamental tissue. They are less separated as you approach the margin. The bast in the bundles is thinner walled. The epidermis, instead of two or three layers of cells, contains six or seven, the inner ones of which will later be developed into bast. These different epidermal cells are marked respectively E and E^1; the layer of bast which, by consolidation and crowding, later becomes the bast zone spoken of in the adult stem, is marked A A, and the intervening fundamental tissue is marked B.

31 Q. What has been your acquaintance with endogenous stems?

A. I have examined hundreds and even thousands of them.

32 Q. Do you find the equivalent of the zone A A in other endogenous plants; or how far, if at all, is the same peculiar to the bamboo?

A. I find the same peculiarity to a certain extent in some other stems, but never, so far as I know, approaching the extreme condition found in the bamboo. In all endogenous stems the bundles tend to become more crowded towards the circumference, with less intervening fundamental tissue, but I know of no stem
which includes such a combination of characters form-
880 ing this almost solid zone of bast as is found in bamboo.
These characters are in combination: (1) an increase in the bundles towards the margin; (2) the compressing of the intervening parenchyma by elongation and thickening of the adjacent cells; (3) loss by transformation of certain vessels in the fibro-vascular bundles, which, as they approach the margin, becomes almost wholly bast; (4) the solidifying and thickening of the walls of the bast cells; (5) either the total loss of the intervening parenchyma or the thickening of its walls, so that it resembles bast. This combination, taken as a whole, is, so far as I know, unique, and found only in the bamboo. Some of these qualities will be found in some stems

and others in other stems, but as a whole I know of no stem that carries this combination to such an extreme. In fact, this zone of bamboo, with its compact bast cells, mitred end to end and firmly adherent upon the adjacent sides, forms a tissue which more nearly resembles a metal wire in its continuity than any other tissue known to me. As illustrating the substantial identity of tissue resulting from this solidity, I may mention that, in splitting the bamboo lengthwise, the splitting will often split the bast cells in halves, instead of separating one fibre from another, thus showing that the cohesion of the separate bast cells is equally strong with the internal cohesion of the particles forming the cell wall. In other words, there is a substantial identity of cohesive force in all parts of the structure. These bast cells are practically parallel, as shown at A in plate No. 9. It will be observed in the cross-section of plate No. 9 that there are shown two rows of fundamental tissue in the entire cross-section of an actual filament. It may well happen in many filaments that there will be absolutely no fundamental tissue in the entire width, but that the same may consist entirely of bast cells. Of course in manufacturing filaments care should be taken in the selection of such filaments as contain the least amount of fundamental tissue. The effect of such a structure is to give great uniformity in electrical conductivity or resistance—the bast cells
881 being substantially identical one with the other, and so closely
adherent as to become practically continuous, thereby causing no difference of electrical resistance worth mentioning, except where the fundamental tissue may be present; and in these the electrical resistance more nearly approximates to that of the bast cells by reason of the enormous thickening of the cell walls. This zone is the closest approximation to a solid homogeneous conductor known to me in the vegetable kingdom.

33 Q. Is there any analogy or similarity between this zone of the bamboo and the substance of paper of any kind known to you?

A. There is no analogy whatever. Any ordinary paper which is made from wood pulp, or vegetable material, is composed of fibres purposely separated and rendered disassociated to the extreme. In matting these fibres into the paper substance the object of the paper-maker is to make the direction of the fibres as heterogeneous as possible, in order to give tenacity to the paper. If the fibres in the paper were parallel, the paper would have no tenacity. In addition, paper necessarily contains fibres of all character; also vessels, ducts and tubes; and necessarily these fibres are more or less broken, macerated and torn; and they present numerous loose ends prominently on the surface of the paper, which appearance it is a part of the art of the paper-maker to hide by loading the paper with filling substances, generally of a mineral character; and, as a consequence, the defects mentioned as belonging to exogenous woods, as to variations of texture, density and electrical conductivity, are excessively exaggerated in a carbonized paper filament. With the exception of the fact that bamboo is of vegetable origin, there seems little or no connection or association in any way between such a substance as paper and the particular zone of bamboo mentioned by me, and which I understand is the zone selected by Mr. Edison, after long experimenting, for the manufacture of carbon filaments for his lamps.

882 34 Q. What would you have understood, and what was commonly understood in the art by "wood carbon or charcoal" on January 9th, 1880?

A. I should say without hesitation that it meant charcoal from any one of the ordinary exogenous woods.

35 Q. Would the use of such expression have suggested to your mind carbonized bamboo as one of the carbons or charcoals usually included in the phrase?

A. The bamboo, being one of the grasses, and the grasses, as we ordinarily know them, having generally quite pliable hollow stems, the bamboo would have been almost the last plant I should have thought of. Really I never would have thought of the bamboo at all. It would never have entered my mind. If I had had my attention called to it, but without giving it special attention, I should have thought that anything from the grass family would be worthless as a carbonized filament or conductor for an incandescent lamp.

36 Q. As matter of fact, exclusive of the use of bamboo for the manufacture of filaments for incandescent lamps, have you ever known of its use as a substance for procuring wood carbon or charcoal?

A. I have never heard of bamboo, nor of any nearly allied structure being used to make charcoal.

37 Q. What percentage of impurity exists in bamboo stems, as compared for example with the impurities you have mentioned in the willow?

A. By careful analysis made in the organic laboratory of the University of Pennsylvania of that part of the stem imported especially for the filament, I have found it to contain 6.42 per cent. of earthy impurities, of which 6.2 per cent. is silica and 0.22 of one per cent. potash and other substances. The excessive amount of silica in bamboo is known to exude into the hollow of these stems in the form of a hydrated silicate of soda, which is known in the arts as tabaschir, a well-known substance in materia medica in the Orient, and sold in the form of small rolls, in which form it is naturally moulded in the hollow stems. This substance is peculiar, in that it possesses the lowest refractive index know- of any 883 substance. In appearance it is glassy in structure, and, in fact, is called a natural glass; containing from fifty to sixty per cent. of water, the rest being silica.

38 Q. Is any species of bamboo native or indigenous to the United States, or so far as you know grown here?

A. None of the species of bamboo grows normally in the United States. Of course, it is cultivated in various greenhouses for botanical or decorative purposes. The bamboo grows naturally only in tropical or subtropical countries.

THURSDAY, *March 21st*, 1889.

Met pursuant to adjournment.

Present: Counsel as before, and the examination of Prof. Wilson proceeded as follows:

Cross-examination of Prof. WILSON by Mr. CURTIS:

39 X Q. Were the various peculiarities of structure and chemical composition of vegetable substances referred to in your answers to questions 5 to 10 inclusive, and 16 to 20 inclusive, and in question 27 well known prior to 1880?

A. It may be stated in a general way that much of the information given in these answers was known to plant anatomists in 1880, but not all. The special study of forest woods with reference to durability is at the present time in active progress. More specialists interested in woods, timbers and forestry are at work on these questions now than ever before. Again the same may be said for the anatomy of plants, and when any new fact is discovered, it may change or throw new light on all that went before it. With special reference to question 27, it may be said that not only have numbers of new endogens been discovered since 1880, but it is impossible to pick up any of the numerous technical journals of plant anatomy and not find special topics worked out at the present time which had not been touched before 1880. 884

40 X Q. What substantial or material part of the information given in your answers referred to in the last question was not known and published prior to 1880?

A. Understanding that the question refers to the anatomy and physiology of vegetable structures generally irrespective of the recognition of their adaptability for electrical purposes, I would say that the general features of endogenous and exogenous structure so far as mentioned by me in the answers referred to were published and known to students of vegetable anatomy prior to 1880. In question 19, I have referred to the effect of cutting filaments from tough and hard woods. Prior to 1880 there had been no study with reference to the effect of cutting small filaments from such woods, so far as I know.

41 X Q. Was there any substantial or material part of the information referred to which was not known and published prior to 1880?

A. Understanding the question as in my previous answer, I should say no.

42 X Q. Is not the family of algæ referred to in your answer to question 5 an extremely large one?

A. Numerically considered, that is, with reference to the individuals, it is immense, but less conspicuous than almost any other group of plants because confined mostly to the water and, second, because the great majority of the individuals are microscopic and unicellular.

43 X Q. It embraces the greater part of marine vegetation, does it not?

A. It comprises nearly all the submarine vegetation, but the

conspicuous marginal plants in salt-water marshes which are generally overflowed with the tide do not by any means, as a whole, belong to this order. Most of them do not. The great majority of the plants belonging to this order are inconspicuous either from
being covered with water or their microscopic nature.

885 44 X Q. Taking the algæ and fungi together should you
say that either numerically or with respect to the total mass of all the plants, these two groups form a very inconsiderable part of the total vegetation of the earth?

A. Numerically they are very great, but mostly microscopic and inconspicuous. The number of species of both fungi and algæ which can be seen and handled under the naked eye is not large compared with the rest of vegetation. The bulk or mass of sea vegetation is naturally large.

45 X Q. Were the characteristics of fungi and algæ mentioned in your answer to question 6 known prior to 1880, or have they been discovered since?

A. I should say substantially known before that time.

46 X Q. Was the relative amount of carbon contained in exogenous and endogenous plants mentioned in your answer to question 9 known prior to 1880, or has it been discovered since?

A. I should say substantially that was known before 1880.

47 X Q. Were the effects of trying to carbonize an ordinary exogenous stem having a bark upon the stem, mentioned in your answer to question 12, known prior to 1880, or have they been discovered since?

A. Known before.

48 X Q. Were the effects of attempting to carbonize green willow twigs and the character of the resulting carbon, referred to in your answers to questions 13 and 14, known prior to 1880, or have they been discovered since?

A. Known before.

49 X Q. Was the effect of an attempt to pass an electric current along a filament or conductor of carbon made from a live green willow twig, referred to in your answer to question 15, known prior to 1880, or has it been discovered since?

A. What knowledge may have existed on this subject before my own examination of such tissues was made I cannot state. From
my own examinations all thin-walled parenchymatous tissues
886 are destroyed first when passing an electric current through
such conductor.

50 X Q. Are you prepared to say that any person familiar with the principles of electrical science, as it existed prior to 1880, would not have been able to predict this result with certainty?

Objected to as incompetent and immaterial.

A. I should say that one could predict nothing of the kind; that such matters rest upon experimental knowledge.

51 X Q. What experience have you had in the making of carbon filaments for incandescent lamps from exogenous woods?

A. I have made a great number of filaments for carbonization out of a variety of different woods. I have studied the effect of carbonization on different structures.

52 X Q. Have you used or attempted to use any of these filaments in electric lamps?

A. I have never used any filaments of my own make in electric lamps. I have, however, studied under the microscope with great care numbers of the filaments which had been tested and burned out, that is, filaments which had had various life-lengths, which were given me by the Edison Company, or rather from the man who was at work in the testing-room of the lamp factory. Filaments not burned out but which had had a remarkably long-life period were given me to compare with others which had lasted longer and shorter periods, in order to get at the reason for the varying life-lengths.

53 X Q. How large were these filaments?

A. I had various sizes corresponding to the ordinary sizes used in the Edison electric lamps of different candle power.

54 X Q. Were any of them as much as a thirty-second or a sixty-fourth part of an inch in diameter?

887 A. I should say that some of them were less, and that some of a very high candle power were more, but for absolute accuracy I must refer to my assistant who made measurements.

55 X Q. Do you know how they were carbonized?

A. I do not.

56 X Q. Have you ever carbonized any conductors for incandescent lamps made from wood by the process described in the Sidot article in evidence herein?

A. I have not.

57 X Q. Have you ever carbonized anything by that process?

A. I have not.

58 X Q. Have you ever tried any experiments with carbons made by that process?

A. I have not.

59 X Q. Were the general peculiarities of structure of the bamboo stem and its differences in structure from ordinary endogenous stems and exogenous woods, as set forth in your answer 29, known prior to 1880, or have they been discovered since?

A. The general anatomy of the bamboo stem considered as a grass, was known prior to 1880. Some of the special peculiarities to which I have called attention in the stems given me for examination by the Edison Company do not exist in all bamboo stems or species, and so far as I know, I have called attention to them for the first time.

60 X Q. To what special peculiarities do you refer?

A. I refer to a peculiarity of the special kind of bamboo given me at the Edison factory, caused by a combination of anatomical characters. This peculiarity is the extreme consolidation of a zone of bast cells in the outer circumference of the stem, and caused by the five anatomical characteristics in combination, set forth in my answer to question 32.

61 X Q. Do you mean by the part of your answer to question 32,

you have just referred to, that you do not find this combination at all in other stems, or that you do not find it so perfectly developed?

A. Some one or more of these five combining circumstances may occur in any endogenous stem, but without the combination
888 of all of them in the extreme no such solidified zone of bast cells could be produced as is found in certain specimens given me for study. It is a very common characteristic in endogenous stems to have the bundles increase toward the circumference, and for the relative amount of bast to increase in said bundles, and also to find a diminution of the connective tissue between such bundles, but in combination with these circumstances to have the connective tissue, where it remains between the bundles, thicken its cell walls until it resemble the adjacent bast cell is not a common characteristic to be found in combination with the others. The extreme of each one of these conditions makes the peculiarity of this species of bamboo.

62 X Q. Was it known prior to 1880 that the fibres of bamboo were parallel to each other?

A. If in this question the fibre vascular bundles are referred to in the general stem, it was known that they were not absolutely parallel. If, however, the reference is to the bast cells in the particular zone of which I have been speaking and from which the Edison filaments are made, I think there had appeared prior to 1880 no special printed matter on this subject. This zone, from which the Edison filament is taken, is made up almost wholly of bast cells which for any short distance would be called practically parallel as shown in plate No. 9, which is very highly magnified, and slight deviations from parallelism are shown.

63 X Q. Bamboo is a fibrous vegetable material within the ordinary signification of that term, is it not?

A. Bamboo would ordinarily be considered a fibrous plant.

64 X Q. Is it not a fact that the particular zone of the bamboo to which you have referred was recognized in the arts as having peculiar strength, density of structure, elasticity and parallelism of fibre and had been used for many years prior to 1880 where these qualities were of advantage, as for instance in the manufacture of what are known as split-bamboo fishing rods?

A. I do not think that this very thin special zone of which
889 I have spoken would be recognized in this way upon careful experimentation. It is the zone just underneath this which, from the fact of the slight separation of the bundles by softer tissues, would be more elastic. In scraping off the so-called rind for manufacturing purposes, I think the particular bast zone of which I have spoken was mostly scraped off with it. The bast cells forming this zone are filled almost solid and are more brittle than the bast structures in general for that reason.

65 X Q. Do you mean to be understood by your testimony on the direct examination, taken as a whole, that there is no vegetable material except the particular kind of bamboo used by Mr. Edison from which good carbon filaments for incandescent lamps can be made?

A. I think the finding of an excellent conductor for an incandescent burner has been the result of a very long series of experimental investigations, and as it rests wholly on an experimental basis I do not believe it possible to say whether another equally good or better conductor or filament may or may not be found. In remote regions like the interior of South America or some parts of Central Asia or Central Australia, we are constantly adding new species of plants and it would be impossible to say that some of these may not furnish equally good material when known.

66 X Q. Suppose this particular kind of bamboo were not known, do you think that it would be impracticable or especially difficult to make commercially useful incandescent lamps with carbons made of any of the other vegetable materials known to you?

A. From my knowledge of other vegetable structures in general I know of no exogenous woods from which incandescent lamps could be manufactured anywhere near approaching in value those made from this particular species of bamboo. In the endogens to which this particular species of bamboo belongs I know of nothing else equaling this. I have no doubt but what lamps might be manufactured from some of the other nearly related species of bamboo which would be of value, but so far as my knowledge of their anatomy goes, not of equal value with the one in question.

890 67 X Q. Do you agree with the following statement made by Mr. Edison in his patent No. 251,540 on the bamboo carbon, which has been put in evidence by the defendant?

"In incandescent electric lighting I prefer to use for the incandescing conductor a small slip or filament of carbon bent into a curve, now generally designated the horseshoe carbon. Great success has attended the use of such carbons made from a naturally fibrous material capable of carbonization, for instance, wood formed into proper shape and then carbonized."

The particular point to which I call your attention is the great success obtained with wood.

A. I should say that in rating the value of any known wood, whether it be from exogenous or endogenous growths, the value of the same for the manufacture of an incandescent light would depend naturally upon a combination of anatomical characters, that the proportionate value would depend especially upon parallelism of the fibres, upon the solidity of the cells making such fibres, and upon the compactness of these special fibres or cells into a solid body. The solidity of such fibrous cells might exist in exogenous woods from the deposition of gums and resins of other substances in the vessels or air spaces or ordinary woody structure. Such solidification of fibres from such causes would not, in my judgment, make good incandescent burners. The fibrous tissue must be solidified in a way which would not be rendered loose and spongy through heat. I do not understand whether when Mr. Edison speaks of "wood formed into proper shape" that he means particularly exogenous woods. I should say from my experience that there is no exogenous wood which would equal in value for the manufacture of lamps some of the endogenous woods.

68 X Q. Is not this a fair statement of the facts as you understand them, that of the various vegetable growths with which you are familiar some are, by reason of their structure, not adapted for
making carbons for incandescent lights, and that the rest have
891 varying degrees of availability for such use up to the particular kind of bamboo used by Mr. Edison which you consider the best adapted of all for such use?

A. It has been proven by experimentation that certain vegetable tissues make poor conductors for incandescent lamps, that others are better and that others still are the best we know. Experimentation has shown I think that up to the present time bamboo, this particular species, is the best substance known for the manufacture of incandescent lights. In examining automatically the structures which have so far been tried the reasons can readily be stated.

69 X Q. Is it not a fact that different specimens of this particular species of bamboo differ from each other materially in their adaptation for making carbons for incandescent lamps?

A. I have not the slightest doubt but what this species would vary to a certain extent in its adaptability for this purpose under the influence of different seasons of drought or rainfall or as to the location in which it might be cultivated. It is one of the facts well known to experts who have to select timber for toughness and durability that the same species vary very much in accordance with the location or growth. Wood formed in excessively favorable seasons when the growth is rapid in any given species is always harder and tougher than wood of similar species grown under unfavorable conditions. Where the growth is slower and in this particular species of bamboo under consideration as in every species of bamboo, any material taken from near the terminal bud would be poor in respect to characteristics sought so that without this experience poor filaments for carbonization might be made from a stem in which certain zones were excellent.

70 X Q. Then in order to secure the best results it would be necessary, would it not, to make a proper selection of the bamboo even assuming this particular species to be used?

A. Yes.

892 71 X Q. So far as structure is concerned what is the general characteristic common to all vegetable materials?

A. Cellular structure.

72 X Q. So far as chemical composition is concerned what is the common characteristic of all vegetable substances?

A. Cellulose is one of the common characteristics.

73 X Q. Is not that the principal one?

A. No, sir; protoplasm is equally important.

74 X Q. In the analyses you refer to in your answer to question 37, how did you separate the earthy impurities from the rest of the material?

A. It was probably done by incineration. I did not do it myself at all. I took it to an expert in chemical work to do.

WILLIAM P. WILSON.

Sworn to before me,
[L. S.] WILLIAM T. FARNHAM,
Notary Public and Special Examiner.

Defendant's counsel offer in evidence the nine plates or drawings numbered one to nine inclusive, referred to by Professor Wilson in his testimony, and the same are marked Defendant's Exhibits Wilson Drawings March 21st, 1889.

Defendant's counsel offers in evidence the specimen of curly maple, referred to by Professor Wilson in his answer to Q. 25, and the same is marked Defendant's Exhibit Wilson Maple Specimen, March 21st, 1889.

893 NEW YORK, *March* 19, 1889.

Met pursuant to agreement.

Present: Mr. Dyer, for defendant, and Mr. Curtis, for complainant.

WILLIAM HOLZER, being called and duly sworn, testifies as follows:

1 Q. What is your name, age, residence and occupation?

A. William Holzer; am in my 45th year; I reside at Menlo Park, New Jersey; I am superintendent of the Edison Lamp Company at Harrison, New Jersey.

2 Q. Are you a practical glass-worker? If so, how long have you been one?

A. I am. I first started in the business in 1859; first started as a boy to learn the business. I worked up till 1866 and then started business for myself and continued until 1879. In 1880, in January, I engaged with Mr. Thomas A. Edison at Menlo Park in the capacity of an expert glass-blower, and since that time I have had charge of the glass-work of his lamp factory.

3 Q. I call your attention to the patent in suit, No. 317,676, granted May 12, 1885, and particularly to figure 5 of the drawing. Please state whether or not, in your opinion as a practical glass-worker, it would be practically feasible to seal the glass plate *y* to the flange *x* of the glass lamp chamber by fusing the glass part together.

A. It would not be feasible.

4 Q. Do you think it could be done with any degree of success?

A. I do not.

5 Q. Would it be practically feasible, in your opinion, to seal into the glass plate *y* the metal tubes which are shown as passing therethrough by fusing the glass upon such tubes?

A. It would not be feasible.

894 6 Q. Do you think it could be done with success, assuming such tubes to be made of platinum?

A. I do not.

Cross-examination :

7 X Q. Where was your place of business from 1866 to 1879?

A. I first started at 430 Market street, Philadelphia, in January, 1866. I remained there about one year. From there I moved to 527 Minor street; remained there until about 1873; then moved to 1128 Market street, Philadelphia. I remained at manufacturing till about 1878 and then closed out business and took an office at 1126 Market street for a short time closing up my business affairs.

8 X Q. What was your business from the time you closed up your glass-blowing business till the time you went into Mr. Edison's employment?

A. From the time I closed up business until January, 1880, I didn't do anything—any business.

9 X Q. Did you do any work for Mr. Edison during that time?

A. No, sir.

10 X Q. What was the general nature of your glass-blowing business?

A. Manufacturing glassware for all purposes—druggists, chemists; glassware for philosophical purposes and general experimental work, making things by blow pipe, bench-working by blowpipe.

11 X Q. Did you make any Geissler tubes or radiometers during that time?

A. I constructed the glass-work for those instruments.

12 X Q. Were the Geissler tubes frequently made out of two or more different parts?

A. They were.

13 X Q. How did you make the joints between the different parts?

A. We take the different parts—we first construct the dif-
895 ferent parts, then subject them to the heat of the blow-pipe
flame, and then manipulate them until they are joined.
After they were joined we would take them and anneal them.

14 X Q. Were they joined by fusing the glass of the two parts together?

A. They were.

15 X Q. What was the reason for making that kind of a joint?

A. To make it air tight, so that after a vacuum is produced there wouldn't be any leaking.

16 X Q. Were the Geissler tubes you made provided with electrodes for getting an electric circuit through the tubes?

A. Well, we would take a piece of a platinum wire and seal it in at the end—well, first we would take the piece of platinum wire and partly cover it with aluminium, then join a small piece of glass on the platinum by fusing it onto it, and then we would insert the platinum wire which was partly covered with the aluminium, then insert it through a tube or bulb with a hole drawn to receive it, then we would subject it to the flame of the blow-pipe and melt the two parts together and then anneal them.

17 X Q. What was the purpose of making that kind of a joint between the platinum wire and the glass of the Geissler tube?

A. To make it air tight after the vacuum is produced.

18 X Q. Were these tubes intended to have a vacuum produced in them?

A. Yes, sir.

19 X Q. How were the tubes attached to the pump for producing a vacuum in them?

A. I have never done the exhausting of the tubes; I have had that work done outside of my factory. I have seen it done at the University of Pennsylvania. There were small tubes placed on the tube that was to be exhausted, and these small tubes were sealed to the pump.

896 20 X Q. How were these small tubes attached to the Geissler tubes, and how were the small tubes sealed after exhaustion?

A. They were sealed on by fusing together, and aftey they obtained the proper degree of exhaustion the small tube which had been contracted to a neck beforehand was sealed off by applying the flame of an alcohol lamp to the contracted neck and fusing the glass part together, closing the opening by fusing the glass.

21 X Q. Did you make the radiometers in the same way in which you made the Geissler tubes?

A. I constructed the glass parts only.

22 X Q. Were these usually made out of two pieces of glass?

A. They were made out of several pieces of glass fused together.

23 X Q. You knew perfectly well, did you not, before 1878 how to join two pieces of glass together by fusion so as to make a perfectly tight joint?

A. In the ordinary way of business, I did; we would often have parties coming in that would want pieces of glass joined together and found that they could not be fused or joined to any degree of satisfaction due to the glass parts not being of the proper composition of glass that would stand the heat of the flame, and upon being forced or ordered to go ahead independent of what would happen to the parts, the glass would fly to pieces.

24 X Q. Why could not the glass flange and the base plate shown in the drawing of the patent in suit be fused together?

A. I notice in the drawing that the glass disc is of such a thickness that in attempting to fuse or seal it to the brim or the flange of the globe which I see is quite heavy, that is, the flange of the globe, that the expansion of the glass by putting the flame to the disc and brim or flange of the tube would cause it to crack, I would consider it impracticable.

25 X Q. Would you have known that in 1878?

A. I would.

897 26 X Q. What changes would have to be made in the parts in order to make it feasible to seal them together?

A. That would be a matter of a series of experiments.

27 X Q. Wouldn't you have known in 1878 how to change the parts so that they could be successfully sealed together?

A. No doubt but what after a line of experiments had been conducted that some idea would suggest itself in reconstructing the apparatus.

28 X Q. Do you mean to say that anything further would be required than to make the glass thinner and to make both parts of the same kind of glass and to use such glass as you ordinarily use in constructing Geissler tubes?

A. As I said before, in conducting experiments in that direction there is no doubt that an idea may suggest itself in getting the instrument in proper shape.

29 X Q. What more would be required in order to make it feasible to seal the two parts together by fusion than is mentioned in my last question?

A. That I could not say. There is no doubt that the experiments prior to 1878 would have led me on to the proper course of constructing the instrument by the fusion of the different parts.

30 X Q. Don't you think it could readily have been done in the same way that you made Geissler tubes?

A. I do not.

31 X Q. When you commenced work for Mr. Edison in 1880 were lamps made in two pieces of glass?

Objected to as immaterial, incompetent and not proper cross-examination.

A. They were.

32 X Q. Were these two pieces united by fusion in substantially the same way in which you joined together the different parts of Geissler tubes and radiometers?

Same objection.

898 A. In the matter of Geissler tubes we have often made connections in the same way—we call it sealed—we fused them together in the same way.

33 X Q. Did you seal the platinum wires into the glass of the lamps you made for Mr. Edison when you first started there, by fusing the glass to the wires in substantially the same way as you had previously sealed platinum wires into Geissler tubes?

Same objection.

A. Practically the same.

34 X Q. Were the lamp globes provided with exhausting tubes sealed onto them in substantially the same way in which exhausting tubes were sealed onto the Geissler tubes and radiometers you had made before that time?

Same objections.

A. At that time we drew out the exhausting tube from the same piece of tubing out of which the tube was blown, but afterwards when we got globes blown from pot glass we sealed on separate tubes for exhausting.

35 X Q. Did you do any work for Mr. Edison before January, 1880?

A. I did not.

36 X Q. Why could not the tubular conductors shown in the drawing of the patent in suit be sealed into the glass base plate if they were made of platinum?

A. In the matter of sealing in the tubes, if they were made of platinum into the disc of glass as I see it here in this drawing, I would say that the difficulty in sealing them in would be in the cracking of the glass as soon as it would be subject to the heat of the flame; my experience has been this, that sealing in platinum wire or attempting to seal in platinum wire into a disc of glass, the result has always been that the glass would fly to pieces, due to the unequal expansion.

899 37 X Q. Couldn't it have been done by making the base piece of thin glass and bulb shaped or curved, as Geissler tubes were made?

A. Prior to 1878 that would have been a matter of a series of experiments to ascertain the proper method by which it could have been done.

38 X Q. You would have expected one of your skilled workmen to have done it, would you not, if you had merely directed him to do it without giving him any special directions as to how he was to do it?

A. I would have not.

39 X Q. You would have expected to accomplish it yourself if you had undertaken it, would you not?

A. That would have strictly depended upon the results of experiments that I would have conducted in that direction.

Redirect examination:

40 Re-D. Q. Referring to your answer to X Q. 29, what did you mean by the statement "that the experiments prior to 1878 would have led me to the proper course of constructing the instrument by the fusion of the different parts"?

A. I meant this—that if a party would call at my office or works and wanted an instrument made similar to the drawing of the patent I would have gone into a series of experiments to ascertain the best method in obtaining results, but I would not say that I would have been successful.

41 Re-D. Q. Would the drawing of the patent in suit have suggested to you as a practical glass-worker, that the glass parts were intended to be fused together or that the metal tubes were intended to be fused into the glass disc?

A. It would have not.

W. HOLZER.

Sworn to before me,
WILLIAM T. FARNHAM,
Notary Public and Special Examiner.

900 United States Circuit Court, Western District of Pennsylvania.

THE CONSOLIDATED ELECTRIC LIGHT COMPANY
against
THE MCKEESPORT LIGHT COMPANY. } In Equity.

SIR: You will please take notice that the defendant in the above-entitled cause desires the evidence of the witnesses hereinafter named to be taken orally under the sixty-seventh rule of the Supreme Court as amended. And you will further take notice that on the 9th day of March, 1889, at the office of John H. Kitchen, Esq., No. 50 Pine street, New York city, a special examiner duly appointed in the above-entitled suit *to* take proves on behalf of the defendant therein, at 10 o'clock in the forenoon; said defendant will at such time and place proceed to take the testimony of Albon Man, Amos Broadnax, Jacob Hays, Hugh McCullough, Lawrence Myers, J. P. Kernochan, Mr. William Hockhausen and others, as witnesses in behalf of defendant. Such examination will proceed as directed by said examiner, and you are hereby invited to attend and cross-examine.

Dated March 8, 1889.

RICH'D N. DYER,
Of Counsel for Def't.

To Thos. B. Kerr, Esq., sol. for compl't.

901 United States Circuit Court, Western District of Pennsylvania.

THE CONSOLIDATED ELECTRIC LIGHT COMPANY
against
THE MCKEESPORT LIGHT COMPANY. } In Equity.

NEW YORK, *March 8th*, 1889.

Testimony taken on behalf of the defendant in the above-entitled cause before John H. Kitchen, examiner, under and in pursuance of the 67th rule of the Supreme Court of the United States, as amended.

Present: Mr. Thomas B. Kerr appears on behalf of the complainant; Mr. H. D. Donnelly appears on behalf of the defendants.

AMOS BROADNAX, a witness on behalf of the defendant, having been first duly sworn, says:

1 Q. What is your name, age, residence and occupation?

A. Amos Broadnax; age 62; residence 41 Jefferson avenue, Brooklyn, and I am a lawyer by profession.

2 Q. What are your relations at present to The Consolidated Electric Light Company, the complainant in this suit?

A. I am of counsel, but in this suit I am not managing counsel.

3 Q. Have you ever had any connection with a corporation known as the Electro-Dynamic Light Co.?

A. I have.

4 Q. What relation to such company have you had?

A. I was counsel for the company in all matters pertaining to its patents. My counselship did not extend beyond that.

902 5 Q. During what years were you counsel for the Electro-Dynamic Light Co.?

A. I was retained in the fall of 1878, and I have continued to be its counsel in such of its matters as relate to patents from that time to this—so far as I know.

6 Q. Do you know who the president and secretary of the Electro-Dynamic Light Company were in the years 1878 and 1879?

A. During a portion of that time—as I recollect it—Mr. Albon Man was president and he was succeeded by Thomas Wallace, of Ansonia, Conn., in the presidency; who was secretary during that time I really do not know; I have an impression that Wm. E. Sawyer was secretary during a part of that time, but who succeeded him I do not now know.

7 Q. Do you know at what time Albon Man and Mr. Wm. E. Sawyer ceased to be respectively president and secretary of the Electro-Dynamic Light Company?

A. I do not know the dates; if I undertake to state the time it would be mere guess; I think Mr. Man ceased to be president some time in 1879, and I think Mr. Sawyer ceased to be secretary in the same year, but what time I don't know, and I am not absolutely certain as to the year; it was certainly in 1879 or 1880.

8 Q. Do you know whether Wm. E. Sawyer is now living?

A. I did not see him die, nor did I see him after he was dead; I believe him to be dead.

9 Q. Do you know who are now respectively the president and secretary of the Electro-Dynamic Light Company?

A. Hugh R. Garden is president, and Mr. Stocker is secretary.

10 Q. If you know please state where they reside.

A. I don't know where Mr. Stocker resides; I have a card given to me by Mr. Garden about a year ago, from which it appears his residence is 61 West Fifty-second street; his place of business is 32 Nassau street, and with him is Mr. Stocker.

903 11 Q. Have you any knowledge or information as to where the books and papers relating to the business of the Electro-Dynamic Co. are or can be found?

A. I suppose that I have in my safe some of the papers relating to their patents, but what they are I could not tell. I think they are only papers that were used in the prosecution of their applications for patents. This is the only knowledge that I have about any of the company's papers. The books of the company I have no knowledge of whatever. The only one of its books I ever had was the minute book. That I had in my office for a few moments, perhaps an hour, some two or three months ago. It was sent to me by Mr. Garden, the president of the company, and to him it was returned. Since then I have not seen it, nor do I know anything about it.

12 Q. Did you examine the minute book of the Electro-Dynamic Light Co. so as to be able to say whether the book of minutes which

you had in your possession, as stated, contained a record of the proceedings of the board of trustees of said company, and if so, state what years it covered?

A. No, I never did. I have had the book in my hands a number of times for the purpose of fixing some dates about the license that was given by the company to Wallace & Sons, of Ansonia, Conn. I have never read the book one-third through, and I don't know what it contains. It is very likely that I have read some of the minutes of its proceedings, but certainly not within the last two or three years, and I have not the faintest idea of what I did read then. The book, when it was brought to my office some two or three months ago, was handed to Thomas B. Kerr; whether he read it or not I do not know, but I don't recollect whether I looked inside of it.

13 Q. Do you know whether the Electro-Dynamic Light Co. has ever had more than one minute book in which the proceedings of its board of trustees were contained or recorded?

A. I do not.

904 14 Q. Had you ever had this book in your possession prior to the time mentioned by you in your former answer?

A. I did.

5 Q. When?

A. When I took the testimony in the interference between Thomas A. Edison on the one side and Sawyer & Man on the other, and also when I took the testimony in the interference of Edward Weston on the one side and Sawyer & Man on the other.

That was four or five years ago. I think I returned it to Mr. Joseph Tate, who I believe, is now associated with John Hays & Co., No. 11 Nassau St., brokers. After that I was never able to find where the book was, and I did not ascertain where it was until about the time it was sent to my office by Mr. Garden, some two or three months ago. That is my best recollection of it now.

I asked Mr. Tate for it in the meantime, and he said he looked for it but could not find it. From whom Mr. Garden got it I do not know. I think Mr. Lawrence Meyers became secretary of the company either shortly before or shortly after I had it, and it is possible he may have had it. I don't recollect having asked him for it, though I may have done so.

16 Q. Can you now state whether the book of minutes of the Electro-Dynamic Light Co., which you have stated that you had in your possession, was the original book of minutes of said company, and whether it contained a record of meetings of said company during the years 1878 and 1879, or either of said years?

A. I do not know whether it was the original book of minutes or not, but I took it for granted that it was. Nor do I know whether the book contained a record of the proceedings of its board of directors. It was given to me as the minute book of the company, and it contained numerous entries of the proceedings of the board of directors of the Electro-Dynamic Light Co. as appears by the book itself, which I had in my possession, and I do not recollect of reading attentively the several entries of the book, and if I did I do not now recollect the contents of such entries.

905 17 Q. Were you and are you familiar with the handwriting of Wm. E. Sawyer?

A. I have seen Mr. Sawyer write and I have received letters from him and I think that I would know his handwriting.

18 Q. Do you now remember whether the minute book of the Electro-Dynamic Light Co. contained any entries in the handwriting of Wm. E. Sawyer, deceased?

A. I think it does. Making my statement on the handwriting itself which I have seen in the book.

19 Q. Please look at the paper-writing which I now show you and state if you know in whose handwriting the same is.

A. The paper you hand me is in my handwriting.

20 Q. Was said letter written at the time it bears date, to wit, on or about January 8th, 1880?

A. I take it for granted that it was, but I have no recollection about it. I had entirely forgotten that I had ever written such a letter.

21 Q. What was done with said letter after it was written by you. What did you do with it?

A. The letter is addressed to one Charles A. Cheever, Tribune building, and I presume I sent it to him.

22 Q. Do you know where you were when you wrote the letter?

A. The letter is written on a piece of paper captioned the "Tribune building," New York, January 8th, 1880. Whether I wrote the letter in the office of Mr. Cheever or my own office I do not recollect; I don't know at whose request I wrote it.

Defendant's counsel now offers in evidence said letter written by the witness to Charles A. Cheever, dated January 8th, 1880, and the same is filed in evidence and marked Defendant's Exhibit "Broadnax-Cheever" Letter.

23 Q. Do you know whether at the times Defendant's Exhibit
Broadnax-Cheever Letter was written the Charles A. Cheever
906 therein referred to was negotiating with the Electro-Dynamic
Light Co. for the purchase of the alleged invention upon
which the letters patent in suit are based?

A. I have been informed and believe that he was.

Cross-examination:

24 Q. Is it a fact that you were subpœnaed to appear here at 10 o'clock, and that at that hour you were to proceed with your cross-examination of Mr. Batchelor at the office of Dyer & Seely, No. 40 Wall street?

A. Yesterday afternoon down to about 4 or 4.30 o'clock I was engaged at the office of Dyer & Seely, No. 40 Wall street, in the cross-examination of Mr. Charles Batchelor in this suit. We adjourned at the time mentioned until this morning at 10 o'clock, at which time I was to proceed with the examination. At about 9 o'clock last evening the subpœna was served upon me to appear here this morning, and I do so appear in obedience to the subpœna.

Redirect:

25 Re-D. Q. Is it a fact that when you came here to be examined as a witness in this suit counsel for defendant offered to defer your examination until this afternoon or until Monday, if you so desired?

A. Yes, that is a fact, and it is also a fact that Mr. Dyer, the managing counsel of the defendant in this case, as I understand it, was present and requested me to remain and be examined, and in obedience to his request I did so.

AMOS BROADNAX.

Sworn to before me this 9th day of March, 1889.

JOHN H. KITCHEN, *Examiner.*

907 Jacob Hays, a witness on behalf of the defendant, being duly sworn, says:

1 Q. What is your name, age, residence and occupation?

A. Jacob Hays; I am 44 years of age; I am retired from business and now in the management of railroads and steamboats.

2 Q. Are you the Jacob Hays named in the certificate of incorporation of the Electro-Dynamic Light Co.?

A. I am.

3 Q. Were you a director of that company in 1878 and 1879?

A. I was.

4 Q. As such director did you attend any of the meetings of the board of trustees?

A. I did.

5 Q. Did you attend all the meetings that were held?

A. I could not say positively, but a majority of the meetings.

6 Q. Were you an officer of the company during the years 1878 and 1879, other than a director?

A. I was.

7 Q. What office did you hold in that company?

A. I was the treasurer.

8 Q. State, if you know, who the other members of the board of trustees were during the years 1878 and 1879?

A. As near as I can remember, Mr. Albon Man, Mr. William E. Sawyer, Hon. Hugh McColloch, Lawrence Meyers, William H. Hays, and I think James P. Kernochan, were members of the board of directors.

7 Q. Are any of the persons named by you in your last answer deceased?

A. William H. Hays, Wm. E. Sawyer, are deceased.

10 Q. Do you know where Mr. Lawrence Meyers resides or now is?

A. He resides in Plainfield, N. J.; now visiting Colorado.

908 11 Q. Do you know as to when Mr. Meyers is likely to return from Colorado?

A. I do not.

12 Q. Do you remember where the Hon. Hugh McColloch now resides?

A. Washington, D. C. A little out of Washington.

13 Q. Who was president of the board of trustees of the Electro-Dynamic Light Co., and who its secretary during the years 1878 and 1879?

A. Mr. Albon Man was the president and Mr. Wm. E. Sawyer was secretary. I cannot say positively that they remained in office throughout the year 1879.

14 Q. Can you say whether Mr. Wm. E. Sawyer was the secretary of the Electro-Dynamic Light Co. during the month of March, 1879?

A. My impression is that he was.

15 Q. Do you remember whether Mr. Wm. E. Sawyer was present and kept a record of the proceedings of the meetings as secretary on the occasions when you attended them?

A. Mr. Sawyer was the secretary at all the meetings and took down the minutes in short-hand. He was a stenographer.

16 Q. Do you know whether he transcribed his minutes after they were so taken into any minute book or record book of the company?

A. He did.

17 Q. Do you now remember of having seen or examined in 1878 or 1879, the minute book of the Electro-Dynamic Light Company in which Mr. Wm. E. Sawyer recorded the proceedings of the board of trustees of said company?

A. I have seen it, but do not remember whether I ever examined it.

18 Q. When and where did you see said book of minutes, while Mr. Sawyer was secretary of the Electro-Dynamic Light Co.?

A. At the office of Classon & Hays, No. 3 Nassau street, where the meetings of the company were held.

19 Q. When last did you see said book of minutes and in whose possession was it?

909 A. Yesterday. Two or three days ago. Mr. Donnelly and a gentleman with him called at my office, No. 11 Pine street, and asked me the question as to where the minute book of the Electro-Dynamic Light Company was; I told him I did not know; his manner excited my curiosity, knowing he was a lawyer; I immediately called upon Mr. Hugh R. Garden, knowing he was the president of the Electro-Dynamic Light Co. I informed him of the conversation which took place between Mr. Donnelly and myself. I asked Mr. Garden if he knew where the minute book was. He told me he did, and that it was in his possession.

20 Q. Where was the business of the Electro-Dynamic Light Co. carried on in March, 1879?

A. 94 Walker street.

21 Q. Do you now remember the names of the persons then in its employ, other than its officers or directors?

A. Mr. Sawyer's father, and a Mr. Myers, whose first name I do not know. A young man now dead, as I am informed. There were other persons employed, but I do not remember their names.

22 Q. Do you remember whether or not the Electro-Dynamic Light Co. suspended, or partially suspended, its business operations in or about the month of March, 1879?

A. They partially did suspend.

Cross-examination:

23 X Q. What was the reason of that suspension?

A. On account of Mr. Wm. E. Sawyer's bad habits.

24 X Q. In what respect?

A. He was a drunkard, and kept company with bad characters.

25 — Q. What effect had that upon his work?

A. It kept him from the attention he should have given to his business.

26 X Q. What was the feeling of the board as to the matter of continuing operations under Sawyer's management?

910 A. They were disgusted with him on account of his habits and inattention to business, and placed in charge Mr. Lawrence Meyers the management, and also for the purpose of trying to keep Mr. Sawyer straight.

27 X Q. Was Mr. Lawrence Meyers an electrician or mechanic?

A. He was not.

28 X Q. What was the character of Mr. Sawyer's workmanship during this period—was it good or bad?

Objected to by defendant's counsel as incompetent and improper, because the question calls for evidence not responsive to the examination in-chief.

A. It was good.

29 X Q. What railroad and steamboats have you management of, and in what capacity?

A. I am the vice-president of the Eighth and Ninth Avenue Street R. R. of this city and treasurer of the People's Line of steamers, known as the N. J. Steamboat Company, running from N. Y. to Albany and return. I am also a director and member of the executive committee of the Brooklyn and New York Ferry Company. I am a member of the N. Y. stock exchange.

30 X Q. Who was Wm. H. Hays?

A. He was my father.

31 X Q. What was his business and his position generally in New York?

A. He was president of the Bank of the State of New York. President of the Eighth and Ninth avenues surface roads of this city, and interested in other institution- and corporations.

32 X Q. Who is Mr. Lawrence Meyers, and what is his standing and position in N. Y.?

A. Mr. Lawrence Meyers is a gentleman of wealth and retired from business, and is at this time the receiver of the Richmond and Allegany R. R.

33 X Q. Who is the Hon. Hugh McColloch?

A. A gentleman of national reputation. Having been
911 twice Secretary of the United States Treasury, and a man of
wealth.

34 X Q. Who is Mr. James P. Kernochan?

A. Mr. Kernochan is a gentleman of wealth. Stands very high, and retired from business, and is connected with the well-known Lorrillard family of this city.

35 X Q. Who is Mr. Albon Man and what has been his standing and connection in this community during your acquaintance with him?

Question objected to by defendant's counsel as immaterial and irrelevant, and as improper because it is not responsive to the examination-in-chief; also because the character of Mr. Man is not a subject of controversy in this suit.

A. Mr. Man is a gentleman and a lawyer by profession, and was for a number of years manager and agent of the Lorillard estate.

Defendant's counsel objects to the answer upon the same grounds as stated in his objection to the last question, and moves to strike the same from the record.

36 X Q. How do you know that the business of the Electro-Dynamic Light Co. was carried on at 94 Walker St.?

A. Because I spent considerable time at the office; on an average four times a week.

37 X Q. What did that business consist of?

A. Experimenting on electric lights and making them.

38 X Q. Did you ever see any of these lights there?

Objected to as incompetent and improper because the evidence called for by the question does not grow out of or relate to the examination-in-chief, and defendant's counsel gives notice that the complainant's counsel makes the witness his own by pursuing this line of inquiry, and he further gives notice that
912 on or before the final hearing of this cause defendants will
move to strike this evidence from the record in this suit.

A. I did.

39 X Q. In process of manufacture?

Same objection. Same notice as to the last question.

A. Yes.

40 X Q. Any of them in use there?

Same objection. Same notice.

A. Yes.

41 X Q. How did they work?

Same objection and notice; also as incompetent and improper because the question calls for the opinion of the witness, and the witness has not been shown qualified to give an opinion upon the subject inquired about.

A. They worked well.

42 X Q. Then it was not on account of the character and operation of the lamps that the company suspended operations, was it?

Same objection and notice as to the last question and answer; also as leading and suggestive.

A. It was not.

Redirect:

43 Re-D. Q. Are you now a director and stockholder of The Consolidated Electric Light Company, the complainant in this suit?

A. I am.

913 44 Re-D. Q. You were not a practical electrician or an electrical engineer in 1879, were you?

A. I was not.

Recross:

45 Re-X Q. What leads you to say, then, that the lamps worked well?

Same objection and same notice as to X Q. 41.

A. Because I was constantly at the office, 94 Walker street, and saw them in use and giving such beautiful light.

Same objection as to the last question and answer. Defendant's counsel gives notice that before or at final hearing he will move to strike the same from the record, for the reasons stated in objection to the answer to X Q. 41.

JACOB HAYS.

Sworn to before me this 8th day of March, 1888.

JOHN H. KITCHEN.

William Hochhausen, being duly sworn, says:

I am 48 years of age and reside in Brooklyn, N. Y. I am an electrician, employed at present by Excelsior Electric Company as electrician and superintendent.

1 Q. What was your business in January, 1880?

A. I was manufacturing dynamo-electric machines.

2 Q. Alone or in company with some other person?

A. In 1880 in company with Mr. Anthony Arnoux.

3 Q. What was the name of the firm at that time?

A. Arnoux & Hochhausen.

4 Q. Where was the firm's business carried on in January, 1880?

A. We were still at the building corner Howard and Centre streets.

914 5 Q. Is Mr. Arnoux living or dead?

A. Mr. Arnoux is dead.

6 Q. When did he die?

A. In the summer of 1884.

7 Q. Please look at the paper-writing I show you and state whether you know in whose handwriting it is, and if so, please give the person's name who wrote it. (Paper shown witness.)

A. This letter was written by Mr. Arnoux.

8 Q. Are the body of the letter and the signature thereto in the handwriting of Mr. Arnoux?

A. Yes, sir; they are both in his handwriting.

9 Q. Had you ever seen this letter prior to your examination to-day?

A. I have not.

10 Q. Do you know at whose request the letter I have shown you was written?

A. I have no knowledge about that.

11 Q. Were you personally acquainted with Mr. Charles A. Cheever at the time this letter was written in January, 1880?

A. I had seen Mr. Chas. A. Cheever previous to that time at our own place of business.

12 Q. Do you know whether this letter was written at the request of Mr. Cheever?

A. I do not.

Letter shown witness is offered in evidence by the defendant and the same is filed in evidence and marked Defendant's Exhibit "Arnoux-Hochhausen" Letter.

The letter is so marked.

J. H. K., *Examiner*.

WM. HOCHHAUSEN.

Sworn to before me this 8th day of March, 1889.

JOHN H. KITCHEN, *Examiner*.

915 ALBON MAN, being duly sworn, says:

1 Q. What is your name, age, residence and occupation?

A. Albon Man; 62 years old; 118 Putnam avenue, Brooklyn. I am a lawyer by profession, and take some interest in electrical matters.

2 Q. Were you the president of the Electro-Dynamic Light Co. in the years 1878 and 1879?

A. I was the president in 1878 from the time of the organization of the company, and in 1879 up to some time in the spring of that year, or early summer, I should think, May or June, when Thomas Wallace, of Ansonia, Conn., was elected president.

3 Q. During the time you were president, in 1878 and 1879, of said company, who was its secretary?

A. William E. Sawyer was secretary from the organization of the company up to some time, according to my recollection, in March, 1879, or a little later, when he resigned. If my recollection serves me, another person was elected then in Mr. Saw-er's place.

4 Q. During the time that Mr. Sawyer was secretary in 1878 and 1879, do you know whether he kept a minute book or record of the

proceedings and acts of the board of trustees of the Electro-Dynamic Light Co.?

A. He did in the minute book of the company of such formal proceedings of the board as are recorded in those minutes.

5 Q. Do you know where that minute book is?

A. I have recently heard that it is in the possession of Mr. Hugh R. Garden; I saw such a book in his hands, I think it was yesterday, at No. 32 Nassau street, in his office, which he told me was the minute book of the Electro-Dynamic Light Co., and I recognized it from its appearance as such. I was well acquainted with the book and have no doubt that it was or is the minute book of that company.

6 Q. State, if you know, what Mr. Hugh R. Garden's relations are to the Electro-Dynamic Light Co.?

A. I only know that he told me that he was its president.

916 7 Q. Do you know who the secretary of said company is at present?

A. I do not.

ALBON MAN.

Sworn to before me this 8th day of March, 1889.

JOHN H. KITCHEN, *Examiner.*

Adjourned to Monday, the 11th of March, 1889, at 11 a. m.

JOHN H. KITCHEN, *Examiner.*

MONDAY, *March 11th*, 1889—11 a. m.

Adjourned to Tuesday, March 12th, 1889, at 11 a. m.

NEW YORK, *March 12th*, 1889—11 a. m.

Met pursuant to adjournment.

WM. HOCHHAUSEN, recalled, says:

Q. Referring to Defendant's Exhibit Arnoux-Hochhausen Letter, January 9th, 1880, please state whether you have read the same and know the contents thereof?

A. I have read the same just now, and know the contents thereof.

Q. Please state whether the statements therein contained are true to your knowledge?

A. They may be true, although the date mentioned in the letter does not agree with my recollection about the time the lamp was placed in Mr. Arnoux's hand, but it is very likely that the lamp referred to in the letter was shown to Mr. Arnoux on the date he mentioned, with a view of having it left in his keeping, and that he neglected to take it up to our office at that time, and that 917 on the appearance of the article in the "Herald" about Edison's incandescent electric light invention, Mr. Sawyer recollected that the lamp was still in his place and he took it up next Monday forenoon to Mr. Arnoux's office. In other respects the letter seems to be correct in accordance with my recollection and knowledge.

Cross-examination:

Q. The article announcing Mr. Edison's invention was published in the "New York Herald" on December 21st, 1879. I understood from your former testimony in this case that Sawyer brought the lamp around the next day; are you not mistaken in your last answer, as to the time when the lamp was placed in Mr. Arnoux's hand?

A. As I have just been informed that the article was published on the 21st of December, 1879, I was at fault in my answer; the date given in the letter must be the true one; and with that understanding I correct my last answer and say that the contents of the letter are true.

WILLIAM HOCHHAUSEN.

Sworn to before me this 12th day of March, 1889.

JOHN H. KITCHEN, *Examiner.*

HUGH R. GARDEN, being duly sworn, says:

1 Q. What is your name, age, residence and occupation?

A. Hugh R. Garden; age 48; occupation lawyer; residence New York city.

2 Q. Do you know of a corporation known as the Electro-Dynamic Light Co., and if so how, if at all, are you connected with it?

A. I know the corporation styled the Electro-Dynamic Light Co., and am the president of it.

918 3 Q. How long have you been president of said corporation?

A. I was elected the president of said corporation during January, 1889, I think.

4 Q. Has the Electro-Dynamic Light Co. a secretary, and if so, please give his name and residence?

A. It has a secretary; his name is C. W. Stocker; his office address is room 607–608, at No. 32 Nassau street, N. Y.

5 Q. Have you now in your possession the book of minutes containing the record of the proceedings of the board of trustees of the Electro-Dynamic Light Co.?

A. I have in my possession a book purporting to contain such record.

6 Q. During what years does said minute book contain a record of the proceedings of the board of trustees of the Electro-Dynamic Light Co.?

Counsel for the complainant stated of record that in accordance with the request of Mr. Lowrey, of counsel for defendant, he has requested the witness to produce the said minute book of the Electro-Dynamic Light Company, before the examiner this morning, and that the witness has done so in accordance with said request, and the book is now produced for use of the defendant's counsel, and the question is objected to for the reason that the book itself is the best evidence and of the periods covered by said book.

A. I am not familiar with the dates or the contents of the minute book, having had no connection officially with the Electro-Dynamic Light Co. prior to the winter of 1888–1889, but at the request of counsel I have brought the minute book, and I offer the same in evidence.

Defendant's counsel objects to that part of the answer of the witness wherein he states that he offers the minute book in evi-
919 dence as not responsive to the question, and he does not consent that the same be offered in evidence at this stage of the examination of the witness.

Counsel for complainants requests that the fact be stated that the witness has shown the book to counsel. (A book is handed to defendant's counsel by the witness.—J. H. K., Ex.)

7 Q. Will you now produce the minute book of the board of trustees of the Electro-Dynamic Light Co., and allow the defendant's counsel to inspect the same?

A. Defendant's counsel has now the minute book in his possession, and the witness will be pleased to have him examine it thoroughly.

It is conceded by complainant's counsel that the book produced is the minute book of the Electro-Dynamic Light Co. and the only one they ever had. As to the period covered, counsel states that the book itself is the best evidence of that. As to the record of proceedings, counsel also concedes that it contains a correct statement of the proceedings of the Electro-Dynamic Light Co. during the period embraced in the book.

8 Q. Please examine said minute book at pages 46 to 53 inclusive, and state whether you find therein a record of the proceedings of a meeting of the board of trustees of the Electro-Dynamic Light Company purporting to have been held on the 20th day of March, 1879?

Objected to as the witness has no personal knowledge of said meeting, and the book itself is the best evidence of the fact inquired for by the counsel, and of its own contents.

A. I can only answer the question by reading what appears on the pages 46–53 inclusive in the book referred to. After
920 reading from the minute book, I now state that within the pages referred to there is what purports to be a record of the proceedings of board of trustees of the Electro-Dynamic Light Company held on the 20th day of March, 1879.

Defendant's counsel offers in evidence from the book of minutes of the Electro-Dynamic Light Company a record of the proceedings of the board of trustees of said company purporting to have been held on the 20th day of March, 1879, at 3.30 p. m., No. 3 Nassau street, N. Y. city, said record being on pages 46, 47, 48, 49, 50, 51, 52 and 53, inclusive, of said minute book, and purporting to have been signed by W. E. Sawyer, sec'y. Said record of March 20th, 1879, is filed in evidence and marked Defendant's Exhibit "Electro-dynamic Light Record, March 20th, 1879."

The offer is objected to as incompetent unless the whole book is offered in evidence; that being a part of their record and as showing only a portion of the proceedings of the said company appertaining to the subject included in the offer, and as an attempt on the part of the defendant to cut off the complainant from proper cross-examination, and also to conceal from the court matter material to the controversy. Notice is hereby given that a motion will be made at or before the hearing of this cause upon proper notice as to time and place to strike out the mutilated record thus attempted to be offered by the defendant.

9 Q. Please examine said record, Defendant's Exhibit "Electro-dynamic Light, March 20th, 1879," and state if you know in whose handwriting it is?

A. I have examined the record referred to and I do not know in whose handwriting it is.

10 Q. Please state from whom you received said book of minutes and how long it has been in your possession?

921 A. The minute book was brought to my office at the time that I was elected president of the company. But who brought it there I do not know. I think this was in January, 1889. I see by reference to the minute book itself that I was elected president on the 19th of December, 1888, to fill the unexpired term of Mr. Thomas Wallace, the former president, and that at the annual election which took place in January, 1889, I was re-elected president, and the book was probably brought to my office at the time I was elected in December, 1888, and has since been in my custody.

11 Q. At the time said minute book was delivered to you, was it put into your custody as the minute book of the Electro-Dynamic Light Company in which the proceedings of its board of trustees were recorded?

A. I so understood it.

Adjourned to 2 p. m.

MARCH 12, 1889.

Met pursuant to adjournment.
Counsel present as before.

It is hereby stipulated that a copy of the minutes of the board of trustees of the Electro-Dynamic Light Company of the meeting held March 20th, 1879, offered in evidence by the counsel for the defendant, may be copied in the record by the examiner and have the same force and effect as the original in the minute book of the said company, subject, however, to the objection made by counsel for the complainant.

It is also agreed that the complainant will produce the said minute book at the hearing of this cause, or at any time during the taking of the defendant's evidence on proper notice from the defendant.

The examiner here copies the said minute-.

922 At an adjourned meeting of the board of trustees of the Electro-Dynamic Light Co., held at No. 3 Nassau street, on Thursday, March 20th, 1879, at 3.30 p. m. Present—Messrs. Albon Man, Hugh McCulloch, Wm. H. Hays, Jacob Hays, Lawrence Myers, Jas. P. Kernochan and W. E. Sawyer; the president in the chair.

The minutes of the previous meeting and of the two adjournments which followed were read and approved.

The treasurer's report to date was presented and read, showing a balance of cash in bank of $2.61. Total liabilities, $3,536.72; of which amount there is due to—

Albon Man	$1,850	
Jacob Hays	750	
Hugh McCullough	150	
Lawrence Myers	150	
Wm. H. Hays	150	
J. P. Kernochan	150	
Man & Parsons, lawyers	310	50

From which the president promised to secure a reduction.

On motion the report of the treasurer was referred to the auditing committee, consisting of the president, vice-president and secretary, for examination and approval.

The president then made the following report which the secretary took down verbatim:

"The president reports that on Tuesday last he discharged the workmen employed by the company at No. 94 Walker street, and gave them notice that nothing further would be required of them by the company; that he consented to Mr. W. E. Sawyer doing any work he desired to do there; and that since that time Mr. Sawyer has been at work there. There is nobody left in the employ of the company except Mr. Edwin L. Myers. The men are paid up to the expiration of the time when they were discharged. Edwin L. Meyers was put in charge of the shop by the president to look after the property of the company, and remains in that capacity
there, receiving a salary of $12 per week. Mr. Sawyer has
923 expressed to the president of the company the greatest
possible confidence that the princip*al* upon which he had been at work to build lamps was correct, and that those lamps that had been put up, except for some unknown reason (probably something about the filling), would be permanent and last forever. Some half a dozen or more lamps that are there are perfect and he (Sawyer) believed would never burn out, but remain as they are, but, in his (Sawyer's) judgment, a manufacture of lamps of that character was so uncertain that he declined to put them on exhibition anywhere. Since the last meeting of the company Mr. Sawyer has been at work principally upon a feeder lamp. On Tuesday evening of this week the feeder lamp was completed and was filled with illuminating gas and lighted up; fed up from the outside without any connection with the air at all, but fed up from the outside. The lamp was filled with illuminating gas because the conveniences of obtaining nitrogen were not at hand, and then

a vacuum made in the lamp, taking out most of the gas and leaving only a very small portion in. The lamp burned well for about half an hour in illuminating gas and was then shut off. Mr. Sawyer had it taken down on the next day, which was Wednesday, and filled by Mr. Stillman, and this morning Mr. Edwin L. Myers run it and fed up the carbon pencil twenty-one times, and his report is that there was no consumption of it, and that the lamp seemed to be a good and perfect lamp; that the carbon was entirely defective and good for nothing, because it had not been treated. It should have been treated before it was put in the lamp. Mr. Sawyer expresses confidence that lamps put up with a feeder of that kind will last forever, and he will be ready to put it on exhibition, but the president himself expresses his own views in regard to it that, while Sawyer's views are probably correct, personally, for other reasons, he is unwilling to go on expending money of himself and others in building lamps."

On motion, it was ordered that the report of the president be entered on the minutes and his action approved.

924 The secretary, Mr. Sawyer, then proposed that the gentlemen present, being unwilling to go on with the business of the company, that he should be allowed the free use of the shop and tools of the company until the 20th of April, in and with which to conduct his own experiments at his own expense; that he should be allowed three months' time in which to pay the debts of the company, and that upon his paying the debts of the company, not to exceed four thousand dollars in amount, all of the members of the board now present, excepting himself, shall turn into the treasury of the company two-thirds of the stock and scrip originally held by them, which shall be used as a working capital to secure funds for carrying on the business of the company, the same to be sold at no less than 50 cents on the dollar of par value. The proposition of the secretary was considered and accepted by unanimous informal agreement, with the understanding that the remaining one-third of stock and scrip retained by the present members of the board, excepting himself, shall be protected from assessment or debt either by two of the present board members, excepting the secretary, retaining their board membership in any new organizations to be effected, or by some other means to be devised hereafter.

On motion of Mr. McCulloch, it was

Resolved, That all authority heretofore given expressly or by implication to any officer of this corporation to contract debts for the company be and hereby is rescinded.

Resolved, That all expenses of the company, excepting the salary of Mr. Edwin L. Myers, be revoked, and that he shall be continued in charge of the property of the company at No. 94 Walker St. until otherwise ordered.

Resolved, That W. E. Sawyer be authorized to use for experimental purposes at his own expense the office and premises, machinery and tools of the company at No. 94 Walker St. free of rent until the 20th of April next.

925 The secretary was requested to state in the minutes that the feeder-lamp invention made by him at the expense of the company is the property of the company for the United States, to which he hereby agrees and assents and will make all necessary assignments, provided the company procures the patent upon it within a reasonable time.

Adjourned.

W. E. SAWYER, *Sec'y.*

Cross-examination:

122 Q. Please examine the minute book and state whether there are any minutes of any other meeting of the trustees of the Electro-Dynamic Light Company signed "W. E. Sawyer, sec'y," and in the same handwriting as the minute of March 20th, 1879, and if so, please give the dates of said meetings?

Defendant's counsel objects to the question *and* as incompetent, on the ground that the question calls for evidence not responsive to the examination-in-chief, and because it calls for the opinion of the witness as to the handwriting of W. E. Sawyer, and the witness is not shown to be competent to express an opinion upon the subject inquired about or to make a comparison as to the similarity or dissimilarity of the handwriting of the person who recorded the proceedings in said book of minutes.

A. Beginning at page 1 of said book, I find what purports to be a meeting of the trustees of the Electro-Dynamic Company, held at No. 3 Nassau street on the 15th day of July, 1878, the said record ending on the 15th page of said book. The record of the proceedings, or alleged proceedings, is in the same handwriting as that of the proceedings of March 20th, 1879, and it closes on page 926 15 with the words "W. E. Sawyer, secretary." The same remarks apply to a record of a meeting purporting to have been held September 10th, 1878, at the same place, beginning on page 16 and ending on page 18. The same remarks apply to a meeting of the board of trustees purporting to have been held October 8th, 1878, beginning on page 19 and ending on page 20, except that the word "secretary" is not written out in full, but is written "sec'y."

The same remarks as the last apply to a meeting of said board purporting to have been held October 15th, 1878, beginning and ending on page 21.

The same remarks apply to a record of what purports to be a meeting of said board held October 31st, 1878, beginning on page 22 and ending on page 26.

The same remarks apply to a record of what purports to be a meeting of said board held on the 12th of November, 1878, beginning at page 27 and ending at page 36.

The same remarks apply to a record of what purports to be a meeting of said board on December 12, 1878, beginning on page 37 and ending on page 40.

The same remarks apply to what purports to be a record of a meeting of said board January 14, 1879, beginning and ending on page 41.

The same remarks apply to a record of what purports to be a meeting of said board February 18, 1879, beginning and ending on page 42.

The same remarks apply to what purports to be a meeting of said board held February 25, 1879, beginning on page 43 and ending on page 45.

On page 45 there is also a record of what purports to be a meeting held March 11, 1879, which is not in the same handwriting, except that the signature "W. E. Sawyer, sec'y," is in the same handwriting as that referred to in the question asked.

There is also on page 45 a record of what purports to be a meeting held March 18th, 1879, which is altogether including the signature, in the handwriting referred to in the question.

927 The same remarks apply to what purports to be a record of a meeting of said board held April 8th, 1879, beginning on page 54 and ending on page 55.

The same remarks apply to what purports to be a meeting of said board held April 19th, 1879, beginning and ending on page 56.

The same remarks apply to what purports to be a meeting of said board held April 26th, 1879, beginning on page 57 and ending on page 64.

The same remarks apply to what purports to be a record of the proceedings of said board held May 13, 1879, beginning at page 65 and ending at page 66.

The same remarks apply to what purports to be a record of a meeting of said board held May 14, 1889, beginning and ending on page 67.

The same remarks apply to a record of what purports to be a meeting of said board held May 20th, 1879, beginning on page 68 and ending on page 76.

The same remarks apply to a record of what purports to be a meeting of said board held June 10th, 1879, beginning on page 77 and ending near the top of page 78.

I find nothing more in said book in the handwriting referred to.

Same objection to answer as to the question.

13 Q. State whether the minutes you have referred to of meetings beginning on July 15th, 1878, and ending on June 10th, 1879, constitute, together with the minutes of March 20th, 1879, all the minutes contained in said minute book between those dates.

Same objection as to last question; also as immaterial and irrelevant, and as improper and incompetent, because the minute book is the best evidence of what it contains.

A. They constitute all of the minutes recorded in said book between the dates mentioned.

928 14 Q. Please read to the examiner the minutes of each meeting you have referred to in your 12th answer, so that he may take them down in the record?

Defendant's counsel objects to the question and to the evidence called for thereby upon the ground that the same is immaterial and irrelevant and the question calls for new matter not relating to or growing out of the examination-in-chief, and because the original record itself, if competent at all, is the only competent evidence of the facts therein recited, and defendant's counsel further objects and protests that it is not competent or proper for the complainants to burden the record of the defendant with new and irrelevant matter or to take the defendant's time, which is limited, in spreading their own evidence upon defendant's record, thereby consuming defendant's time and greatly adding to the expense of this litigation.

The defendant's counsel also objects that no proper or sufficient foundation has been laid by the complainant's counsel for the introduction of the minutes of said alleged meetings in evidence.

The defendant gives notice that if the complainant's counsel pursues the line of examination indicated in the question, he will make said witness his own and will be bound by the evidence called out, and he further gives notice that he will move the court before final hearing or at final hearing to strike said incompetent, immaterial and irrelevant matter from defendant's record.

Counsel for complainant states that he has no desire to take defendant's time; that he has proposed to defendant's counsel to permit the examiner's clerk, who is taking this testimony, to copy the minutes called for in the question on the record and to permit the witness to compare the said copy after it is made. That during said time, the examination of other witnesses 929 can proceed, attendance of counsel being unnecessary here, but defendant's counsel has seen fit to refuse. Complainant's counsel offers to have copies of the said minutes made and put in subject to the objection of defendant's counsel already taken, just as complainant's counsel has stipulated in a copy of the one minute defendant's counsel has offered. Complainant's counsel states that so far from delaying defendants he has provided counsel to attend two other examinations now going on in defendant's behalf in different places, and that his course in this matter has been rendered necessary by the unfair and improper course of the defendant in attempting to put in part of the minutes in the hand of William E. Sawyer, without putting the whole of them in.

A. (Witness reads:)

At a meeting of the trustees of the Electro-Dynamic Light Co. held at No. 3 Nassau St., in the city of New York, on the 15th day of July, 1878.

Present—Messrs. Hugh McCulloch, Wm. H. Hays, Albon Man, Jacob Hays, Lawrence Myers and W. E. Sawyer; Mr. Jas. P. Kernochan being represented by Mr. Albon Man—trustees.

On motion Mr. Hugh McCulloch was appointed chairman, and W. E. Sawyer, secretary *pro tem.*

The counsel of the company reported that the certificate of incorporation had been filed in the office of the secretary of state and in the office of the clerk of New York county, on the 11th day of July, 1878; and presented a certified copy of the certificate as filed.

On motion of Mr. Albon Man it was resolved to ballot for officers.

The balloting resulted in the unanimous election of the following officers:

President, Wm. H. Hays.
Vice-president, Albon Man.
Secretary, W. E. Sawyer.
Treasurer, Jacob Hays.

930 The vice-president-elect took the chair and on motion it was

Resolved, That the patents and patent rights and agreements belonging to William E. Sawyer and Albon Man, relating to the subject of electric lighting and the production and distribution of electric currents be purchased by the company and that the president and secretary be and hereby are directed to issue to the said Sawyer and Man the whole capital stock of the company and two hundred and ninety thousand dollars in scrip certificates of the company, payable out of profits, in the form now presented to the company and exhibited here on the minutes; the price at which said patents and patent rights and agreements are purchased being $300,000.

Following is a list of the patents, viz:

"Electric lamps," No. 205,144.
"Electric lighting system," No. 205,303.
"Regulators for electric lights," No. 205,305.

And two-fifths of the following patents, viz:

"Electric engineering and lighting apparatus and system," No. 194,111.
"Electric engineering and lighting system," No. 196,834.
"Electric lighting apparatus," No. 194,503.
"Electric candles," No. 194,500.

The agreements between W. E. Sawyer and Albon Man bear date as follows:

February 15th, 1878.
March 19th, 1878.
March 25th, 1878, and
May 11th, 1878.

On motion the secretary read the following by-laws, which were adopted, viz:

931 BY-LAWS OF THE ELECTRO-DYNAMIC LIGHT COMPANY.

I.—*Board of Trustees.*

The stock, property and concerns of the company shall be managed, except as hereinafter provided, by a board of seven trustees, who shall be stockholders, and shall hold their offices until others are elected in their stead, and who shall have power to fill vacancies in their body, but only by the concurring vote of a majority of the trustees then existing.

II.—*Officers.*

The regular officers of the company shall be a president and vice-president, treasurer and secretary.

III.—*Annual Election.*

The annual election of trustees shall be held on the second Tuesday of January in each year, at the office of the company in the city of New York, at such hour as the board shall direct—or, if no other hour be designated, then at 3 o'clock p. m. At the same time and place three inspectors shall be chosen to hold the next annual election. Such election shall be by ballot; each share of stock entitling the holder to one vote.

IV.—*Election of Officers.*

The president, vice-president, treasurer and secretary shall be elected annually within forty days after the election of the board of trustees, and they shall hold their offices until their successors are chosen, save in cases of removal by the board or other disqualification.

Vacancies in office may be filled at any meeting of the board.

932 Such elections shall be by ballot; and a majority of the whole board for the time being shall be necessary to a choice.

V.—*Meetings of the Board.*

The stated meetings of the board of trustees shall be held on the second Tuesday of each month, at the office of the company in the city of New York, at such hour as the board shall direct; or, if no other hour be designated, then, at 3 o'clock p. m.

A majority of the whole number of trustees for the time being shall constitute a quorum for the transaction of business at any meeting, whether stated or special.

The president, vice-president or any two trustees may direct the call of a special meeting of the board at discretion.

Any meeting may adjourn from time to time to a day and hour then specified.

VI.—*Call of Special Meetings.*

Special meetings may be called by the president, vice-president or any two trustees, notice to attend which shall be given to all by mail or otherwise.

VII.—*Order of Business.*

The order of business at meetings of the board of trustees (unless dispensed with at any meeting by unanimous vote) shall be:

1. Calling the roll.
2. Reading the minutes of the preceding meeting or meetings.
3. Reading the minutes and reports, consecutively, of the execu-

tive committee, president, treasurer, standing committees and special committees.

4. Miscellaneous business.

All questions shall be decided by the vote of a majority of the trustees present at any meeting, except as herein otherwise
933 provided, and the yeas and nays shall be recorded on the demand of any member.

VIII.—*Executive Committee.*

There shall be an executive committee to consist of three trustees. It shall be chosen, and vacancies therein filled, by the board of trustees. The committee may fix the time for its stated meetings, and may be called together also for special business by any member thereof.

All ordinary executive powers, not specially delegated to the offices of the company, or to other committees, shall be exercised by the executive committee—subject, however, to such regulations or directions as the board of trustees may adopt.

The executive committee shall have power, subject to such regulations as the board of trustees may adopt, to suspend any superintendent, clerk or agent of the company from duty or employment. It shall also exercise a general supervision over the pecuniary affairs of the company, and advise with the officers in respect to any measure of finance, and examine as often as they may think proper, or as the board may direct, all accounts and vouchers of the treasurer and other officers or agents, and report thereon.

IX.—*Subordinate Officers.*

The board of trustees may appoint such superintendents and other subordinate officers, clerks or agents as the business of the company may require, and may fix their salaries or other compensation.

X.—*Duties of President.*

The president shall preside at the meetings of the board and discharge all duties usually pertaining to the office.

934 In case of his absence or disability, his duties shall be performed by the vice-president; and if both be absent or unable to attend to such duties, then a president, *pro tem.*, to be named *viva voce* or otherwise by the board.

XI.—*Duties of Treasurer.*

It shall be the duty of the treasurer to receive and safely keep all moneys belonging to the company, which shall from time to time be deposited in bank to the credit of the company by its corporate name. He shall keep correct books of account, which shall be the property of the company; and shall preserve correct vouchers for all disbursements, except petty cash; and shall exhibit the financial condition of the company by report at the annual meeting, and also, whenever required, to the board of trustees or executive committee. He shall be custodian of the corporate seal.

XII.—*Duties of Secretary.*

It shall be the duty of the secretary to attend the meetings of the board and keep correct and full minutes of the proceedings; to keep the records, correspondence, and papers of the company; to give notice of all special meeting- of the company and of the board of trustees, and also (when requested) of the meetings of committees; to furnish to each committee or its chairman a copy of every resolution appointing such committee, or relating to the committee or its business; to conduct the general correspondence of the company; and to discharge all other duties usually devolved upon a secretary.

XIII.—*Transfers of Stock.*

The secretary shall keep a suitable (or scrip)* book in which all transfers of the stock shall be made.

935 No transfer of stock or scrip shall be made until the previous certificate (if any) given for the same stock or scrip shall have been surrendered and canceled.

No transfer shall entitle the holder to a dividend, or to vote upon stock or scrip, unless regularly entered upon the transfer book.

The transfer book shall be closed for ten days prior to the annual election, and for ten days prior to the payment of any dividend.

On the day of the annual election, the secretary shall furnish for use of the inspectors an alphabetical list of all the stock and scrip holders at the time of closing the books preparatory thereto, with the number of shares held by each.

XIV.—*Stock Certificates.*

All certificates of stock and scrip shall be signed by the president and countersigned by the secretary, and the corporate seal affixed, and unless so authenticated, they shall not be valid.

XV.—*Safeguard Against Personal Liability.*

For the protection of the stock and scrip holders and officers of the company against personal liability, and to preserve the credit of the company, it is expressly provided that no work shall be ordered or authorized, or liability of any kind incurred by or on behalf of the company unless ample means shall at the time be in the treasury and immediately available to meet such liability. It shall be the duty of the executive committee to see that this by-law is strictly complied with, and they shall have full power to prevent any violation of it by officers or agents of the company.

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* Interlineation in book.

XVI.—*Special Meetings of Stock and Scrip Holders.*

936 Special meetings of the stock and scrip holders shall be called by the secretary when required to do so by the president or board of trustees, or by stock and scrip holders owning at least one-half in amount of all the capital stock and scrip. Such call shall be made by circular addressed by mail to all the stock and scrip holders whose residence shall be known, to their residence or at their registered address.

XVII.—*Disbursing Officers May be Required to Give Security.*

The treasurer, or any other officer or agent of the company who shall control or disburse the moneys thereof, shall (if the board of trustees or executive committee require the same) give security for the faithful discharge of the duties of such office or agency, and to account for such moneys—which security shall be in such form and amount as said board or committee may require.

XVIII.—*Corporate Seal.*

The corporate seal of the company shall be a circular one with the name of the company thereon, and the word "seal," the impression of which is affixed to the record of these by-laws in the minute book of the company.

{ Impression of }
{ Seal. }

XIX.—*Execution of Documents.*

All deeds, leases and other documents affecting the property of the company, and requiring to be executed under its seal, shall be executed by the president or acting president, and attested by the secretary.

XX.—*Checks.*

No moneys can be drawn from bank or other place of deposit thereof, except by checks signed by the president or vice-president and also by the treasurer.

937 XXI.—*Alteration of By-laws.*

These by-laws may be altered or amended by a vote of not less than two-thirds of the whole number of trustees for the time being at any regular meeting of the board, provided distinct notice of the intention to propose such alteration or amendment shall have been given in the notice calling such meeting, or at the next previous regular meeting when a quorum shall have been present.

The secretary presented a seal, impression of which is on the margin of the minutes, which on motion was adopted as the seal of the company.

On motion, Messrs. Lawrence Myers and Jacob Hays were appointed a committee to supervise and receive the assignments of patents and agreements and to supervise the issue of the stock and scrip of the company in accordance with the resolution adopted.

The committee reported that they had received the assignments of the patents and agreements referred to in the resolution and presented the same to the trustees.

On motion, Messrs. Classon and Hays, of No. 3 Nassau St., New York city, were appointed transfer agents of the company.

Messrs. Wm. H. Hays and Albon Man tendered their resignation of the offices to which they had been elected, and the resignations were accepted, whereupon,

On motion, it was resolved to proceed to ballot to fill the vacancies thus created.

The balloting resulted in the unanimous election of Mr. Albon Man, for president, and Mr. Lawrence Myers, for vice-president.

Adjourned subject to call.

W. E. SAWYER, *Secretary.*

938 Pursuant to call the regular monthly meeting of the board of trustees of the Electro-Dynamic Light Co. was held at No. 3 Nassau St., on Tuesday, Sept. 10th, 1878. Present, Messrs. Hugh McCulloch, Wm. H. Hays, Jacob Hays, Lawrence Myers, Albon Man and W. E. Sawyer. The minutes of the previous meeting were read and approved.

The president reported that an informal proposition had been made to him to purchase ten thousand ($10,000) of the scrip of the company which has been set apart as a working capital and stands in the name of Jacob Hays, treasurer, in trust, at the par value thereof; whereupon

On motion of Mr. McCulloch, the president and treasurer were authorized, by a unanimous vote, to sell and transfer ten thousand dollars of the scrip held by the treasurer in trust.

The president further reported that he had expended of his own money and taken vouchers in the name of the company therefor receipted as paid by him to the extent of $729.74, in the preparation of lamps and other electrical apparatus and in the payment of $250 to W. E Sawyer for $1,000 of the scrip of the company, assigned to the company by Mr. Sawyer; and that there is a small bill in addition due to Messrs. Arnoux & Hockhauser, Nos. 2 and 4 Howard St., New York, for work and materials.

On motion it was resolved that the vice-president and treasurer be authorized to act as an auditing committee to audit the accounts when there is money in the treasury to pay the same.

The president further reported that there is a proposition pending for the privilege of placing the lighting apparatus of the company in the Davol mills at Fall River, Mass.

On motion of Mr. Wm. H. Hays the president was authorized in his discretion to make arrangements with the proprietor of the Davol mills.

The president further reported that the company is in need of a

dynamo-electric machine for the proper exhibition of its
939 lighting apparatus, the price of which is $600; whereupon,
on motion of Mr. McCulloch, it was

Resolved, That the president be authorized to order such a dynamo-electric machine as may be needed.

On motion it was resolved that the president be authorized to employ as chemist of the company Prof. F. N. Holbrook, of Columbia college.

On motion it was resolved that the clerk of Mr. Jacob Hays be employed to take care of the books of the company, and to be paid a fair price for his time and services.

Adjourned.

W. E. SAWYER, *Secretary.*

At the regular monthly meeting of the board of trustees of the Electro-Dynamic Light Co., held at No. 3 Nassau St., on Tuesday, Oct. 8th, 1878. Present—Messrs. Wm. H. Hays, Jacob Hays, Lawrence Myers, Albon Man and W. E. Sawyer.

The minutes of the previous meeting were read and approved.

The president reported:

1st. That he had made arrangements with Mr. Wm. C. Davol, Jr., treasurer of the Davol Mills of Fall River, Mass. [at the expense of the mill Co.]* to equip the said mills at the expense of the mill Co., with the electric lighting apparatus of the Electro-Dynamic Light Co., the mill Co. to pay a royalty of one hundred dollars per annum for the use of the same and as an acknowledgment of the patents and rights of this company.

2d. That the apparatus of the company is substantially complete for exhibition.

3d. That the present workshop of the company is unsuitable
for the exhibition of the light and experimental purposes.
940 On motion of Mr. Jacob Hays, it was resolved—
That the president be, and hereby is, authorized to procure suitable quarters for manufacturing and exhibiting the apparatus of the company.

On motion it was resolved—

That the president and treasurer be, and hereby are, authorized to pay W. E. Sawyer at the rate of fifty dollars per week as electrician of the company.

On motion of Mr. Wm. H. Hays, the president was authorized to procure letters patent of the United States upon new inventions as speedily as he may deem it necessary.

On motion, the president was authorized to employ Mr. E. L. Myers as chemist of the company in place of Prof. Holbrook.

Adjourned.

W. E. SAWYER, *Sec'y.*

At a special meeting of the board of trustees of the Electro-Dynamic Light Co., held at No. 3 Nassau St., on Tuesday, Oct. 15th,

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*Erased in book.

1878, notice to attend which was sent to all. Present—Messrs. Hugh McCulloch, Wm. H. Hays, Jacob Hays and Lawrence Myers. The president being absent, Mr. Myers, vice-president, was called to the chair. Mr. Jacob Hays acted as secretary *pro tem.*

On motion of Mr. Wm. H. Hays, the president was authorized to exhibit the electric light wherever he may deem proper for the interests of the company.

On motion of Mr. McCulloch, the president was authorized to procure letters patent in foreign countries upon the inventions owned by the company, provided the expense of procuring such letters patent can be paid by sale of stock of the company.

Adjourned.

W. E. SAWYER, *Sec'y.*

941 At a special meeting of the stockholders of the Electro-Dynamic Light Co., held at No. 3 Nassau St., on Thursday, Oct. 31st, 1878, notice to attend which was sent to all, present Messrs. William H. Hays and Jacob Hays, Hugh McCulloch, Lawrence Myers, Jas. P. Kernochan, Albon Man, W. E. Sawyer, Wm. H. Church and H. L. Judd, the president in the chair, the secretary read the following communication from Mr. G. P. Lowery:

Porter, Lowery, Soren & Stone, attorneys and counsellors at law,
No. 3 Broad street (Drexel building).

NEW YORK, *Oct. 30th,* 187–.

P. O. box 1836.

DEAR SIR: Referring to my visit to 94 Walker St. this morning, I think it desirable to repeat to you more deliberately than may be done in a hurried conversation, that the field of electric lighting is so vast and promises such great results, that good business men would commit a great error if they should allow themselves to become, in the outset, involved in any uncalled-for struggle for the possession of the whole field, and a small part of it would be enough for all.

As I said to you this morning, the suggestions which passed between us, arising apparently in both our minds out of the same practical considerations, were not intended by me to express the opinions of my associates, for I had not seen any of them since reading in the morning paper the announcement of the Sawyer-Man light; nor do I understand what you said as in any way committing you, except to the general proposition, that it was always in these matters wiser to unite strong parties than to divide them and leave them to expend their strength in opposition.

I want to repeat, therefore, that I shall be at all times in favor of considering more carefully the general ideas which we mutually expressed, and that without any very great reference to the question who would or who would not succeed in the final contest.

942 As I understand it, you have not a correct idea of Mr. Edison's light; in fact, he has not allowed any one to know what his invention consists of, but I understand that you have what is apparently to me a very good light, and even if we were

able to sustain both rival patents, we should be competitors, which itself would be commercially a great mistake.

I have already described to one of the directors of our company what I saw of your light, and I shall mention our conversation to others as I shall chance to meet them.

You will be glad to hear that a telegram from Menlo Park this morning informed me that Mr. Edison slept twelve hours last night without pain and is therefore out of the difficulty which has prevented him from working for the last few days.

I presume that your foreign patents are taken out and I think there is a much greater field over there than here, and also if there should be a practical union of these interests in any way it would be enormously to the advantage of both, on the other side, to be represented by the same strong banking house or houses.

Very truly yours,

(S'd) G. P. LOWREY.

Albon Man, Esq., 94 Walker street, city.

On motion, Messrs. Hugh McCulloch, Wm. H. Hays and the president of the company were appointed a committee to confer with Mr. Lowery in relation to the subject-matter of the foregoing communication.

Adjourned.

W. E. SAWYER, *Sec'y.*

At the regular monthly meeting of the board of trustees of the Electro-Dynamic Light Co. held at No. 94 Walker St. on Tuesday, Nov. 12th, 1878, at 4 o'clock p. m. Present—Messrs. Albon Man, Jacob Hays, Lawrence Myers and W. E. Sawyer.

943 The reading of the minutes of the previous meeting was dispensed with.

The president reported that he had received two more letters from Mr. G. P. Lowrey, which the secretary read as follows:

NEW YORK, *Nov. 2d*, 1878.

DEAR SIR: I have this moment received your letter, which however I have not time to read as I am going out.

I was surprised this morning to hear that my letter to you was being spoken of as an advance towards a consolidation of our company with yours. I am sure you cannot have made such a mistake. At any rate, if such an impression was derived from what I wrote, there was no such specific purpose in my mind, and I desire to correct it now and to add that I have not the slightest idea that the Edison Electric Light Co. would entertain any such proposition from you, and certainly they would not make it.

It is one of the dangers of private intercourse that it is liable to these misconstructions.

Very truly, G. P. LOWREY,
By K.

Albon Man, Esq., 94 Walker St.

NEW YORK, *Nov. 6th*, 1878.

DEAR SIR: I received your letter of Oct. 31st just as I was leaving my office. I had time to glance at the first page of it hastily, and then thinking I might not have another opportunity for several days, I dictated to my stenographer my letter to you of November 2d, and left it to be written out and signed by him for me. I have just this morning returned to the city and take the first opportunity to make a more formal reply.

I adhere to the general ideas of policy which I expressed
944 to you in conversation and in my former letter. I do not
think the matter is in any situation, however, to require the present consideration of whether or not we are likely to be rivals, and as such injurious to each other. That time may very likely come and perhaps soon, and as one of those interested in Mr. Edison's patents I shall be ready and disposed towards whatever may seem to be required by good business judgment.

I should not allude to any possible contest between our patents except from your having expressed a belief (very proper from your standpoint) that "Mr. Edison's light, if put in operation, must in the end pay tribute" to you.

I am entirely satisfied that the most exhaustive search of what has been done by others will show that Mr. Edison has produced a perfectly novel invention.

Very truly yours, G. P. LOWREY.

Albon Man, Esq., 3 Mercer St., city.

The president stated that he had made no reply to either of these letters and did not consider any necessary.

The letter of Oct. 31st, written by the president, referred to in Mr. Lowrey's communication of Nov. 6th, was presented and read as follows:

(Copy.)

NEW YORK, *Oct. 31st*, 1878.

DEAR SIR: I have to acknowledge the receipt this afternoon of your letter to me of Oct. 30th inst. We feel very confident of the success of our inventions and the stability of our patents. Some of your people, and if we are not mistaken from Mr. Edison's own laboratory, have seen our light and can attest its excellence, as can also a vast number of people who have thronged to see it. Of course we have not made public all that we have done, nor do we suppose that Mr. Edison has done so, but we do distinctly claim that we are
the inventors of all that we use, and that we can show our
945 priority over Mr. Edison and every one else in these inven-
tions, and we cannot but feel from what we see published that many of these inventions are essential to the successful working of Mr. Edison's light.

If we are right, Mr. Edison's light if put in operation must in the end pay tribute to us. At the same time, my dear sir, we do not claim to be all the world, nor to contain all the wisdom of it, nor to know in advance all that has been and will be found out about lighting by electricity. Permit me just here to pay what is but just tribute to the ability, skill and inventive talent of Mr. Edison, and to admit that his well-known character in this respect is a great advantage to those attempting to bring his inventions before a public whose confidence in him as an inventor is great. I admit at the same time the high character, standing and wealth of your associates, as you must that of those who are associated with us. I do not permit myself for a moment to think that either you or those associated with you would think of attempting to deprive us by litigation or otherwise, of our just rights, notwithstanding any inference to the contrary that might be drawn from your letter. Having thus cleared the ground I have to say that I can see no ground of objection to a union of interests that should do away with intagonism if a fair basis for such union can be found. But on the contrary, I can see and I have no doubt the eminent business men who are associated with us in interest would also see that great advantages might be derived to both companies from such a union.

If you will bring about the appointment of a proper committee from your company for the purpose, I will see to it that representatives from our company shall meet them as soon as you advise me for the discussion of the subject. The matter may be informal, if you desire it, at first.

I am happy to hear of Mr. Edison's improved health.

In the matter of foreign patents I believe we are all right.

Very respectfully yours, ALBON MAN.

946 G. P. Lowrey, Esq., Drexel building, cor. Wall & Broad Sts., N. Y.

The treasurer reported as follows:

Receipts from sales of stock and scrip, $2,616; money loaned by Mr. Albon Man, $600; excess of salary paid Edwin L. Myers, $20.

Total receipts, $3,236.

Total expenditures to Nov. 12th, $2,224.21.

Balance in bank, $1,011.79.

$26,600 scrip in treasury.

The treasurer's report was accepted and placed on file.

The treasurer further reported that for the $600 borrowed for the company from Mr. Man, the vice-president and treasurer have signed a demand note.

On motion the action of the vice-president and treasurer was approved.

On motion the president was authorized to pay the bill of Edward P. Hampson for a steam engine put up at the company's workshop, amounting to $401.55, subject to the acceptance of a proposition by said Hampson to replace the present engine by a larger one costing $1,065.

Adjourned.

W. E. SAWYER, *Sec'y.*

At the regular monthly meeting of the board of trustees of the Electro-Dynamic Light Co., held at No. 94 Walker St., on Thursday, Dec. 12th, 1878, adjourned from the 10th; present, Messrs. Hugh McCulloch, Wm. H. Hays, Jacob Hays, Lawrence Myers, Albon Man and W. E. Sawyer, the president in the chair.

The minutes of preceding meetings were read and approved together with the interlineations in the minutes of the special meeting of the board of trustees, held Oct. 15th.

The president reported that he had received from W. E. Sawyer an assignment to the company of seven different applications for patents, which he presented as follows:

947 Electric lamps,	filed	Dec. 2d.
Do. do.	"	Nov. 30.
Do. do.	"	Nov. 19.
Thermo lamp,	"	Nov. 25.
Electric lighting apparatus,	"	Nov. 19.
Electric lighting apparatus,	"	Dec. 2d.

On motion the treasurer was directed to have the assignment recorded in the Patent Office at Washington.

The president reported that at a special meeting of the board, held Oct. 15th, on motion of Mr. McCulloch, the president was authorized to procure letters patent in foreign countries upon the inventions owned by the company provided the expense of procuring such letters patent can be paid by sale of stock of the company; that he was unable to make such sale of stock, and that therefore the company had not become the owners of the foreign patents and had no interest whatever therein.

The report was accepted, approved and ordered to be placed on the minutes.

The treasurer reported to Dec. 10th balance in bank $737.79.

The report was approved and accepted.

The treasurer further reported that the company had borrowed of Albon Man $500 on a demand note signed by the vice-president and treasurer; and that the company had borrowed of Jacob Hays $600 for which a demand note had been given by the president and treasurer.

On motion of Mr. McCulloch the action of the president and vice-president in borrowing $500 of Mr. Man and $600 of Mr. Hays was approved.

On motion of Mr. McCulloch, it was—

Resolved, That Lawrence Myers be appointed superintendent of the company with full power to supervise and direct its business with a view to pushing forward the construction of lamps and other apparatus necessary for practical work under the patents owned by the company; to sell and dispose of the stock or scrip of the
948 company; to communicate and correspond with parties that may desire to become purchasers of the right to use the inventions secured by the patents; and to do whatever in his judgment may be necessary to advance the interests of the company in conference with the president, secretary and treasurer.

Adjourned.

W. E. SAWYER, *Sec'y.*

At the regular monthly meeting of the board of trustees of the Electro-Dynamic Light Co., held at No. 94 Walker St., on Tuesday, Jan. 14th, 1879, present Messrs. Hugh McCulloch, Jacob Hays, Lawrence Myers, Jas. P. Kernochan, Albon Man and W. E. Sawyer, the president in the chair, the minutes of the previous meeting were read and approved.

Adjourned.

W. E. SAWYER, *Sec'y.*

At the regular monthly meeting of the board of trustees of the Electro-Dynamic Light Co., held at No. 94 Walker St., on Tuesday, Feb. 18th, 1879; adjourned from Feb. 11th, present, Messrs. Hugh McCulloch, Jacob Hays, Jas. P. Kernochen and W. E. Sawyer, Mr. McCulloch in the chair, the minutes of the previous meeting were read and approved.

The report of the treasurer was presented and ordered to be read at the next meeting.

On motion, it was

Resolved, That the president and secretary be and hereby are authorized to furnish lamps to applicants upon such terms as may be agreed upon between them and the applicants.

Adjourned to meet at No. 3 Nassau St., on Tuesday, Feb. 25th, at 3 o'clock p. m.

W. E. SAWYER, *Sec'y.*

949 At an adjourned meeting of the board of trustees of the Electro-Dynamic Light Co., held at No. 3 Nassau street, on Tuesday, Feb. 25th, 1879, present Messrs. Hugh McCulloch, Wm. H. Hays, Jacob Hays, Lawrence Myers, Jas. P. Kernochan, Albon Man and W. E. Sawyer, the president, in the chair.

The minutes of the previous meeting were read and approved.

The report of the treasurer was passed over to the next meeting.

The president presented the following paper which was read by the secretary:

"New York, *Feb.* 13, 1879.

"It has been agreed by Mr. Sawyer with Mr. H. L. Judd that Mr. Judd should go on at his own risk and cost to make an electro-dynamic machine of the kind invented by Mr. Sawyer upon the understanding that he, Judd, should have ¼ the interest in the invention both in the United States and foreign countries and should be employed to make the machines for this country for the Electro-Dynamic Light Co. at reasonable prices and exclusively for use in the U. S. But Mr. Sawyer, having before then assigned the invention to said company for this country it is understood that he was acting for said company, subject to its approval, it being also understood that proper provisions would be inserted in the agreement between Mr. Judd and the Co. for preventing licensing by his ¼ interest, without approval of the Co. or its officers and for joint account of the owners.

"I personally approve this arrangement and will in good faith seek to have it approved and carried out by the Electro-Dynamic

Light Co., and have conversed with the other directors, or most of them, who also promised to vote to carry it out.

"(Signed) ALBON MAN.
W. E. SAWYER."

950 On motion the action of the president and secretary in the foregoing arrangement was unanimously approved.

On motion the president and treasurer were authorized to borrow of all the trustees, excepting the secretary, the sum of $500, in proportion to their respective interests.

Adjourned to meet at the same place on Tuesday, March 11th, at 3.30 p. m.

W. E. SAWYER, *Sec'y.*

TUESDAY, *March* 11, 1879.

No quorum present. Meeting adjourned to Tuesday, March 18, 1879, at No. 94 Walker St., at 3½ p. m.

W. E. SAWYER, *Sec'y.*

TUESDAY, *March* 18, 1879.

No quorum present. Meeting adjourned to Thursday, Mar. 20th, 1879, at No. 3 Nassau St., at 3½ p. m.

W. E. SAVAGE, *Sec'y.*

NOTE.—Minute of meeting of March 20, 1879, copied in evidence above.

At the regular monthly meeting of the board of trustees of the Electro-Dynamic Light Co., held at No. 3 Nassau St., on Tuesday, April 8th, 1879, at 3.30 p. m. Present, Messrs. Hugh McCulloch, Wm. H. Hays, Jacob Hays, Lawrence Myers, Jas. P. Kernochan, Albon Man, and W. E. Sawyer; the president in the chair.

The minutes of the previous meeting were read and approved, a part of the minutes on page 53 having first been amended to read as follows:

951 "The secretary was requested to state in the minutes that the feeder-lamp invention made by him at the expense of the company is the property of the company for the United States, to which he hereby agrees and assents, and will make all necessary assignments, provided the company procures the patents upon it within a reasonable time."

The treasurer reported as follows:

Balance in bank, $2.61.

Total liabilities, $3,666.69, of which amounts there is due:

Albon Man	$1,862 50
Jacob Hays	750 00
Hugh McCulloch	150 00
W. H. Hays	150 00
Lawrence Myers	150 00
J. P. Kernochan	150 00
Classon & Hays	141 97

Adjourned.

W. E. SAWYER, *Sec'y.*

A special meeting of the board of trustees of the Electro-Dynamic Light Co. was held at 94 Walker St., on Saturday, April 19th, 1879, at 3 p. m. Present: Messrs. Hugh McCulloch, Jas. P. Kernochan, Jacob Hays, Albon Man, and W. E. Sawyer; the president in the chair.

The reading of the minutes of the previous meeting was dispensed with.

On motion of Mr. McCulloch, the president was authorized to continue the use of the premises at 94 Walker street for a period of one month or longer, not to exceed three months from May 1st.

Bills of Frasse & Co. and Mueller & Neumann were presented and approved.

Adjourned to meet at the call of the president or secretary.

W. E. SAWYER, *Sec'y.*

952 A special meeting of the board of trustees of the Electro-Dynamic Light Co. was held at No. 94 Walker St., on Saturday, April 26th, 1879, at 3 p. m. Present, Messrs. Lawrence Myers, Jacob Hays, Albon Man and W. E. Sawyer—the president in the chair.

The minutes of the two previous meetings, held April 8th and 19th, were read and approved.

The president reported as follows:

"That the interference case with Keith and with Maxim, arising from the application of Sawyer & Man for a patent for manufacturing carbon for electric lights, which has been assigned to the Co., has been proceeded with. The Co.'s attorney, Mr. Broadnax, reports that there is no interference with the claims made in our application for a patent, and that as soon as he can get the testimony of Mr. Maxim (that of Mr. Keith having already been taken and he disclaiming any claim to the invention for which we have applied for a patent) he can make an arrangement with these parties to have our patent issued, they withdrawing any opposition to it. The attorneys for Maxim and Keith have both expressed themselves as satisfied that there is no interference, and the only object in having Mr. Maxim's testimony now is that he may not in the future be permitted to reissue any patent that he might obtain for his supposed improvement in such manner as to interfere with ours, it being understood by Mr. Broadnax that Maxim will disclaim under oath, as Keith has done, any claim to the invention in that form in which we have made it."

The president further reported that the premises at No. 94 Walker street can only be hired temporarily for office purposes only.

The president further reported that he has received an offer of $125 for the engine and boiler belonging to the company, but that W. E. Sawyer has informed him that a Co. is about being formed for the manufacture of telegraphic apparatus which he thinks would be glad to buy the engine, machinery and tools of this Co. at a fair and reasonable price before a great while, and he ad-

vised that they be allowed to remain where they are
953 for the present. If necessity arises, they can be removed to
the store of Gillis & Geoghegan, in Wooster street, from
which they can be advertised and sold if the Co. desires.

The report of the president was accepted and ordered to be entered upon the minutes.

The secretary was requested to enter upon the minutes the fact that "at this meeting the room is illuminated by five feeder lamps manufactured by Mr. Sawyer, and all the trustees present are well pleased with the exhibit."

The secretary reported that he has applied for the patent upon the feeder lamp and presented bill of expenses amounting to $51.80.

The application for patent is entitled "electric lamps and switches therefor," and its receipts is acknowledged by a letter from the Commissioner of Patents, dated Washington, April 23d, 1879.

On motion of Mr. Myers, it was unanimously

Resolved, That the bill of W. E. Sawyer, amounting to $51.80, for applying for letters patent upon the feeder lamp, be approved and paid.

The secretary further reported that the Commissioner of Patents requires a model of the invention before taking official action upon the feeder-lamp application; and on motion of Mr. Hays, the secretary was directed to have the model constructed at the expense of the company as quickly and cheaply as possible.

The secretary further reported that the feeder lamp is now complete; that nothing remains to be done except to manufacture and sell lamps and switches; and there being no necessity for further experimenting, he recommended that the workshop of the company be closed and the machinery and tools sold; that the dynamo machines be located in some place provided with steam power; and that an office be hired in which lamps may be charged and kept on exhibition and the electricity be conveyed by wires from the dynamo machines to the office.

The secretary stated that it was impossible for him to make
954 long carbons for the feeder lamps out of materials at hand
and that it was absolutely necessary to order a supply from
France at once.

The secretary recommended *that* the immediate construction of twenty feeder lamps and switches at Mr. Judd's factory, or elsewhere.

The reports, statements and recommendations of the secretary were received and ordered to be entered upon the minutes.

The secretary individually made the following proposition:

That if the members of the board desire to resume the position occupied by them previous to the meeting of March 20th, 1879, at which W. E. Sawyer's proposition to pay off the debts of the Co., etc., etc., was made and accepted, he (Mr. Sawyer) will co-operate with the other members of the board in bringing about that result upon the following basis:

First. W E. Sawyer to be reimbursed for all the moneys expended by him on his own account for the 6 weeks ending April 29th, amounting to $800.

Second. The company to pay him $3,500, and he will assign for the same $3,500 of his stock and scrip in the company, and this sum of $2,500 shall be for his salary as electrician of the Co. for one year.

Third. W. E. Sawyer to have the privilege of buying back the above $3,500 of stock and scrip within one year at par, and he will give his services to the Co. as electrician for the coming year without further consideration.

Fourth. A sale to be made of a sufficient amount of the scrip of the company now in the treasury to provide the sum of $2,500 to be used exclusively for the manufacture of lamps and to pay the expenses of their exhibition, over and above the existing debt of the Co. and other expenses, according to the intention of the secretary in making this proposition.

Fifth. W. E. Sawyer, as electrician of the company, to have exclusive charge and direction for one year of all work connected with the manufacture, charging and putting up of lamps, and all electrical work, subject only to the direction of the board of trustees.

955 Sixth. That an understanding be arrived at respecting the sale of rights, increasing the capital stock of the Co., and admission to the Co. of certain capitalists with whom W. E. Sawyer has been negotiating to carry out his proposition of March 20th.

It was understood by the secretary that decisive action is to be taken upon the foregoing proposition previous to the secretary's departure from New York on Tuesday night or Wednesday morning next.

On motion it was resolved that the secretary's proposition be entered upon the minutes and taken under consideration.

Adjourned to meet at the call of the president.

W. E. SAWYER, *Secretary.*

The regular monthly meeting of the board of trustees of the Electro-Dynamic Light Co. was held at the office of Classon & Hays, No. 11 Nassau St., on Tuesday, May 13th, 1879, at 3 o'clock p. m., present, Messrs. Albon Man, Lawrence Myers, Jas. P. Kernochan, Jacob Hays, and W. H. Hays, the president in the chair.

Mr. Myers was elected secretary *pro tem.*, and he reported that Mr. Hugh McCulloch desired him to act for him in his absence.

The reading of the minutes of the previous meeting was dispensed with.

The president reported that Mr. W. E. Sawyer believes that he can make an arrangement with Mr. Thomas Wallace, of Ansonia, Conn., to go on and build and sell the lamps of this Co. in lots of six lamps or less and to pay the Co. a royalty of three dollars per lamp.

On motion it was

Resolved, That Mr. Albon Man be reimbursed for a dynamo-electric machine purchased by him for the company.

956 The president reported that he had sold the Co.'s steam engine for $165, and odds and ends of no further use to the Co. for $30.69, and that he has stored the remainder of the property of the Co. in a store-room over his own office; that he has paid out bills against the Co., for which vouchers are rendered $86.98, leaving in the hands of the treasurer $108.71.

The president further reported that Man & Parsons, lawyers, will accept $250 in payment of their bill.

On motion, it was

Resolved, That Mr. Joseph Tait be paid $200 for keeping the books of the Co. for one year from July 15th, 1878.

Adjourned to meet at the same place on Wednesday, May 14th, 1879, at 2.45 p. m.

W. E. SAWYER, *Secretary.*

At an adjourned meeting of the board of trustees of the Electro-Dynamic Light Co., held at No. 11 Nassau St., on Wednesday, May 14th, 1879. Present: Messrs. Albon Man, W. H. Hays, Jacob Hays, Lawrence Myers, J. P. Kernochan and W. E. Sawyer. The president in the chair. The minutes of the meeting held April 26th, 1879, and of the meeting held May 13th, 1879, were read and approved.

Mr. W. E. Sawyer gave formal notice that he shall not carry out the proposition made by him on the 20th of March, 1879, relative to a reorganization of the company, and that he withdraws such proposition.

Adjourned to meet at the call of the president and secretary.

W. E. SAWYER, *Sec'y.*

At a special meeting of the board of trustees of the Electro-Dynamic Light Co., held at No. 11 Nassau St., on Tuesday, 957 May 20th, 1879. Present: Messrs. W. H. Hays, Jacob Hays, Lawrence Myers, Albon Man and W. E. Sawyer. The president in the chair.

The reading of the minutes of the previous meeting was dispensed with.

The president stated that the notice of the meeting had been sent to all of the trustees, and said:

"I hold in my hands and present to you, gentlemen, the resignation of Mr. Jas. P. Kernochan, as a trustee of this company."

The letter of resignation of Mr. Kernochan was read by the secretary, as follows:

(Copy.)

"To the president and trustees of the Electro-Dynamic Light Co.

"GENTLEMEN: I beg hereby to offer my resignation as a trustee of the Electro-Dynamic Light Co.

"And hoping that our company may meet with full success under the new organization.

"I am truly yours, JAS. P. KERNOCHAN.

"New York, 19 May, 1879."

On motion of Mr. Jacob Hays the resignation of Mr. Kernochan was accepted, and on further motion of Mr. Hays, Mr. Thomas Wallace was unanimously appointed a trustee of this company in place of Mr. James P. Kernochan, resigned.

Mr. Wallace being present the president formally notified him of his appointment, and Mr. Wallace accepted the position.

The president also presented the resignation of Mr. W. H. Hays as one of the trustees of the Co., and the letter of resignation was read as follows:

(Copy.)

"To the president and trustees of the Electro-Dynamic Light Co.

"GENTS: I beg hereby to offer my resignation as a trustee 958 of the Electro-Dynamic Light Co., & hoping that our company may meet with full success under the new organization.

"I am truly yours, W. H. HAYS.

"New York, May 19, '79."

On motion of Mr. Jacob Hays, the resignation of Mr. Wm. H. Hays was accepted.

On further motion of Mr. Jacob Hays, Mr. Uri T. Hungerford was unanimously appointed a trustee of this company in place of Mr. Wm. Hays, resigned; and the secretary was directed to notify Mr. Hungerford of his appointment.

The president then formally tendered his resignation as president of the company, while thanking the board for the courtesy and appreciation of his services uniformly shown him.

On motion of Mr. Jacob Hays, the resignation of Mr. Man as president was accepted; and Mr. Man having, before the acceptance of his resignation, appointed Messrs. Jacob Hays and W. E. Sawyer tellers to receive and count the ballots for his successor, balloting for a new president of the company was on motion proceeded with, and the tellers reported as follows:

For Mr. Thomas Wallace as president, four votes and one blank.

Mr. Wallace being then declared duly elected president of the company in place of Mr. Albon Man resigned, briefly thanked the gentlemen present and took the chair.

Mr. Man then said:

"Mr. President and gentlemen of the board of trustees, I hold a promissory note of Mr. Thomas Wallace for $5,000, given to the treasurer of the Electro-Dynamic Light Co in payment for scrip contributed by the former trustees of the company for the purpose of paying off the debts of the company. We have received this note with the understanding that it shall not be discounted or go out of the hands of the treasurer or his house, in some way, 959 so that Mr. Wallace can, at any time, take it up; but it is desired that the affairs of the company be closed up, and to that end I move that the treasurer be authorized to apply this note to the extinguishment of the debts of the company."

The president declared that such a course would be satisfactory to him, and on motion it was—

Resolved, That the note of Mr. Thomas Wallace for $5,000 be used for paying off the debts of the company.

Mr. Man then said:

"The question arises, gentlemen, in regard to going on with the manufacture of our lamps. I suppose that, in accordance with Mr. Sawyer's understanding, Mr. Thomas Wallace, or his house, proposes to go on and build a lot of these lamps and put them out experimentally."

The president said in reply:

"My idea of this matter was that the house that I am connected with—Wallace & Sons, who are fitted up for this electrical work—should add this lamp to the business they are already doing in this direction; that they should use their present machinery for manufacturing, and facilities for introducing this lamp as widely and generally as it is possible to do, and that the connection between that house and the company would be that they should pay for every lamp made and sold a royalty to this company. That will simplify the business of this company. It is simply to receive a royalty, have correct books of account kept and sworn statements made, and the royalties paid right into the company, and that is according to the understanding I had with Mr. Sawyer, and I presume it has been so understood. Mr. Sawyer asked me to look the matter over and I thought, myself, after looking the thing over carefully, that three dollars per lamp would be about the proper royalty to be paid. I should be satisfied to pay that royalty. I should be satisfied as a stockholder of this company and as a stockholder of Wallace & Sons."

On motion of Mr. Man it was then unanimously—

960 Resolved, That Wallace & Sons be authorized to build and put up the lamps and other apparatus of the company, paying to the company a royalty of three dollars per lamp for such lamps as they shall put up until some further and more positive arrangement can be made.

A bill of H. L. Judd & Co. of $60 for work and materials was presented, approved and ordered to be paid as soon as there shall be sufficient funds in the treasury.

Mr. Man then presented the resignation of Mr. Lawrence Myers as a trustee of this company, carrying with it his resignation as vice-president of the company, and the letter of resignation was read as follows:

(Copy.)

"New York, *May 19th*, 1879.

"To the president & trustees of the Electro-Dynamic Light Co.

"Gentlemen: I beg hereby to offer my resignation as a trustee of the Electro-Dynamic Light Co. & hoping that our company may meet with full success under the new organization.

"I am, truly yours, L. MYERS."

On motion of Mr. Jacob Hays the resignation of Mr. Myers was accepted, and on motion of Mr. Man

Mr. John B. Wallace was appointed a trustee of this company in place of Lawrence Myers, resigned.

The secretary was directed to notify Mr. Wallace of his appointment.

On motion of Mr. Man the board proceeded to the election of a vice-president to fill the vacancy occasioned by the resignation of Mr. Myers, and the tellers, Messrs. Hays and Sawyer, reported as follows:

That three votes had been cast for Albon Man and one blank, and Mr. Man was declared duly elected vice-president of the company.

961 Adjourned to meet at No. 11 Nassau St. on the second Tuesday of June next, at 3 o'clock p. m.

W. E. SAWYER, *Sec'y.*

The regular monthly meeting of the board of trustees of the Electro-Dy*m*amic Light Co. was held at No. 11 Nassau St. on Tuesday, June 10th, 1879, at 3 o'clock p. m. Present: Messrs. Thomas Wallace, Uri T. Hungerford, Albon Man, Jacob Hays and W. E. Sawyer. The president in the chair.

The reading of the minutes of the two previous meetings was dispensed with.

Mr. Dow, attorney for Messrs. Wallace & Sons, of Ansonia, Conn., presented and read the draft of a license between this company and Messrs. Wallace & Sons, and on motion, Messrs. Hugh McCulloch, Albon Man, Jacob Hays, Thomas Wallace and Uri T. Hungerford, were unanimously appointed a committee to draw up such a license as this company is willing to give Messrs. Wallace & Sons for the right to manufacture and sell lamps under the company's patent; and the vice-president, Mr. Albon Man, was unanimously authorized to sign such license on behalf of the company.

Adjourned.

E. W. SAWYER, *Sec'y.*

Defendant's counsel objects to the answer of the witness on the same grounds as stated in his objection to the question, and gives notice that before or at final hearing he will move to strike the same from the record.

Cross-examination closed.

HUGH R. GARDEN.

Sworn to before me this 12th day of March, 1889.

JOHN H. KITCHEN, *Examiner.*

962 WEDNESDAY, *March 13th*, 1889—11 a. m.

Met pursuant to adjournment.

Pursuant to written notice complainant's counsel produces the original letter written by William D. Baldwin to Thomas Wallace, president of the Electro-Dynamic Light Co., bearing date New York, January 8th, 1880.

It is stipulated by and between counsel that said original letter may be copied by the examiner upon his minutes, and that such copy may be used at the hearing of this cause with the same force and effect as the original letter.

The original letter to be produced at the hearing if the defendants shall require the same.

It is further stipulated and admitted by complainant's counsel that said original letter was written on the day of its date, to wit, January 8th, 1880, and that the same was at that time delivered into the custody of the Electro-Dynamic Light Company and in whose possession it has since remained.

It is also admitted that Thomas Wallace was the president of the Electro-Dynamic Light Co. prior to and on the 8th day of January, 1880.

The following is the letter referred to and is filed and marked Exhibit "Baldwin-Wallace Letter, January 8th, 1880:"

"NEW YORK, *January 8th*, 1880.

"To Thos. Wallace, pres't Electro-Dynamic Light Co.

"SIR: I have this day prepared an application for patent of the arch form of incandescent carbon electric lamp, made by William E. Sawyer and Albon Man as joint inventors, containing a request for the issuing of such patent to your company, and have prepared and hold for filing and record at Washington an assignment of the same to the Electro-Dynamic Light Company.

963 "I acknowledge myself to be the attorney in this matter of said company and subject in all things to its direction with power in them to revoke my authority at any time.

"The expenses and my charges are to be paid by Mr. Charles A. Cheever, who has in contemplation the purchase of said patent or the invention to which the application relates and no charges are to be made by me against your company, except for such services as may be rendered after Mr. Cheever shall have failed to make purchase and as shall have the approval of the company. I will not make any alteration in the claims or specification of said patent enlarging its scope beyond its intended purpose of covering the arched or angular form of the carbon used for incandescent electric lights.

"Yours truly, WM. D. BALDWIN."

Adjourned to 3 p. m.

3 p. m.—Adjourned by consent to Thursday, March 14th, 1889. at 10 o'clock a. m.

FRIDAY, *March 15th*, 1889—11 a. m.

Counsel for defendant offers and files in evidence stipulation made between counsel dated March 14th, 1889, marked Exhibit "Interference Stipulation," and requests that the same be copied on the minutes. The stipulation is as follows:

The complainants, by its counsel, hereby stipulates and consents that the defendant may introduce and file in evidence at or before the closing of its proofs in this suit, and as a part of said proofs the deposition of any witness examined in the interference (Sawyer & Man *vs.* Edison), with the right on the part of either party to recall any such witness for further examination or cross-examination, and also defendant may introduce and file in evidence in this 964 suit any exhibits contained in said interference record. Such depositions of witnesses to have same force and effect as if the witnesses had been regularly called, sworn and examined herein, and such exhibits to have same force and effect as originals properly proven, introduced and filed in this suit, subject to objection as to competency and materiality.

This stipulation to be without prejudice to the claim of the complainant that it has already well and sufficiently introduced the entire interference record in evidence, and that the same is now a legal part of the complainant's case herein.

Dated New York, March 14th, 1889.

THOMAS B. KERR,
For Complainant.
H. D. DONNELLY,
For Defendant.

Adjourned to March 15th, at 11 a. m.

N. Y., March 15th, 11 a. m.—Adjourned to March 18th, 11 a. m.

N. Y., March 18th, 1889, 11 a. m.—Adjourned to March 19th, at 2 p. m.

N. Y., March 19th, 2 p. m.—Adjourned to March 20th, 11 a. m.

N. Y., March 20th, 11 a. m.—Adjourned to March 21st, at 11 a. m.

Testimony in Edison vs. Sawyer-Mann Interference, Offered under Stipulation of March 14th, 1889.

MARTIN N. FORCE, a witness produced in behalf of Mr. Edison, being duly sworn, testified as follows in answer to questions proposed to him by GEORGE W. DYER, counsel for Edison:

1 Q. What is your residence and occupation; by whom are you employed, and how long have you been so employed?

965 A. My residence is Menlo Park, N. J. My occupation is assisting Mr. Edison in his experiments. I have been so employed since about 1875.

2 Q. What sort of work did you first do for Mr. Edison?

A. I did carpenter work.

3 Q. If you did any particular carpenter work for him in relation to the laboratory, please state what it was and when it was done?

A. I helped to erect the laboratory, putting up shelves in the same, and I did carpenter work at his pen factory; about in the fall of '75 and the spring of '76.

4 Q. If at any time you changed the nature of your *your* work for Mr. Edison, what new work did you enter upon, and when did you do so?

A. I was at the pen factory packing the pens, and some of the time I ran the engine. Then I went in the laboratory to assist in the laboratory, about the spring of '78. My duties were anything I was asked to do; assisting at making and charging batteries, cleaning the laboratory and such work. And since that time my work has been general in the laboratory, assisting wherever I was called upon.

5 Q. Please examine the paper now shown you, marked Edison's Exhibit No. 5; state whether the signature M. N. Force upon the same is your signature, and when was the same made?

Question objected to as going to show that the invention in question was made before the date alleged in the preliminary statement of Mr. Edison.

A. I have examined the paper; the signature is mine. It was made at the date of this paper, December 3d, 1877.

6 Q. Please look at exhibit, marked Edison's First Incandescent Lamp, and state whether you have seen the same before, and if so, when and where?

Same objection as to previous question.

966 A. I have looked at the instrument. I have seen it in the laboratory at Menlo Park. I have seen the instrument setting on the shelf at the upper part of the laboratory. I should say it was about three years ago, as near as I can remember.

7 Q. Have you assisted at any experiments in electric lighting with incandescent paper carbons or witnessed such experiments at Menlo Park? If so, state the earliest times of the same.

A. I assisted Mr. Batchelor about September or October, 1878, I don't exactly know which, to make some carbons. The carbons were rolled with a sort of a coating of tar, and carbonized in a crucible filled with charcoal or something of that description, and also carbonized in a combustion tube. As near as I can remember at that time they were put in the bell jar of a vacuum pump. The air was then exhausted, and an electric current passed through the carbon.

7½ Q. Please examine the paper now shown you marked Edison Exhibit No. 9. State whether or not the sketches on that paper represent the bell jar employed in the experiments you have related.

A. I have examined the Exhibit No. 9, and find it to be, as near as I can remember, a drawing of the vacuum pump which we used at that time.

Counsel for Edison gives notice that he here closes his examination-in-chief of this witness, and gives him over for cross-examination.

Cross-examination by AMOS BROADNAX, Esq., counsel for Sawyer and Man:

Counsel for Sawyer and Man gives notice that his cross-examination is not intended to waive any objection taken to the testimony.

8 X Q. Did you sign your name on this paper, Edison Exhibit No. 5, in presence of Mr. Edison and Mr. Batchelor?

A. Yes, sir.

967 9 X Q. Where were they?

A. In the laboratory, at Menlo Park.

10 X Q. Was it in the morning or in the evening?

A. In the evening.

11 X Q. Was it by gas-light or by daylight?

A. I don't exactly remember whether it was by gas-light or by daylight.

12 X Q. What was the object of making that paper?

A. As a record, I suppose, of the experiment.

13 X Q. What experiment?

A. The experiment shown on the paper.

14 X Q. In whose handwriting is this paper?

A. It looks like Mr. Edison's handwriting somewhat.

15 X Q. Did you see him write it?

A. I do not remember seeing him write it.

16 X Q. Can you swear that this is his handwriting?

A. No, sir; I wouldn't swear that it's his handwriting.

17 X Q. Can you swear that that paper was written December 3d, 1877?

A. No, sir; I wouldn't swear that it was written at that date, of course.

18 X Q. Can you swear that you signed your name on it on December 3d, 1877?

A. I can swear that that's my signature.

19 X Q. Can you swear that you made this signature on December 3d, 1877?

A. I made that signature at that time; yes, sir.

20 X Q. How do you fix the date of the making of that signature on that paper?

A. I have no particular way of fixing the date, but generally at the time an experiment is tried we always sign, and I never sign unless I see the experiment.

21 X Q. Did you witness the experiment referred to on that paper?

A. Yes, sir; I was there at the time, but I don't know the details of the experiment.

22 X Q. What was intended to be proved by the experiment?

A. I couldn't say what he intended to prove.

968 23 X Q. What did the experiment consist of? What did he do?

A. I don't remember. I can't give the details of the experiment.

24 X Q. How do you know that the experiment referred to on that paper was made on or about December 3d, 1877? What circumstance can you mention that was contemporaneous with that experiment?

A. I don't know that I have anything particular to call the same to my mind. I used to frequent the laboratory to see them experiment, but did not enter into the details of the experiments. There is no particular circumstance that I recall to my mind.

25 X Q. Did you see Mr. Edison make any experiments with the Exhibit Edison's First Incandescent Lamp?

A. No, sir; I don't remember seeing any.

26 X Q. You say you assisted Mr. Batchelor to make some carbons out of paper coated with tar. Did you mean to be understood as saying that the carbon you assisted Mr. Batchelor to make was in the form of a knitting needle?

A. The carbons that I assisted Mr. Batchelor to make were rolled by the hand, coated with tar, and in the form of a small cylinder.

27 X Q. How big were they?

A. They were different sizes. They may have been the size of a quill, or the size of a finger, or smaller.

28 X Q. How much smaller were they? Were any of them as small as an eighth of an inch in diameter?

A. I don't just remember the sizes, and couldn't say as to that. We didn't care particularly as to the size.

29 X Q. Can you state how long they were?

A. They may have been an inch, or two inches, or three inches.

30 X Q. How many of them did you make?

A. I would not say as to the number. There may have been ten, or there may have been fifty.

31 X Q. Did you see any of these carbons put in the vacuum chamber of the pump represented by Edison Exhibit No. 9?

969 A. Yes, sir; I think I saw those put in.

32 X Q. Are you sure you saw those carbons put in that chamber?

A. Yes, sir; in a chamber similar to this drawing.

33 X Q. How many did you see put in?

A. I don't just remember the number; I think there were more than one.

33½ X Q. Can you swear that there was more than two put in?

A. I wouldn't swear that there were more than two; there may have been. My memory don't serve me as to that point.

34 X Q. Was you present during the whole of the experiment?

A. I was present with Mr. Batchelor at the carbonizing and at the vacuum pump. I wouldn't say that I was always at that place, but I was usually present.

35 X Q. Did you work the vacuum pump?

A. Yes, sir; I used to do the pumping most of the time.

36 X Q. Did you see these carbons illuminated by the electric current in the vacuum chamber of the pump?

A. Yes, sir; I remember of seeing them lighted.

37 X Q. Did you see more than one of them lighted?

A. I don't say as to the number I have seen lit, but I remember seeing the carbons illuminated in that chamber.

38 X Q. Was there more than one pump in the vacuum chamber of which you saw these carbons placed and illuminated?

A. No, sir; there was only the one pump at that time.

39 X Q. Was there more than one carbon in the chamber at any one time?

A. I don't remember more than one at a time, but there may have been more.

40 X Q. Did the experiments last more than one day?

970 A. I would not say as to that. I don't remember how many days.

41 X Q. Who was present during these experiments besides yourself and Mr. Batchelor?

A. I think Mr. Edison was present. I don't call to mind any others.

42 X Q. Were the experiments continued more than two days?

A. I don't remember how many days. It may have been one or two, or perhaps a week.

43 X Q. Can you swear that these experiments continued for more than two days in the fall of 1878?

A. I would not swear that they were continued more than two days, although they may have been.

44 X Q. Can you swear that they were continued for two days?

A. I think, as near as I can remember, they were continued for that length of time.

45 X Q. When the carbons were illuminated by the electric current, how long did they last?

A. I would not say as to how long they lasted exactly.

46 X Q. Well, about how long?

A. As near as I can remember, they lasted probably a minute, or a couple of minutes, or five minutes.

47 X Q. These paper carbons about which you have been testifying, are they the first which you saw made at Menlo Park by Mr. Edison and Mr. Batchelor?

A. As near as I can remember, they were about the first.

48 X Q. And you are certain that that was in the fall of 1878?

A. Yes, sir; it was in September or October, 1878, to the best of my recollection.

MARTIN N. FORCE.

971 Edward H. Johnson, a witness produced in behalf of Mr. Edison, being duly sworn, testified as follows in answer to questions proposed by George W. Dyer, counsel for Edison:

1 Q. State your residence and occupation, and whether or not you are one of the assistants of Mr. Edison, and, if so, how long you have been with him in that capacity.

A. I reside in New York city. My occupation is that of a practical electrical engineer. I have been engaged for the past ten years in practically applying Mr. Edison's inventions in telegraphy, telephony, and now in the electric light, and in such capacity I have been his assistant, not directly employed in his laboratory until September last, but always with the parties who were putting Mr. Edison's inventions on the market. My relations with him and his work were such that I was a very frequent visitor at his laboratory.

2 Q. What, if anything, do you know of the experiments of Mr. Edison in the summer of 1876, in the carbonization of paper for various purposes?

Question objected to in so far as it applies to electric lighting, if it is intended to show that Mr. Edison carbonized paper for that purpose in 1876.

A. In the fall or winter of 1876 I sought to organize a small business for myself under the name of the American Novelty Company, the object of which was to acquire numerous inventions of Mr. Edison, Mr. Batchelor, Mr. Adams, my own, and others, and to put them upon the market. Several such were acquired, namely, Edison's duplicating ink, Edison's battery carbons, Edison's jeweller's engraving machines and others which I cannot now recall. The attempt to form a company to carry on such a business was practically a failure, owing to the lack of funds. I remember, in discussing with Mr. Edison at his laboratory, quite prominent 972 mention was made of numerous articles which he, Mr. Edison, was intending to manufacture of carbon. I cannot now recall all of them in detail, but they were such articles as dishes, small vessels, resistance coils, battery carbons, etc. I remember, on frequent occasions, seeing Mr. Edison carbonizing certain of these articles under pressure, that being the particular feature of the invention. In discussing the matter with Mr. Edison, Mr. Batchelor and Mr. Adams, they informed me that they purposed making such carbons of bituminous coal, paper and wood. My knowledge of the experiments was necessarily confined to information given me at the time by these gentlemen, as I was so occupied in New York that my visits to the laboratory were mainly for the purpose and with the object of consulting with Mr. Edison, and not in assisting him in his experimental work.

3 Q. At what date do you know, of your own knowledge, of Mr. Edison engaging in experiments in the electric light, with incandescent conductors made of paper carbon?

A. I fail to recall now the exact date when I first saw Mr. Edison's paper-carbon experiments.

4 Q. When was your first knowledge of Mr. Edison's experiments in electric lights?

A. In the summer of 1878, on his return from the Colorado scientific expedition, which he had accompanied for the purpose of endeavoring to measure the heat of the corona during the sun's eclipse, with the tasimeter, which he had invented. It is from this date that my recollection runs freely as to Mr. Edison's electric-light work. Prior to that, anything that he did did not sufficiently attract my attention to fix either the date or the experiment on my mind.

5 Q. Since the summer of 1878, what has been your knowledge with regard to persistent and continuous work on the part of Mr. Edison in incandescent electrical lights?

A. That Mr. Edison pursued experimentation in this direction uninterruptedly night and day, from that date to this, with 973 his customary energy and persistence, when fully started in a given direction for a given object.

6 Q. What is the earliest date within your recollection of the employment of paper-carbon conductors for incandescent electric lights by Mr. Edison?

A. I have a not well-defined recollection of witnessing certain experiments with paper carbons for this purpose in the winter of 1878–'79. In the summer of '79 I went to Europe, and saw nothing more of Mr. Edison's experiments until January, 1880, when I visited Mr. Edison's laboratory upon a mission from England, and there saw a large number of paper-carbon lamps in actual operation. I returned to England within a fortnight, taking six of the paper-carbon lamps with me, and did not again visit the laboratory until September 1st, 1880.

Counsel for Edison closes the examination-in-chief of this witness and offers him for cross-examination.

Cross-examination by AMOS BROADNAX, counsel for Sawyer and Man:

7 X Q. Please state your name and age, Mr. Johnson.

A. My name is Edward H. Johnson, and my age is 35 years.

8 X Q. Please to fix the date exactly when Mr. Edison returned from the scientific expedition organized to observe the sun's eclipse.

A. I can't fix that date from memory.

9 X Q. Have you any memoranda to which you can refer by which you can fix the date?

A. Not to my knowledge. I do not make it a rule to preserve memoranda or papers of any description.

10 X Q. You say, in answer to question 4 of your examination-in-chief, that the first knowledge you had of Mr. Edison's experiments in electric lights was in the summer of 1878, after his return from the scientific expedition to which I have referred. 974 Please to state whether you derived that knowledge from others or whether you witnessed those experiments yourself.

A. I witnessed numerous experiments myself.

11 X Q. These experiments that you say you witnessed yourself, were they made immediately upon his return from the scientific expedition referred to?

A. I cannot now recollect whether they were or were not.

12 X Q. State how long after his return you witnessed these experiments, as nearly as you can recollect.

A. I am unable to do that, being wholly without other guide to my recollection than my memory that it was immediately upon his return that he began active experimentation on the electric light.

13 X Q. These experiments that you say you witnessed, is your recollection of them sufficiently distinct to enable you to describe them? If so, please do so.

A. No, sir; it is not. I only remember the fact of frequently seeing Mr. Edison and his assistants occupied with them. My interest was not enlisted, and I did not particularly examine into or investigate this branch of the laboratory work.

14 X Q. In answer to question 6 of your examination-in-chief you say you have "a not well-defined recollection of witnessing certain experiments with paper carbons for this purpose in the winter of 1878–'79." Please to state whether your recollection of the experiments referred to by you in that answer is distinct enough to enable you to describe them, and if so, please describe them?

A. My recollection is of seeing a feeble light, and of Mr. Edison remarking that here might grow out something from the American Novelty Company experiments. I cannot say what his exact words were, but this is the purport of them; nor can I describe otherwise the light that was shown.

15 X Q. How often did you witness experiments made by Mr. Edison in incandescent electric lighting with carbonized paper in the winter of 1878–'79?

975 A. I cannot say positively that such experiments as I saw were upon the incandescent principle at all, my recollection of these experiments being too indefinite to enable me to describe either the principle or the method of its application.

16 X Q. State, if you please, when you first saw this exhibit, Edison's First Incandescent Lamp.

A. It is impossible for me to state when I first saw it. Mr. Edison showed me his light on more than one occasion in its earlier stages. I have no recollection of the shape or design of the lamp referred to in your question.

17 X Q. State, if you know, when it was that Mr. Edison invented and made the tasimeter to which you have referred for measuring the heat of the corona of the sun during the expedition to Colorado.

A. I cannot fix the date other than that it was during the time of his telephone experimentation, the tasimeter being an invention coincident with the telephone. It was some time during the latter half of the year '77 or early part of the year '78. This is my best recollection.

EDW'D H. JOHNSON.

John Kruesi, a witness produced in behalf of Mr. Edison, being duly sworn, testified as follows, in answer to questions proposed to him by George W. Dyer, counsel for Edison:

1 Q. State your age, residence and occupation.

A. Age, 38; residence, Menlo Park, N. J.; I am a machinist, at present engaged in the electric tube works at 65 Washington street, New York, as manager.

2 Q. State how long you have been connected with Mr. Edison, and in what capacity?

A. For nearly nine years. About five years as machinist and four years as foreman of the machine shop.

976 3 Q. Please look at the paper which I now hand you, marked Edison's Exhibit No. 4, and state whether the signature J. Kruesi, upon the same, is your own handwriting and when it was made.

Question objected to as immaterial.

A I have examined the paper. The signature is my own handwriting. I think it was made about the time the paper is dated. That is November, 1877.

3 Q. Have you any doubt upon that point?

A. I have no reason to be doubtful about it, but I don't remember when I signed it.

4 Q. What was your habit or practice about signing similar papers?

Objected to as not competent. The question is as to when he signed this paper.

A. I generally signed them within a few days after they were written, or after the instrument was made.

5 Q. What is the earliest date which you remember of Mr. Edison experimenting with electric lights?

A. I am not sure whether it was the summer of '77 or summer of '78.

6 Q. What is the earliest date you remember of his experimenting with paper carbons for electric lights?

A. I don't remember the date when he began. When he experimented with paper carbon was in 1877, but I don't know what the paper carbons were for.

Counsel for Edison here closes his examination-in-chief of this witness, and submits him to counsel for Sawyer & Man for cross-examination.

Cross-examination by AMOS BROADNAX, counsel for Sawyer & Man:

7 X Q. What experiments did you see Mr. Edison make with paper carbons in 1877?

A. I don't remember any experiments.

977 8 X Q. Was you foreman of Mr. Edison's machine shop and his laboratory, and generally of his mechanical works at Menlo Park?

A. Yes, sir.

9 X Q. When did you commence to be foreman and when did you cease to be foreman?

A. I commenced in December of 1877, and ceased to be foreman in February, 1881.

10 X Q. Do you recollect seeing Mr. Edison make any experiments in electric lighting with carbonized paper during the time that you was foreman?

A. Yes, sir.

11 X Q. When did you first witness such an experiment?

A. The earliest I remember was in 1879.

12 X Q. What time was it in 1879?

A. I think it was in summer.

13 X Q. What was the experiment?

A. Paper-carbon horseshoe, substantially like this in Exhibit Edison's Commercial Incandescent Electric Lamp.

14 X Q. Do you recollect seeing Mr. Edison experiment with carbonized paper in this lamp marked Edison's Exhibit First Incandescent Lamp?

A. I do not recollect it.

15 X Q. State where you first saw that lamp?

A. In Newark, N. J.

16 X Q. When?

A. Before we moved to Menlo Park.

17 X Q. What was it used for?

A. It is used with an air pump for experiments.

18 X Q. Have you seen the lamp frequently since?

A. No.

19 X Q. Did you ever see it in the laboratory at Menlo Park?

A. I recollect to have seen it at Menlo Park; yes, sir.

20 X Q. Whereabouts did you see it in Menlo Park—in the laboratory?

A. Yes; in that building which we call the laboratory.

978 21 X Q. Whereabouts was it kept in the laboratory?

A. I don't know that it ever had a certain place.

22 X Q. Was it in plain sight most of the time?

A. Yes, sir; I think so. Everything was in plain sight. There was nothing stowed away.

23 X Q. During the time that you was machinist, and before you became foreman, was you frequently and constantly going in and out of the laboratory as a workman?

A. Yes, sir.

24 X Q. And the same is true during the time that you was foreman?

A. Yes, sir.

25 X Q. Did you put these binding posts on this lamp, Edison's first incandescent lamp?

A. No; I did not put them on personally.

26 X Q. Did you see them put on?

A. No; I do not recollect.

27 X Q. Do you know who put them on?

A. No; I do not recollect who put them on.

28 X Q. Do you know when they were put on?

A. No.

29 X Q. Who did you have in the machine shop at Menlo Park that done that kind of work during the time that you was machinest there?

A. I had several workmen at that kind of work.

30 X Q. Please to give the names of those workmen, and where they are now?

A. Rudolph Heuse, who is dead. Echron, I don't know where he is. I think his first name was Albert, but am not quite sure. Baer was the name of another. I don't remember his first name, and I don't know where he is.

31 X Q. Referring now to Edison's Exhibit No. 4, do you know in whose handwriting it is?

A. Yes, I recognize it as Mr. Edison's own handwriting.

32 X Q. When was it written?

A. I think previous to that date there, or at the time of that date.

979 33 X Q. Do you know of your own knowledge that it was written then?

A. No, I do not.

34 X Q. Have you a distinct recollection of the experiments referred to by this paper?

A. No, sir.

35 X Q. Have you such a recollection of them as to enable you to state when they were made?

A. No.

36 X Q. At the time you signed this paper, was that piece torn out between your name and Mr. Batchelor?

A. I do not recollect, but I don't think so.

37 X Q. Do you recollect whether anybody else's name was signed between yours and Mr. Batchelor's?

A. I do not recollect.

Cross-examination ended.

Re-examination by George W. Dyer, counsel for Edison:

38 X Q. How early do you remember seeing the lamp, Edison's Exhibit First Incandescent Lamp, with the binding posts on it, and the clamps inside of it?

A. I couldn't state the date. I recollect the lamp from general appearance.

JOHN KRUESI.

Francis R. Upton, a witness produced in behalf of Mr. Edison, being duly sworn, testifies as follows in answer to questions proposed to him by George W. Dyer, counsel for Edison:

1 Q. Please state your age, residence and occupation.

A. Age, 28; residence, Menlo Park, N. J.; occupation, manufacturer of electric lamps.

980 2 Q. State whether at any time you went into the employment of Mr. Edison, and what your duties were.

A. I entered the employment of Mr. Edison about November, 1878. I can fix the date exactly by reference to my accounts, and will do so. My first occupation was making a search through the records of electric lighting in the Astor library. When this was completed to Mr. Edison's satisfaction I entered his employ at Menlo Park to assist him in making calculations.

3 Q. What special training or acquirements had you for making such calculations?

A. Before entering college, and while in college, I gave special attention to the mathematical branches. After leaving college I studied two years under Professor Brackett, of Princeton, learning how to use physical apparatus, and becoming proficient in algebra and calculus. After that I spent one year in Berlin in the laboratory of Professor Helmholz.

4 Q. Please state now the particular branches connected with the electric light which come under your immediate supervision after entering the employment of Mr. Edison?

A. In the first place I made such calculations as were in my power regarding the electrical conditions necessary in a system of electric lighting in answer to questions asked by Mr. Edison, as for instance, I have the memorandum December 15, 1878, this problem given to me when I first came into the laboratory: "Example No. 1, 100 lamps, 10,000 ohms," (diagram shows lamps in *in* multiple arc); "100 lamps, 1 ohm" (diagram shows lamps in series). "How much heat in each lamp? Heat=C^2 R. Ans. The same." This problem is an example of the work I had to do. Besides calculations I assisted Mr. Edison in experimenting, translating and keeping records.

5 Q. At the time of entering into the direct employment of Mr. Edison in the latter part of 1878, what, if anything, was he doing in experimenting and perfecting electric lighting?

A. He was experimenting with the platinum spiral lamp
981 with a thermal regulator. I remember helping to measure
the expansion of the heated spiral of platinum. Besides this Mr. Edison was making an extended series of experiments to find the laws of magnetism. He was also studying publications referring to constructions of dynamo machines.

6 Q. I wish to call your attention to experiments connected with determining the laws of resistance as applied to carbons, particularly those made of paper, and the mechanism and apparatus essential for the production of incandescent electric lighting.

Objected to by counsel for Sawyer & Man as impertinent.

A. Mr. Edison had me calculate the size and weight of cables necessary to carry the current to a certain number of lamps of given resistance (my impression is 100 ohms) at various distances from the machine, so that a certain per cent. of the energy in the circuit could be used in the lamps. He also had me construct tables, showing the joint resistance of a number of lamps in multiple arc. Mr. Edison concluded that to make a successful electric lamp it should have in the neighborhood of 100 ohms resistence. He tried a large number of devices for obtaining this resistance from metal wire. At the same time he was carrying on experiments with the telephone. In the course of these experiments with the telephone threads of carbon were made. He had these tested for resistance and found them very high. This suggested to him the possibility of successfully making high resistance carbon lamps. He, with the assistance of Mr. Batchelor, made a large number of lamps with carbon filaments. At that time my attention was more particularly drawn to the vacuum pumps, and the construction of dynamo machines. I was employed in testing the efficiency of Mr. Edison's machine, and did not follow all the experiments that led to the paper loop. I recollect when one

982 of the first successful loops was made. Francis Jehl and I measured the resistance, cold, of the carbon My recollection is that it was about 140 ohms. The carbon was burnt for a number of hours and again tested, and no change found in its resistance. This was repeated several times, burning and testing, until the lamp gave out. I remember that we all felt very much elated at the fact of the carbon not changing its resistance, for it showed that there was no wasting away of the carbon. We then felt that it was possible to make a system of the electric lighting, simply by adding to the life of the lamp, which we have since done.

7 Q. Of what material were the threads or filaments of carbon made, referred to in your previous answer?

A. My impression is, from ordinary sewing cotton. I recollect that Mr. Batchelor procured from the Clark thread works special samples of cotton thread afterward.

8 Q. When did you know of Mr. Edison's experiments on conductors made of carbonized paper?

A. I can only recollect now the finished loop, as mentioned in a previous answer.

9 Q. When, to the best of your recollection, did Mr. Edison determine the prerequisite of high resistance for a successful incandescent electric light?

A. Early in 1879.

10 Q. How early was his attention turned to the production of more perfect dynamo machines?

A. He was experimenting on them before I entered his employ.

11 Q. When, so far as you know, did Mr. Edison turn his attention to improved means for producing a vacuum in electric lamps.

A. The first recollection that I have is when he sent me to Princeton to borrow a Geissler pump. I can't fix the date now, but may be able to do so.

12 Q. Did you at any time, under Mr. Edison's direction, experiment on improved means for producing a vacuum in incandescent lamps, and if so, at what time?

983 A. By his wish I commenced to learn to blow glass. Not succeeding at this, he advertised for a competent glass-blower, and the first glass-blower was a German from New York, and then a young man by the name of Boehm. I worked with these, helping to the best of my ability, in making pumps for producing a vacuum in incandescent lamps. Before September 16th, 1879, pumps had been made that worked satisfactorily.

13 Q. At the time these means of producing vacuum had been determined, had resistance of carbon filaments been determined?

A. I cannot recollect.

14 Q. At this same time had the dynamo machines been satisfactorily perfected?

A. They were perfect enough to make us sure that if a lamp of sufficiently high resistance could be made, it could be used successfully in a system of electric lighting.

15 Q. At what date did Mr. Edison produce an incandescent electric lamp fit to compete commercially with gas?

Counsel for Sawyer & Man objects to the question as immaterial.

A. To the best of my recollection it was in November, 1879, when the stable resistance of a paper-carbon loop was determined.

16 Q. At that time was the system worked out, and the various forms of apparatus essential to carry it into successful use?

Objected to as immaterial.

A. Yes.

17 Q. From the date of your employment by Mr. Edison have you labored constantly and incessantly under his direction in the perfection and production of incandescent lights and the apparatus necessary to make them available?

A. With the exception of about two weeks; yes.

18 Q. When did Mr. Edison first produce for public exhibition his incandescent electric lamps with paper-carbon conductors?

984 A. The next day after the publication of the article in the New York "Herald," which I find here, marked Edison Exhibit No. 2, dated December 21, 1879.

19 Q. Please look at the lamp now shown you, which is marked "Exhibit Edison's Commercial Incandescent Electric Lamp." State whether that represents the character of lamp referred to in your previous answer?

A. Yes.

20 Q. State, if you please, about the extent and kind of use made then and afterwards with that kind of lamp.

A. Wires had been run in the laboratory building. In connection with these chandeliers had been placed so that the light from the lamps could be used while experimenting. Lamp posts were placed on the road to the depot. My impression is that this was all done before December 21st. The dynamo machines were in place. Mr. Edison was waiting for his foreign patents to be issued, I understood, at the time. Wires were also run to my house and to Mr. Edison's house; in one case using a special line of poles, in the other the Western Union poles. The light was used in the hall and two rooms of my house, for all ordinary purposes, and while tests were being made burned continually and without interruption for several weeks, from dark until ten or eleven o'clock. There were, I think, from sixty to over one hundred lamps in the circuit. While the public exhibitions were given my duty was to watch the dynamo machines to see that no harm was done them, and to explain to visitors their working and the working of the light. I had a lamp hung over my dining-room table, which we used regularly to eat by at night. I remember having a dinner party, with one lamp hung over the table giving sufficient light. This was all done within three weeks after that publication.

21 Q. State, if you please, whether the data relating to these lamps were put in your charge. If so, about what time was it?

985 A. Mr. Batchelor started the book giving the hours burned of the lamps. The record of the lamps, I notice, is in Mr. Batchelor's handwriting until January 5th, 1880. After that

time a young man named Herrick kept the record. I helped him at various intervals while he was keeping the record, examining into the accuracy of his records, and checking his figures. The record was kept for Mr. Edison, who wished to know the life of the lamps. If the lamps were scattered it required constant watching to make the record exact. The machines were run during the day and night. When Herrick was absent a slip was left for him giving the number of hours which the machines ran. If any lamp broke notice was given him as soon as discovered. All the lamps were numbered, so that they could be recognized. The record I refer to is that from which Edison Exhibit No. 3 is taken.

22 Q. When did you begin to manufacture lamps especially adapted for incandescent electric lights?

Question objected to as utterly immaterial.

A. About November, 1879.

23 Q. From an examination of the record of lamps before referred to, can you state about the average life of the lamp used in the latter part of 1879 and the early part of 1880 at Menlo Park?

Question objected to as immaterial.

A. I think that so much of the record as is printed is a fair statement, though it does not give several lamps that burnt an exceptionally long time For example, one on the lamp post at the corner of Mr. Thornall's barn, which burnt from 1,400 to 1,500 hours. I recollect this lamp distinctly as giving a bright light. I recollect examining it to see if the number was on it. I have a tabular statement of the life of these lamps, which I will endeavor to find and put in evidence.

24 Q. Did all these lamps about which you have just testified have carbon conductors made from paper?

A. Yes.

986 25 Q. Have you continued the manufacture of such lamps since?

A. Yes.

26 Q. What do you know of the sale to and use by other parties of such lamps—I mean electric lamps with paper-carbon conductors?

A. The steamship "Columbia" was fitted out in May of 1880, I think, with about 150 of these lamps. An exhibition was given while the steamer was at the dock in New York, lighting the saloon and a number of state-rooms.

27 Q. Was any publication made by you about the last of December, 1879, or early part of January, 1880, about the state of perfection at that time of Mr. Edison's inventions in incandescent electric lamps?

A. I wrote an article about that time which was published in "Scribner's Monthly" for February, 1880. This article is a full description of Mr. Edison's labors to that date.

Article produced, put in evidence and marked Edison's Exhibit No. 10.

The exhibit is objected to on behalf of Sawyer & Man as incompetent, irrelevant and immaterial, and not legal evidence in any sense.

28 Q. Mr. Man, in his testimony in this interference, speaks of using "principally ordinary blotting paper" for incandescent conductors for electric lamps. Have you had any experience in the carbonization of ordinary blotting paper; if so, with what results?

A. I have had some experience. Carbons made from blotting paper are easily broken and not as durable as carbons made from compressed paper.

29 Q. Mr. Man further testifies in the same interference of "rubbing down and working out by hand the carbons." Have you had any experience in this kind of manipulation of paper carbons?

A. I have never tried the process mentioned. I should judge it to be extremely difficult.

987 30 Q. Referring to the answer to cross-question 67 on page 18 of the printed testimony of Albon Man, what office would be filled by the interior conductor coated in the manner described?

A. I should say that the paper loop is mostly useful for mechanically holding the solutions with which it is said to be treated, and that the larger portion of the current would be carried by the carbon from the substances with which the loop is treated, so that the greater portion of the light would be given by them. The looser and more porous the paper the less will it carry the current and give the light from itself.

31 Q. I call your attention to your answer to question 23, and ask if Edison's Exhibit No. 3 gives a correct statement of the life of the lamps therein recorded as not destroyed, and ask you to supplement the history of the lamps which were not destroyed, so as to show their full duration.

A. So far as it goes it is correct, but on examining the records I find that the lamps are continued in another book, for example, lamp No. 159 is continued in Book No. 74, copying the original record and carrying the record to January 30th, 1880. The lamp is shown to have a life of 683 hours and 45 minutes.

Lamp 223, which is copied on page 3, burned 367 hours and 17 minutes.

Lamp 155 is recorded as burning 562 hours, 14 minutes; 201 is recorded as burning 638 hours. Lamp 164 is recorded as having burned 640 hours, 14 minutes. Lamp 172 is recorded as burning 638 hours and 14 minutes. I find these memoranda on pages 1 and 2, page 5, 7 and 8, 9 and 10, 11 and 12, pages 13 and 14, respectively.

Counsel for Edison tenders the above record book for examination to counsel for Sawyer & Man, and puts in evidence copies of the pages above named, the same being marked Edison's Exhibit No. 11.

988 Counsel for Sawyer & Man objects to the exhibit as an incomplete copy of the record referred to, and as impertinent, the copy being no evidence unless the record itself is put in.

32 Q. Have you read the printed record of the testimony of Messrs. Sawyer & Man in this interference?

A. The larger portion of it.

33 Q. Where a paper-carbon conductor built up in the manner described by Sawyer & Man in their testimony is used in an electric lamp, what special function as regards incandescence is exerted by the paper-carbon portion of such conductor?

A. As a mechanical support for holding the solutions with which the carbon is built up.

34 Q. Would not materials other than paper carbon serve for such a support?

A. Yes; asbestos, for instance, in the cases where they dip the loop into solutions; or fiber of any description.

35 Q. I wish you would examine the answer of William E. Sawyer to the 18th question, and the statement about candle power, duration of burners, fracture, &c., and state what results would follow from the various conditions named in his answer.

A. I should judge from the surface of the lamp in Sawyer's Exhibit No. 4, and from the thickness of the carbon, that it might be possible for a lamp to last, giving twenty-five candles, for the time mentioned. The surface, I should think, is twice as great as that in Exhibit Edison's Commercial Incandescent Electric Lamp. Since the economy of a lamp is inversely as the surface, it would take more power to obtain the same light from the Sawyer, as from the Edison. At the same time the thickness of the carbon is so great that it should also last much longer than the Edison carbon. The resistance of the carbon shown in the drawing must be in the neighborhood of 1 ohm at the most. This, in my opinion, renders the lamp totally uncommercial owing to the enormous loss there must be from conduction through the clamps. For example, the Edison carbon having 100 ohms and the clamp 1 ohm, only $\frac{1}{101}$ of 989 all the energy used by the lamp will be lost in the clamp, while in the lamp, Sawyer's Exhibit No. 4, if the clamp has a resistance of 1 ohm, the same as in the Edison, one-half of the total energy used in the lamp will be lost in the clamps. Besides this, the increase of the size of the carbon allows more heat to be conducted from it to the clamps. As a result, I should judge it would be impossible to seal the lamp unless some device were used to dissipate this heat, making the lamp very large and clumsy.

36 Q. Referring now to the description and sketches given in the printed record of Sawyer & Man's testimony, of the perfected lamp made by them, state whether in your opinion such a lamp would be a practical lamp, and give your reasons?

A. I do not think that it is a practical lamp. The first objection is on account of its low resistance, as stated in the previous answer. Besides the heat at the clamps, owing to the large currents that would have to be employed to give out sufficient energy for light from a small resistance, there would be a great deal of trouble in making the clamp last, as the tendency for arcs to spring between the clamp and the carbon would be so greatly increased.

I do not consider it possible to make such a lamp and hermetically seal it in a glass case, preventing any air from reaching it. Unless this is done, a carbon lamp blackens the globe that surrounds it very quickly. Judging from my experience with nitrogen placed in the globe around a lamp, it would be extremely difficult for a carbon to give the same light continuously for a number of hours. I tried for over a week at one time to make a carbon, composed of paper only, burn in an atmosphere of nitrogen, without success.

I took every precaution that Mr. Edison and his chemist, Dr. Moses, suggested to make the nitrogen pure. The experiment was carried on in the bell jar of an air pump. The air was exhausted from the bell jar, and nitrogen drawn in. Then again exhausted, and nitrogen again drawn in. I made the nitrogen, holding it in large bags, then, before drawing it in, the bell jar was dried
990 and passed over hot copper filings. With loops made of paper only, no light could be made. I should also say, that the lamp, Sawyer's Exhibit No. 4, if filled with nitrogen would soon lose it, if lighted many times. When lighted, the gas inside the globe will be expanded, thrusting out the nitrogen. When cold, the outside air will be drawn in to replace the nitrogen. Judging from the style of the lamp, I should say that the gas would be very much compressed when the lamp was lighted, owing to the great amount of heat evolved in a small chamber.

Counsel for Edison gives notice that he here closes his examination of this witness, and offers him to counsel for Sawyer & Man for cross-examination.

Cross-examination by Amos Broadnax, counsel for Sawyer & Man:

37 X Q. What is your name?

A. Francis R. Upton.

38 X Q. Have you fixed the exact date, by reference to your accounts, when you went into the employ of Mr. Edison?

A. November 15, 1878.

39 X Q. Have you been continually in his employ from that time to this?

A. Yes, to the first of January, 1881, when I became superintendent at the lamp factory of which he is chief owner.

40 X Q. Where is the lamp factory of which he is the chief owner; and what kind of lamps are manufactured there?

A. The factory is situated at Menlo Park; and the lamps are those suitable for his system of electric lighting.

41 X Q. Are the lamps that are manufactured at that factory substantially like the lamp Exhibit Edison's Commercial Incandescent Electric Lamp?

A. Yes, with the exception that bamboo is used in a large 991 number on account of the ease of manipulating it, instead of paper, for the illuminating conductor.

42 X Q. Which makes the best carbon for electric lighting by incandescence, paper or bamboo?

A. Bamboo.

43 X Q. How is bamboo superior to paper for that purpose?

A. On account of the difficulty of procuring paper of even thickness, and because the fibres of bamboo are continuous in the direction in which the current flows.

44 X Q. How does the resistance of an illuminating conductor made of bamboo compare with the resistance of a similar conductor made of paper?

A. The resistance of the bamboo is slightly less than that of paper.

45 X Q. Is the difference in the resistance of the two carbons sufficient to affect the practical working of the lamp?

A. No.

46 X Q. Then, for all practical purposes, in this respect they are the same?

A. Yes, in so far as their illuminating properties are concerned.

47 X Q. What proportion of the lamps manufactured by you are fitted with illuminating conductors made of carbonized paper?

A. One to two per cent., I should judge.

48 X Q. In preparing your carbons for electric lamps, do you treat them electrically in the presence of hydrocarbon gas?

A. No.

49 X Q. What training have you had as an electrician?

A. A college course of electricity, the handling of electrical apparatus in the physical laboratory at Princeton, and one year's work at electrical measurements of various kinds at Berlin before entering Mr. Edison's employ; since I have been with Mr. Edison I have made calculations concerning electrical matters, 992 and assisted in a large number of electrical experiments.

50 X Q. Do you consider yourself an expert in the practical application of electricity in electric lighting?

A. So far as relates to the incandescent electric light, I do.

51 X Q. Before you went in the employ of Mr. Edison, were you acquainted with him?

A. I had met him once in a visit to his laboratory.

52 X Q. In answer to question 5 you say when you went into the employ of Mr. Edison he was experimenting with the platinum spiral lamp with a thermal regulator, and was making an extended series of experiments to find the laws of magnetism, and was also studying publications relating to constructions of dynamo machines. How long did Mr. Edison continue on those experiments, and in studying publications referring to constructions of dynamo machines?

A. Up to the present time, I should say; of course, with intermissions, giving time for his experiments to be carried out.

53 X Q. Does Mr. Edison still continue in his experiments upon the platinum spiral lamps with thermal regulators?

A. Yes; through his assistants.

54 X Q. I read your answer to question 6 of your examination-in-chief (counsel reads): Please to state when it was that he tested the thread of carbon made in his telephone experiments for the purpose of ascertaining its resistance, referred to in the answer I read?

A. My impression is that it was in August or September, 1879; that is the best of my recollection.

55 X Q. In answer to that question you say: "I recollect when one of the first successful loops was made; Francis Jehl and I measured the resistance, cold, of the carbon." State, as nearly as you can recollect, when it was that you and Francis Jehl measured the resistance of the paper-carbon loop, referred to in that answer?

993 A. To the best of my recollection, in November, 1879.

56 X Q. You say, in answer to the same question, that your attention was more particularly drawn to the vacuum pumps, and to the construction of dynamo machines. State, if you please, when it was that you succeeded in getting a pump by which you could obtain a satisfactory vacuum in the illuminating chamber of your lamps?

A. To the best of my recollection, in July, 1879.

57 X Q. In answer to that same question, you also say: "I remember that we all felt very much elated at the fact of the carbon not changing its resistance, for it showed that there was no wasting away of the carbon; we then felt that it was possible to make a system of electric lighting simply by adding to the life of the lamp, which we have since done." State, if you please, in what way you have since added to the life of the lamp?

A. First, by making better clamps for the carbon, so as to hold the carbon firmly, and prevent arcing. Secondly, by making better carbons. Third, by improved methods of getting the vacuum, so as to be sure that all the lamps are well exhausted, even when the workman is not expert.

58 X Q. In answer to question 11 you say the first recollection you have of Mr. Edison turning his attention to improved means for producing a vacuum in electric lamps was when he sent you to Princeton to borrow a Geissler pump. Have you been able to fix the date exactly when that was?

A. I have not. I looked last night but could find no record by which I could fix the date exactly.

59 X Q. Was it after you went to Princeton to borrow the pump, that you came to New York to advertise for a glass-blower for Mr. Edison, as stated in answer to question 12?

A. I did not advertise; but it was after that that Mr. Edison advertised for a competent glass-blower.

60 X Q. State, if you recollect in what paper it was that that advertisement was inserted?

994 A. My impression is, the "Herald."

61 X Q. Give the date as near as you can recollect?

A. It was in the summer of 1879. I can't fix the date.

62 X Q. How often did Mr. Edison advertise for glass-blowers;

and state whether all the advertisements were subsequent to the time that you borrowed the pump at Princeton?

A. My impression is twice. All the advertisements were subsequent.

63 X Q. This lamp referred to by you as being at the corner of Mr. Thornall's barn, as burning from fourteen to one thousand five hundred hours—what was the luminosity of that lamp in candle power?

A. I should judge from twelve to sixteen candles.

64 X Q. How long would such a lamp last, in your judgment, yielding a luminosity of twenty-five candle power?

A. From four hundred to six hundred hours.

65 X Q. What, in your judgment, would be the average life of the lamps referred to in the record, about which you have been testifying, yielding a luminosity of twenty-five candle power?

A. As the lamps were then made, when not very good, they would arc at high candle power, excepting these, I should say from 100 to 200 hours.

66 X Q. Do you mean to be understood as saying, if the plan of the lamp was skillfully carried out in its construction and organization, it would endure from one to two hundred hours at a luminosity of twenty-five candle power—referring of course to the lamps noted in the record?

A. I do.

66½ X Q. Have you ever tried any of your lamps like Exhibit Edison's Commercial Incandescent Electric Lamp, raised to a luminosity of twenty-five candle power?

A. We never have at that point. We have tried above and below, and my judgment is as stated.

995 67 X Q. At what luminosity have you tested the candle power of the lamp referred to in my last question?

A. At forty-eight candles.

68 X Q. How long did the carbon endure at a luminosity of forty-eight candle power?

A. My impression is somewhere in the neighborhood of fifteen hours.

69 X Q. What size was the carbon?

A. Substantially the same as that in the Exhibit Edison's Commercial Incandescent Lamp.

70 X Q. In answer to question 27 you say that you wrote the article contained in "Scribner's Monthly" for February, 1880, marked Edison Exhibit No. 10; are the statements of facts contained in that article true, of your own knowledge?

A. So far as I was able to verify them they were.

71 X Q. At the head of that article I find the following statement: "Editor 'Scribner's Monthly,' dear sir, I have read the paper by Mr. Francis Upton, and it is the first correct and authoritative account of my invention of the electric light. Yours truly, Thomas A. Edison, Menlo Park, N. J." Was that written by Mr. Edison?

A. It was, at the suggestion of the editors of "Scribner's Monthly."

The fac-simile of the letter as written by Mr. Edison is published in the fore part of this book.

72 X Q. Did Mr Edison revise this article before it was published?

A. He revised portions of it.

73 X Q. Did he read the whole of it before it was published?

A. I cannot say. I think he did not read the historical part.

74 X Q. Which one of the patents granted to Sawyer & Man is "for a stick of carbon rendered incandescent in nitrogen"?

A. In answer to the question I refer to the patent 205,144.

996 75 X Q. Now, please to point out the claim in that patent that is "for a stick of carbon rendered incandescent in nitrogen"?

A. Claim 16 is the one that I referred to more especially, which reads: "In the sealed globe of an electric lamp which contains an azotic or other atmosphere, an absorbent of carbonic acid gas," together with the following in the body of the specification, "To charge our lamp we prefer to employ nitrogen gas, and this we produce in the lamp by our improved process in a state of great purity."

76 X Q. Now, after reading the claim and the extract from the specification, don't you think your statement in your magazine article is too broad?

A. Not in a mere brief summary of the history of electric lighting, as is purported to be given in the article.

77 X Q. Do you swear that the statement in the magazine article of the Sawyer & Man patent is an accurate statement of the facts as they appear in the patent?

A. The patent itself is the best evidence of what it contains. If what I stated is right it can be verified from the patent.

FRANCIS R. UPTON.

Mr. KRUESI recalled:

39 Q. I asked you in questions 5, "What is the earliest date which you remember of Mr. Edison's experimenting with electric lights?" To which you answered, "I am not sure whether it was the summer of '77 or summer of '78." Please state whether you have made such examination of memorandum books since giving the above answer, as will enable you to fix the time more definitely.

Objected to on the ground that it is a re-examination of the witness on a point about which he had already been examined.

997 JOHN KRUESI, a witness produced in behalf of Mr. Edison, testifies on oath as follows, in answer to questions proposed by GEORGE W. DYER, counsel for Edison:

40 Q. Have you been previously examined in this case?

A. Yes.

41 Q. Since your former examination have you found a memorandum book which enables you to fix with certainty dates about which you were uncertain when you testified before?

Question objected to upon the ground that it is intended to call out matter and facts about which the witness has been already examined.

A. Yes, sir.

42 Q. Refreshing your memory by such memorandum book, what is the earliest date you are able to fix in which Mr. Edison was engaged in experimenting upon electric lights?

Objected to as immaterial.

A. January the 5th, 1877.

43 Q. If you have such memorandum book, please produce it and describe what the book is?

Objected to as immaterial and impertinent.

A. I do produce the book. The book is a memorandum book in which I put the time down for which I requested pay, showing how the time, or in what the time was occupied.

44 Q. Is this book in your own handwriting?

A. Yes, sir.

45 Q. Were the entries made at the time marked in the book?

A. They were always made never later than the next following Saturday, and generally every day; sometimes even three or four times in one day.

998 46. Q. Please read from the book the items which bear upon experiments in electric lights by Mr. Edison, giving the dates which appear in the book?

Objected to as incompetent to prove the contents of the book, unless the book is put in evidence.

A. "January 5th, 1877, electric lamp, 3 hours," "January 6th, 1877, electric lamp, 4 hours." "1877, January 20, air pump, 8 hours."

47 Q. For what purpose was the work done on this air pump under date of January 20th?

A. To my best recollection for an electric-light purpose.

Memorandum book referred to put in evidence and marked Edison's Exhibit No. 12.

Exhibit objected to as incompetent evidence upon any issue in the cause.

Counsel for Edison gives notice that — here concludes his examination of this witness and offers him to counsel for Sawyer & Man for cross-examination.

Cross-examination by AMOS BROADNAX, counsel for Sawyer and Man:

48 X Q. Is this book in your handwriting, the whole of it?

A. Yes; I don't see anything that isn't my own handwriting.

49 X Q. In whose employ were you when you made this memorandum book?

A. In Mr. Thomas A. Edison's.

50 X Q. And does this book show the time that you was at work on different kinds of work for Mr. Edison?

A. Yes, sir.

51 X Q. Where was you working from June the 13th, 1876, to January 2d, 1877?

A. I was working for Mr. Edison in Newark, N. J.

999 52 X Q. Are all the entries in this book made in lead pencil?

A. All except a few entries in the last four leaves of the book, and three entries in October, 1875.

53 X Q. Referring now to the entries in this book made on the page beginning with January 2d, 1877—do you swear that the entries on that page are all in your own handwriting, and that they were made by you on the day of the date set down in the left-hand column of the page?

A. Yes, I am positive that they are all in my own handwriting, and that they are put down not later than the next following Saturday to these respective dates, or on the same day that they are dated.

54 X Q. Does the column of figures on this page headed particular jobs represent the number of hours you were employed each day upon the job mentioned in the middle columns, in which the name of the job is given?

A. Yes, sir.

55 X Q. Does this represent your own time, and not the time of somebody else?

A. It is only my own time.

56 X Q. By this book it appears that January 5th you worked three hours on electric lamps. What kind of electric lamp was you working on, and what was you doing to it during those three hours?

A. I do not remember the lamp, nor exactly what I did to it.

57 X Q. Is the same true as to the work it appears that you done on electric lamp on January 6th—4 hours?

A. Yes, sir.

58 X Q. Is this your book?

A. Yes, sir.

59 X Q. Your own private property?

A. Yes, sir.

60 X Q. Has it been in your possession ever since it was made?

A. It has been in my possession ever since I made the entries.

1000 61 X Q. Why didn't you refer to this book and produce it when you was previously examined in this case?

A. I was called to this examination from my place of business in the city of New York, and the book I kept in my house at Menlo Park, New Jersey. Therefore I did not have it at hand.

62 X Q. Have you got any more books bearing upon this subject?

A. Yes, sir. I have some more, but to my knowledge they do not bear upon this subject.

63 X Q. How does it happen that there are no entries in this book from June 13, '76, to January 2d, '77?

A. The entries may be in another book, on account of the dissolving of partnership between Mr. Edison and Mr. Murray at that time.

JOHN KRUESI.

STEPHEN D. FIELD, a witness produced in behalf of Mr. Edison, being duly sworn, testifies as follows, in answer to questions proposed to him by GEORGE W. DYER, counsel for Edison:

1 Q. Please state your name, age, residence and occupation.,

A. Stephen Dudley Field; 35 years old; residence, New York; occupation, electrical engineer.

2 Q. Please state whether or not you visited Mr. Edison at Menlo Park, in 1877, and if so, at what time during that year.

A. I visited Mr. Edison's place during the summer of 1877. To the best of my recollection it was the middle or latter part of the month of August.

3 Q. When at Menlo Park, at the time named, did you see Mr. Edison perform any experiments in incandescent electric lighting, and if so, please state what the experiments were?

1001 Question objected to as going to prove that the invention was made before the date alleged in the preliminary statement of Mr. Edison, and notice of motion to strike it out at the hearing.

A. I went there at Mr. Edison's invitation to witness experiments in incandescent lighting. The experiment consisted in the heating, by means of a bichromate battery, of small crystals, of what Mr. Edison called silicon, said crystals being supported between carbon clamps.

4 Q. Please examine exhibits marked Edison's Exhibits No. 4 and No. 13, already in testimony in this case, and state whether or not these exhibits indicate substantially the character of the experiments which you then witnessed.

Objected to as immaterial and incompetent. Notice of motion to strike out.

A. The experiments which I witnessed are indicated in figures 1 and 2 of Exhibit 4, and the middle and lower figures of Exhibit No. 13. The exception being that the source of power in the experiments was a bichromate battery in place of magneto machines, as shown in the exhibit.

5 Q. During that visit to Mr. Edison, did he explain to you what he had previously done in incandescent electric lighting, and if so, what explanation or information did he give?

Same objection and same notice.

A. My recollection is that he stated that this use of silicon he hoped would give him an inoxidizable agent for a burner, and thereby greatly simplify the problem of incandescent lighting.

Beyond that I have no recollection of any conversation between us, except he referred to a note book which he showed me, wherein he had first discovered the incandescent properties of silicon.

1002 6 Q. Do you recollect whether or not Mr. Edison spoke of materials for incandescent conductors, which had been previously tried by him and found to be oxidizable?

Same objection and same notice.

A. My recollection is that we had a general conversation on the subject, the details of which have, however, almost entirely escaped my memory.

7 Q. Who was present during these experiments you have mentioned, besides yourself and Mr. Edison?

Same objection.

A. Dr. Cornelius Herz, now in Paris, and Mr. Batchelor, I believe, and one or two of Mr. Edison's assistants.

Counsel for Edison gives notice that he here closes his examination of this witness, and offers him for cross-examination.

No cross-examination.

STEPHEN D. FIELD.

THOMAS B. STILLMAN, a witness produced in behalf of Mr. Edison, being duly sworn, testifies as follows, in answer to questions proposed by GEORGE W. DYER, counsel for Edison:

1 Q. Please state your name, age, residence and occupation?

A. Thomas B. Stillman; 29 years old; residence, Plainfield, N. J.; occupation, analytical chemist and assayer.

2 Q. Please state whether or not you are acquainted with William E. Sawyer, the electrician.

A. I am.

1003 3 Q. Please examine the paper I now show you, marked Edison's Exhibit No. 8, and state whether or not you read the same soon after its publication in the newspapers?

Objected to as immaterial.

A. I have examined the paper shown me; I read it; it might have been one month, but not later than three months after its publication.

4 Q. Did you ever hear William E. Sawyer speak of the authorship of that article, marked Edison's Exhibit No. 8?

Same objection.

A. I have.

5 Q. How often have you heard him so speak?

A. Once, certainly; and I think twice.

6 Q. Repeat what he said as nearly as you can remember it.

Objected to as incompetent and immaterial.

A. I can't state what he said; he called my attention to the article, and asked me if I had read it. I said "No." I then read it.

7 Q. How did he speak of it—as his article?

Objected to as leading.

A. I can't say that he did. My impression is he said "my challenge."

8 Q. Do you remember what he said when he asked you to read the article?

A. I don't recollect any more than what I have said, positively.

9 Q. Have you heard the article referred to in his presence as his article?

Objected to as incompetent.

A. Not in those words as coming from him, but the impression derived from what he said led me to think he wrote the article.

1004 10 Q. Have you heard the article referred to in his presence, as his challenge, or as Sawyer's challenge to Edison?

Objected to as incompetent.

A. Not by other parties, but when Mr. Sawyer drew my attention to it as his challenge.

11 Q. Are you acquainted with Mr. William E. Sawyer's signature?

A. Yes, sir.

12 Q. Please examine the paper now shown you, state whether or not the signature, W. E. Sawyer, is in the handwriting of William E. Sawyer?

Objected to as incompetent.

A. I think it is—yes, sir.

13 Q. Have you any papers in your possession in the handwriting of William E. Sawyer, containing his signature?

Objected to as incompetent and immaterial.

A. I have.

14 Q. Please produce the same?

Same objection.

A. I produce a note sent to me by William E. Sawyer.

The paper first mentioned is put in evidence and is marked Edison's Exhibit No. 23.

Exhibit 23 objected to as not being shown to be in the handwriting of Mr. Sawyer, or caused to have been written by him, and as not being produced by the person to whom it is addressed; and as incompetent, irrelevant and immaterial.

Second paper referred to, being a note to the witness, is put in evidence and marked Edison's Exhibit No. 24.

1005 Objected to as incompetent, irrelevant and immaterial.

15 Q. Please state if you find the newspaper article put in evidence, and marked Edison's Exhibit No. 23, published in the New York "Sun" of January 5, 1880?

Objected to as incompetent, irrelevant and immaterial; and upon the further ground that there is no proof that the paper put in evidence was January 5, 1880.

A. I find it published in the paper dated on that date—January 5, 1880.

16 Q. Also is the paper now shown you, the same extract cut out of the newspaper?

A. Yes.

Extract referred to put in evidence and marked Edison's Exhibit No. 25.

Objected to as incompetent and no proof of anything except its own existence.

17 Q. Were you subpœnaed as a witness in this case for Mr. Edison?

A. I was.

Counsel for Edison here closes his examination of this witness and offers him for cross-examination.

Cross-examination by Amos Broadnax, Esq., counsel for Sawyer & Man:

1 X Q. When was this paper marked Exhibit 24 written?

A. I can't give the date of it.

2 X Q. How do you know this paper is in the handwriting of Mr. Sawyer?

A. It is the same handwriting I have always seen him use.

1006 3 X Q. How often have you seen him write, if at all?

A. A number of times; I can't state exactly how many.

4 X Q. About how many?

A. I couldn't state about how many; I have been connected with him nearly three years.

5 X Q. Can you swear that you saw Mr. Sawyer write ten times in these three years?

A. Yes, sir.

6 X Q. And use the same handwriting every time?

A. Yes, sir; with one exception—when he couldn't see.

7 X Q. Did you see him write when he couldn't see?

A. I did not. He had injured his eyes by an explosion. I had a note written from him when his eyes were in that condition, where he stated that fact. That note was in a different handwriting.

8 X Q. In whose handwriting is this paper—Edison Exhibit 23?

A. I don't know; it looks like Sawyer's uncle's—Leonard Sawyer.

9 X Q. Did you see Mr. Sawyer sign this paper?

A. No, sir.

10 X Q. It's not in the handwriting of Mr. Sawyer, is it?

A. No, sir.

11 X Q. Do you know whether Mr. Sawyer read it or heard it read after it was written?

A. I do not.

12 X Q. Do you know whether he dictated it?

A. I do not.

13 X Q. Is this the paper Mr. Sawyer referred to as his challenge to Mr. Edison?

A. No, sir; the paper he referred to as his challenge to Mr. Edison is Edison's Exhibit No. 8.

14 X Q. Do you know who wrote this paper—Exhibit No. 8?

A. No, sir.

THOS. B. STILLMAN.

1007 WILLIAM SAWYER, a witness produced in behalf of Mr. Edison, being duly sworn, testified as follows, in answer to questions proposed to him by GEORGE W. DYER, counsel for Edison:

1 Q. Please state your name, age, residence, and occupation.

A. Name, William Sawyer; age, 59; present location, Earle's hotel; occupation, gentleman, as near as I can act one.

2 Q. Are you the father of William E. Sawyer, the electrician?

A. Yes.

3 Q. Please examine the paper now shown you which is marked Edison's Exhibit No. 8, and state whether you read the same soon after the date of its publication.

Objected to as incompetent, irrelevant, and immaterial.

A. I think I read that, about the time of its publication. I couldn't swear positively that this is the same thing, but think it is virtually the same. It was a challenge.

4 Q. Did you ever hear your son, William E. Sawyer, deny being the author of this challenge?

A. No, sir; nor I never heard him acknowledge it.

Latter part of the answer objected to by counsel for Edison as not responsive.

5 Q. Have you not stated within a week that your son, William E. Sawyer, wrote this challenge before referred to?

Objected to as incompetent.

A. I may have made that remark. I couldn't say that I did not. I have no recollection of making that remark, neither will I say that this is the challenge, shown me, that he wrote.

1008 6 Q. Have not you stated within a week that you went into a certain place and found your son dictating this challenge to a messenger boy?

Objected to as also being incompetent.

A. Emphatically, no. I may have stated that I understood that he did dictate to a messenger boy, and the messenger boy wrote it down as it came from his lips, but not from my personal knowledge. It was hearsay.

7 Q. From whom did you understand that William E. Sawyer dictated that challenge to a messenger boy?

A. I couldn't tell; not within my recollection.

8 Q. Did you ever hear this challenge talked over in the presence of William E. Sawyer?

A. No, sir; to the best of my recollection, I never heard the subject-matter talked over in his presence, either with myself or any other parties.

9 Q. Have you not stated within a week that you advised your son William E. Sawyer that he ought not to have published the challenge referred to, or so advised him at the time the challenge was being dictated?

Objected to as leading and immaterial.

A. I do not recollect of doing so.

10 Q. At what place did you understand this challenge, so called, was dictated?

A. According to the best of my recollection he was boarding at 200 West Forty-second street, at the time of this publication.

11 Q. I do not ask where he was boarding, but where, as you understand it, he was when this challenge was dictated?

Question objected to as calling for hearsay evidence, and upon the further ground that the witness has not stated that he understood the challenge to be dictated at all.

1009 A. I have answered this question before. He may, however, have been boarding at 267 instead of 200 West Forty-second street. My present impression is that it was dictated either at 200 or 267 West Forty-second street. I would not state positively to either place, as I have no means of fixing it.

12 Q. Have you not stated within a week that that challenge was dictated at the corner of Walker and Elm streets?

Objected to as grossly leading and immaterial.

A. I have no recollection of it.

13 Q. Have you any recollection of talking with any one whatever about this challenge within a week?

A. I have no recollection of it.

14 Q. You stated conversationally, a moment ago, did you not, that you were very much annoyed when you read this challenge in the newspapers?

Objected to as leading and immaterial.

A. I did so state confidentially to Mr. Dyer.

15 Q. Had you any doubt at the time of reading this challenge that it proceeded from your son, William E. Sawyer?

Objected to as leading and immaterial, as to what his opinion was, or doubts upon the subject.

A. Of course, I took it for granted, as all others would, the communication being over his signature.

16 Q. Were you subpœnaed as a witness in this interference?

A. Yes.

Counsel for Edison closes his examination of this witness, and turns him over for cross-examination.

1010 Cross-examination by AMOS BROADNAX, Esq., counsel for Sawyer and Man:

17 X Q. Do you know of your own knowledge, whether your son, William E. Sawyer, wrote or dictated this article, cut from a newspaper, and marked Edison's Exhibit No. 8?

A. No.

WM. SAWYER.

JAMES A. RUSSELL, a witness produced in behalf of Mr. Edison, being duly sworn, testifies as follows in answer to questions proposed to him by GEORGE W. DYER, counsel for Edison:

1 Q. Please state your name, age, residence and occupation.

A. Residence 347 West Thirty-sixth street, New York; I am a canvasser for the Edison Electric Light Company; my name is James A. Russell, and I am 44 years of age.

2 Q. State whether or not you know Mr. William Sawyer, who has just testified as a witness in this case and in this room?

Objected to as immaterial.

A. Yes; I know him.

3 Q. State whether or not you have heard Mr. William Sawyer lately make any statements regarding the authorship of a newspaper challenge published in the New York "Sun," December 22d, 1879, marked Edison's Exhibit No. 8, and if so, when and where were such statements made, and what was the statement?

Objected to as calling for mere hearsay testimony, at second or third hand, and after the witness, William Sawyer, has testified that he really didn't know anything about it.

1011 A. On Sunday last at Earle's hotel, talking with Mr. Potter. Mr. Potter had a conversation with him about a man named William Sharpe, who had formerly been in the employ of William E. Sawyer. Mr. Potter said he would like to hire him as he was an expert mechanic. He said he wanted to hire him for a gentleman friend of his in Reading, Pennsylvania. This man wanted him to do some very fine work. That was his object in calling on Mr. Sawyer.

Mr. Sawyer said: "Do you know how that article was written?" He said: "Ed. was drunk, and it was written by a District telegraph boy at his dictation, and he told Ed. he had made a mistake," and Ed. says, "I've done it, I've done it. They can't answer it." I don't know that he said he was drunk, but that he was a little off.

4 Q. What article was referred to in the last part of your answer?

A. The challenge, Edison's Exhibit No. 8. I want to add to my last answer that Mr. Sawyer said, "Ed. slings a nasty pen, and talks too much."

Counsel for Edison closes his examination of this witness and offers him for cross-examination.

Cross-examination by Amos Broadnax, Esq., counsel for Sawyer and Man:

5 X Q. At the time you overheard this conversation which you have related in your examination-in-chief, did Mr. Potter show Mr. Sawyer this exhibit?

A. No.

6 X Q. How did he identify the article?

A. He mentioned the fact that the article was written in the "Sun" just before Christmas.

7 X Q. Did he say that he saw his son dictate the article?

A. Yes.

8 X Q. How did you come to go there?

1012 A. I went to H. Dralle, 93 Walker street, and he told me that William Sawyer, Sr., could give me all the information.

9 X Q. What did you want of Mr. Sharpe?

A. I wanted some excuse to have an interview with Mr. Sawyer.

10 X Q. And the object of your interview, as I understand you, was to see what you could suck out of him about this matter.

A. Not to suck out of him, but to obtain anything I could that would benefit my employers.

JAMES A. RUSSELL.

James D. Potter, a witness, produced in behalf of Mr. Edison, testifies as follows, in answer to questions proposed to him by George W. Dyer, counsel for Edison:

1 Q. Please state your name, age, residence and occupation?

A. James D. Potter; age 57; residence, 390 Manhattan avenue, Brooklyn; I am engaged in mining.

2 Q. Are you acquainted with William Sawyer, who has just testified in this case and in this room?

A. I am acquainted with the gentleman who calls himself William Sawyer. I have just come in this building and did not see Mr. Sawyer here.

3 Q. Have you had a conversation with William Sawyer lately about the authorship of an article called a challenge, published in the New York "Sun," December 22d, 1879, marked Edison's Exhibit No. 8, and if so, when and where did you have this conversation, and if anybody was present besides yourself and Mr. Sawyer, state who was present?

Question objected to as calling for mere hearsay testimony, as contradicting the statement made by one of Mr. Edison's own witnesses.

A. It was on Sunday, July 17th, at 2 o'clock, at Earle's hotel; Mr. James A. Russell was present.

1013 4 Q. Please state what Mr. Sawyer said in regard to the authorship of the article referred to in the former question?

A. We had a conversation in regard to a man named William Sharpe, desiring to know his locality, as I wished to hire him for a gentleman in Reading. He informed me where Sharpe could be found; said he was at Ansonia, Connecticut, employed by the Wallace Manufacturing Company. Then the conversation drifted off to electricity. He said, "Ed. was one of the best electricians in the United States." I told him I had read many articles of his son's about electricity, electric light, etc. He said, "Did you read that challenge in December, '79?" I said, "Yes, sir;" and also said "that never was answered." He replied, "He couldn't answer it." He then said, "Do you know how that was written—under what circumstances?" I said, "No, I do not." He said, "I'll tell you. Ed. got a telegraph boy to write it." He said "he was pretty full," or "he was drunk;" one or both expressions. "While he was dictating it he would fall asleep or dose off. He would wake up and ask, 'Where did I leave off? What did I say last?' The boy wrote the article, and that was the way he wrote it. He was writing the article when Sawyer came in. He said to him, 'Ed., do you think you're doing right?' He said, 'Yes, I've done it, I've done it. They can't answer it.'"

Examination ended. No cross-examination,

JAMES D. POTTER.

James E. O'Keeffe, a witness, produced in behalf of Mr. Edison, testifies as follows in answer to questions proposed by George W. Dyer, counsel for Edison:

1 Q. Please state your name, age, residence and occupation?

1014 A. James E. O'Keeffe of 65 Monroe street, New York; office boy to the Aldine Publishing Company; age, 15.

2 Q. What were you doing before you went in the office of the Aldine Publishing Company?

A. Working in E. Daly's boat shop.

3 Q. Where before that?

A. With Matthew, Leach & Co.'s wholesale and retail tea store.

4 Q. Were you ever in the employ of the American District Telegraph Company. If so, when and where?

A. In the 15th district, from May, 1879, until February, 1880.

5 Q. Look at this newspaper article I show you which is marked Edison's Exhibit No. 8, and state what you know, if anything about that article?

A. I remember hearing him speak about a challenge, and there was words in it that I couldn't spell and he told me how to spell them—big words.

6 Q. Did you write that article from anybody's dictation?

A. Yes, sir.

7 Q. When was it; and where was it?

A. In Dralle's lager-beer saloon, corner of Elm and Walker streets, in December, 1879, on Sunday morning.

8 Q. What did you do with the article after you wrote it from dictation?

A. I handed it back to Mr. Sawyer.

9 Q. Then what did you do with it?

A. He put it in an envelope, and I went up to the Sun office.

10 Q. Did you leave the paper at the Sun office?

A. Yes, sir; and I brought back an answer.

Counsel for Edison closes his examination-in-chief of this witness, and gives him over for cross-examination.

Cross-examination by AMOS BROADNAX, counsel for Sawyer and Man:

11 X Q. Was the article you wrote from Mr. Sawyer's dictation printed in the "Sun"?

1015 A. I don't know; I didn't see it.

12 X Q. Can you produce the paper that you wrote from Mr. Sawyer's dictation?

A. No, sir.

13 X Q. When did you read that paper—Edison's Exhibit 8?

A. To-day.

14 X Q. Is that the first you read it since you wrote it from Mr. Sawyer's dictation?

A. Yes, sir.

15 X Q. Now, can you swear that this paper, Exhibit 8, is a copy of the paper that Mr. Sawyer dictated to you, as you have stated?

A. I can't say that it's all, but I know some of it is.

16 X Q. After the paper was printed, did you compare the printed paper with the paper you say you wrote from Mr. Sawyer's dictation?

A. No, sir.

17 X Q. Have you ever seen the paper that you wrote from Mr. Sawyer's dictation, and that you took to the Sun office, since you took it to the Sun office?

A. No, sir.

18 X Q. What was the answer that you brought back from the Sun office?

A. I don't know; Mr. Sawyer didn't receive the answer, but the man behind the bar. Mr. Sawyer was upstairs.

19 X Q. Was Mr. Sawyer drunk when he dictated the paper to you?

A. He acted like it.

Redirect examination by Mr. GEORGE W. DYER, counsel for Edison:

20 Q. Have you ever written any other paper from dictation for anybody else?

A. Yes, sir; once before; for a man down in New street.

JAMES E. O'KEEFFE.

1016 Present: Amos Broadnax, counsel for Sawyer & Man, and Geo. W. Dyer, counsel for Edison.

Francis R. Upton, a witness produced on behalf of Edison, being duly sworn, testifies as follows in answer to questions proposed by George W. Dyer, counsel for Edison:

1 Q. You have already testified in this case, haven't you?

A. Yes.

2 Q. Do you know Alexander Welsh, who has testified in this case as a witness for Sawyer & Man?

A. Yes.

3 Q. When did you first become acquainted with him?

A I first met him in the fall of 1880.

4 Q. Under what circumstances?

A. He was employed in the lamp factory, and I came in contact with him in my visits to that place; the Edison lamp factory at Menlo Park was referred to.

5 Q. How long did Welsh work at the lamp factory at Menlo Park?

A. Until about February, 1882.

6 Q. What was his employment when he first worked at the lamp factory?

A. My impression is he was employed in exhausting the lamps.

7 Q. Do you know how long it was after that he began to work at carbonizing?

A. He commenced carbonizing about February, 1881.

8 Q. Did he commence then to learn the business of carbonizing?

1017 A. He had some slight acquaintance of the methods used from seeing the process carried on. When he commenced at this time, he was instructed specially in this branch and gave his whole time to it.

9 Q. Were his instructions confined to Mr. Edison's methods of carbonizing?

A. As far as I know, they were.

10 Q. Was there any time he was given full charge or the carbonizing, and if so, about what time was that?

A. From the time he was employed in carbonizing until he was discharged, he was given full charge of the carbonizing.

11 Q. Do you remember the time when he was thus employed in the carbonizing?

A. From February, 1881, till February, 1882, is my recollection.

12 Q. Why was Alexander Welsh discharged?

A. Because we had lost confidence in him.

13 Q. For what reason?

A. When he was placed in charge of the carbonizing it was expressly mentioned that he should report experiments truthfully. We were satisfied he was not doing so; this lack of truthfulness had become a by-word in our factory.

14 Q. Since he was discharged what has been his attitude towards

the Edison Electric Light Company, and the interests of Mr. Edison?

A. Most of the time active opposition.

15 Q. What instances, if any, can you give of active opposition?

A. It has come to my knowledge several times that he was employed in trying to get workmen in the Edison interests, away to other companies.

16 Q. Mr. Welsh in his testimony says that you made promises which you failed to fulfill, which led in consequence to a very bad feeling between us; this was an answer to X Q 105. Have you anything to say in regard to this statement of Mr. Welsh?

A. I have absolutely no recollection of any unfilled promises to
Mr. Welsh. I had no bad feeling towards him, except that
1018 I had been provoked by finding out how grossly he had
abused the opportunities that were given him.

17 Q. Mr. Welsh says in his redirect testimony, in answer to questions 116 and 117, that he has since been solicited to return to the employ of Mr. Edison by yourself. Have you anything to say as to that?

A. After his discharge from the lamp factory I was desirous of preventing him from carrying information gained by him, at the employ of the lamp factory to opposition companies. I recommended him to the superintendent of the Isolated Company, as a bright man, at the same time cautioning him regarding his habit of untruthfulness.

18 Q. Do you know Robert White, a witness who has testified in this case in behalf of Sawyer and Man?

A. I do.

19 Q. Did he work at the lamp factory at Menlo Park, and, if so, in what capacity?

A. He worked there as fireman in carbonizing.

20 Q. About what time did he leave the lamp factory and under what circumstances?

A. He was discharged at the same time as Welsh.

21 Q. Why was he discharged?

A. Because we did not think it prudent to discharge Welsh and leave his intimate friend behind.

22 Q. Mr. Welsh testifies that he made certain exhibits of paper carbon on a morning in July, 1881, between about 7:15 and a quarter to 8, and that it was necessary to complete them at that hour because the train left at eight (8) for New York, and Robert White testifies that you were present during a portion of the time when such exhibits were being made. What recollection have you as to the facts thus testified about?

A. I have no distinct recollection of being present at the time mentioned. I am very positive that there was no train at eight for New York.

24 Q. What hour nearest that time did the train run?
1019 A. At 7.30, within a very few minutes; the next train
after was 9.20.

24 Q. Robert White testifies that in that carbonization you threw

water upon the carbonizing box to hasten the cooling of it. What do you say to that statement?

A. I do not recollect doing anything of the kind.

25 Q. He testifies further that you then carried away the specimens of carbonized paper for the purposes, Mr. Welsh informed him, of giving them to Mr. Chas. Batchelor at the depot. What have you to say to that statement?

A. I can't recollect so doing.

26 Q. Do you remember the fact that at the time Mr. Batchelor testified in this case, in July, 1881, he produced specimens of carbonized paper purporting to have been made in the manner described by Mr. Man and Mr. Sawyer in their previous testimony in this case?

A. I have been informed that he did so.

27 Q. Have you any knowledge or information who made those exhibits produced by Mr. Batchelor, and where they were made, and during what time of the day?

A. I have always understood that he (Mr. Batchelor) made them himself, assisted by Mr. Atcheson, the night before he testified regarding them, and that they were made in the laboratory at Menlo Park.

28 Q. Was the laboratory a distinct building from the lamp factory, and, if so, about what distance from it?

A. It was entirely distinct and separated from the lamp factory by a distance of about 1,500 feet. The lamp factory was at the foot of the hill, the laboratory on top. Men employed in one were not allowed in the other, except on business.

29 Q. Were you present during the time when Mr. Alexander Welsh gave his evidence in this case?

A. I was most of the time.

30 Q. Were you present when Alexander Welsh produced and
put in evidence samples of carbonized paper purporting to
1020 have been made in accordance with descriptions in the former testimony of Mr. Man and Mr. Sawyer?

A. I was.

31 Q. Did you examine such specimens at the time sufficiently to form an opinion upon them?

A. I did.

32 Q. What opinion did you then form of them, as adapted to practical use, in incandescent electric lamps?

A. I formed a very decided opinion that for practical use in incandescent electric lamps they would prove an utter failure. First, in manufacturing lamps the breakage in clamping such loops would be so great as to preclude their use in competition with materials now ordinarily used. Secondly, owing to the irregularity of the carbon they, if it were possible to bring them to incandescence, would be so irregular as to shorten their life very materially. Third, owing to their extreme lack of elasticity it would be almost impossible to transport lamps if such could be made.

33 Q. In the first reason given in the previous answer what would cause the breakage in clamping referred to in that answer?

A. In clamping carbons it is necessary to handle them and to hold them firmly. From my experience I should judge there would be great liability of breakage in either of these operations. The cause of it would be the friable nature of the carbon. I scarcely dared touch the exhibits for fear of breaking them.

FRANCIS R. UPTON.

1021 Same counsel being present, and PHILIP S. DYER being duly sworn, is produced as a witness in behalf of Thomas A. Edison, and answers to the questions propounded to him as follows:

1 Q. Please give your name, age, residence and occupation.

A. Name, Philip S. Dyer; age, 26; residence, East Newark, N. J.; employed as book-keeper for the Edison lamp factory.

2 Q. How long have you been in the employ of the Edison lamp factory as book-keeper?

A. Since January 1st, 1881.

3 Q. Do you know Alexander Welsh, who has testified as a witness in this case in behalf of Sawyer and Man?

A. Yes.

4 Q. Was he at any time in the employ of the Edison Lamp Company at Menlo Park?

A. Yes, sir.

5 Q. When did he enter such employ?

A. About October 1st, 1880.

6 Q. When did he take charge of carbonizing?

A. About the latter part of January, 1881.

7 Q. When did he leave the employ of the Edison Lamp Company?

A. Latter part of January, 1882; discharged.

8 Q. Why was he discharged, if you know?

A. Considered untrustworthy and unreliable.

9 Q. Do you know what his reputation for veracity was among the employees of the company?

A. Very bad.

10 Q. Do you know Robert White, who testified as a witness in this case for Sawyer and Man?

A. I do.

11 Q. Do you know when he was employed by the Edison Lamp Company at Menlo Park?

A. Yes, sir.

1022 12 Q. What date was it?

A. Middle of April, 1881.

13 Q. When did he leave the employ of the Edison Lamp Company, and why?

A. In the latter part of January, 1882; discharged because he was considered unreliable and a friend of Alexander Welsh.

14 Q. What do you know about Mr. Alexander Welsh having attempted to entice away men from the Edison Lamp Company after he had been discharged by them?

A. I know of a conversation he had with one man and know of a telegram he sent to another man, and that man told me Welsh was trying to get him.

Answer objected to as mere hearsay.

Cross-examination by AMOS BROADNAX, counsel for Sawyer and Man:

15 X Q. What was in the telegram?

A. Welsh wanted this man to meet him in Brooklyn on a certain night.

16 X Q. What was the man's name?

A. Robert McKune.

17 X Q. When was that?

A. I think in the fall of 1882.

18 X Q. What time in the fall of 1882 was it?

A. I can't say definitely.

19 X Q. Please to repeat the words of the telegram.

A. As near as I can remember, "Meet me in Brooklyn this evening;" I can't remember where the place was.

20 X Q. And you inferred from the language of that telegram that Mr. Welsh was trying to induce the man McKune to leave the employ of the Edison Lamp Company, as I understand it?

A. I inferred that from the telegram after what McKune told me that Welsh had been trying to get him to go over there previous to that time.

1023 21 X Q. What did McKune tell you; please to repeat his words as near as you can.

A. That Welsh had sent word to him several times to meet him.

22 X Q. To meet him for what purpose?

A. Relative to taking a position in the company that Welsh was with.

23 X Q. Did McKune meet him?

A. Not to my knowledge.

24 X Q. How did McKune come to make this statement to you that Welsh was trying to get him to leave the employ of the Edison Lamp Co.?

A. On account of my giving him the telegram, and friendly relations between us, he being about my age. All the telegrams came to my office by telephone.

25 X Q. What was Mr. Kune's duties in the Edison lamp factory?

A. Cutting bamboo fibres for use in the Edison lamp.

26 X Q. Can't you fix the time a little more definitely when you received this telegram from Mr. McKune?

A. No, sir.

27 X Q. Did you ever know Mr. Welsh to tell a falsehood?

A. Yes, sir.

28 X Q. What did he lie about?

A. Everything.

29 X Q. Lied all the time?

A. Yes, sir; pretty near all the time.

30 X Q. Can you mention something he lied about?

A. Yes, sir.

31 X Q. Please do so.

A. He lied to me one time about owning a horse. He lied to me several times about his accounts.

32 X Q. Did he swear to these lies, any of them?

A. No, sir.

33 X Q. How do you fix the dates of the time that Mr. Welsh went in the employ of the Edison Lamp Company, and the time that he left the employ of that company?

1024 A. From records now in the hands of the Edison Lamp Company.

34 X Q. Do you refer to the time books of the Edison Lamp Co.?

A. Yes, sir.

35 X Q. Who kept those books at the time you say Mr. Welsh went in the employ of that company?

A. The assistant in the office at Menlo Park, John Randolph.

36 X Q. Did you examine that book before you came here to give testimony yourself?

A. I examined that book first when I went in the employ of the Edison Lamp Company in 1881.

37 X Q. When did you last examine it upon this question of fixing time when Mr. Welsh went in the employ of the Edison Lamp Company, and when he left that employ?

A. I examined the book last which contains the memorandum of his entering the employ of the Edison Lamp Company last week not with any idea of testifying here.

38 X Q. How large is that book?

A. Larger than a sheet of legal-cap paper.

39 X Q. How thick and how much larger?

A. The cover of the book is 9 x 14 and 1$\frac{3}{4}$ inches thick.

40 X Q. If you can do so, please to produce the book?

A. I do produce the book.

41 X Q. Please to take this book and read from it all the entries you can find in it respecting the time credited to Alexander Welsh?

A. I do so. (Witness reads from page 166.)

Alexander Welsh.

1880.				
Oct. 7th.	By 68 hours........................	7	....	$4 76
" "	To check........................		$4 76	
" 14.	By 60 hours........................		....	4 20
" "	To check..................		4 20	
" 21.	By 75 hours........................		....	5 25
" 21.	To check........................		5 25	
" 28.	By 90 hours........................		....	6 30
" "	To check........................		6 30	
Nov. 4.	By 69 hours........................	8$\frac{1}{3}$	....	5 75
" "	To check.......		5 75	

1025 32 X Q. Is that all you find in the book that goes to show the time when Mr. Welsh entered the employ of the Edison Lamp Company and when he left it?

A. That is all I find in that book to show when he entered the Edison Lamp Company's employ.

43 X Q. How does that account show that Mr. Welsh did not enter the employ of the Edison Lamp Company before October 1st, 1880?

A. The first entry of his name and the first account that we had with him and the first knowledge of a man by the name of Alexander Welsh.

44 X Q. Was this book kept by the Edison Lamp Company or by Thomas A. Edison?

A. Strictly speaking, it was kept by the employees of T. A. Edison, but the Edison Lamp Company paid for the man's services keeping the account.

45 X Q. Do you know of your own knowledge that Alexander Welsh was not in the employ of Thomas A. Edison or the Edison Lamp Company previous to October 1st, 1880?

A. No, sir.

46 X Q. Is your statement that Alexander Welsh went in the employ of the Edison Lamp Company first on October 1st, 1880, based upon the entry in this book you have already quoted?

A. Not wholly.

47 X Q. What other fact or circumstance is your statement to that fact based upon?

A. Conversations with Welsh and other employees of the Edison Lamp Company.

48 X Q. Please to repeat what conversation you may have had with Mr. Welsh upon that subject.

A. Conversation was general. It was a curiosity to know what time Welsh went to work for the Edison Lamp Company.

49 X Q. Can you swear to anything that Mr. Welsh said that enables you to fix that date?

A. A conversation that I remember having one time with Welsh about the rights of the older employees of the lamp company.
1026 Welsh only being there a few months previous to my going there, our rights were about equal.

50 X Q. Is that all?

A. Yes; I remember Welsh saying that he was there about three or four months before I. I also remember Mr. Holzer, the superintendent, saying so, and others.

Redirect examination by Geo. W. Dyer:

51 Re-D Q. This book that you testified about—what is written on the outside of the book?

A. "Time book."

52 Re-D. Q. What is printed on the back of the book?

A. "T. A. Edison."

53 Re-D. Q. After you went into the employ of the Edison Lamp Company, were regular books first started for that company?

A. Yes, sir.

54 Re-D. Q. By whom and under whose directions?

A. By Mr. Wm. Carman, under the directions, I suppose of Mr. Edison. Mr. Carman started the books, and then I kept them afterwards.

55 Re-D. Q. Was this account of Mr. Welsh that you have quoted transferred to the company's books?

A. It was.

56 Re-D. Q. And charged against the Edison Lamp Company?

A. Yes, sir.

57 Re-D. Q. Was that the earliest account in which Mr. Alexander Welsh's name appears on the books of the Edison Lamp Company?

A. Yes, sir.

58 Re-D. Q. Do you know how the morning trains from Menlo Park to New York ran in July, 1881?

A. Yes, sir.

50 Re-D. Q. What were the hours?

A. 6.55 first; 7.21, 9.21 and 11.21.

1027 Recross-examination by Mr. BROADNAX:

60 Re-X Q. What is printed on the side of this book about which you have testified?

A. "Platina."

PHILIP S. DYER.

U. S. Circuit Court, Western District of Pennsylvania.

THE CONSOLIDATED ELECTRIC LIGHT COMPANY
vs.
MCKEESPORT LIGHT COMPANY.
} In Equity.

NEW YORK, *April 25th*, 1889.

Testimony taken on behalf of defendant before William T. Farnham, special examiner herein, pursuant to the 67th rule of the U. S. Supreme Court in equity as amended.

Attended at office of Amos Broadnax, 120 Broadway, New York. Present: Mr. Donnelly for defendant, and Mr. Broadnax for complainant.

CALVIN GODDARD, a witness called on behalf of the *plaintiff* and duly sworn, testified as follows:

By Mr. DONNELLY:

1 Q. What is your residence and occupation?

A. 205 West Fifty-seventh street; my occupation—well, it is various.

2 Q. Well, generally?

A. Say general manager.

1028 3 Q. Do you remember the circumstance of going either alone or with any gentlemen for the purpose of seeing the

Sawyer-Man electric lamp? And if so state when such visit was and who accompanied you.

A. I don't think I can fix the date definitely. I have no memorandum, but I recollect distinctly going to a workshop or laboratory which was occupied by Mr. Sawyer to see an incandescent light, and with me were Mr. Lowery, at whose invitation I went, Mr. Galloway, Mr. Edward N. Dickerson; I think Mr. J. Hood Wright accompanied us. I am not clear about that, but that is my impression, and possibly some one else. I don't remember distinctly as to others.

4 Q. Do you remember the year and the time in the year it was when you made that visit?

A. No, that I cannot fix. My impression would be that it was some time in 1878, for it was early in the history of the Edison Company.

5 Q. And what time in the year was it?

A. I couldn't say.

6 Q. You don't remember whether it was in the fall?

A. I have no means of fixing the season of the year. I think it was later than the summer. It may have been in the fall or winter, because I was absent during the summer.

7 Q. Do you remember where this place was located which you visited?

A. No, I don't know the exact locality. It was on one of the cross-streets I should think out of Broadway, below Canal street, and in the neighborhood of Centre street in this city. I don't remember the exact address.

8 Q. Did you see an electric lamp at this place?

A. Yes, my recollection is very distinct as to what I saw.

9 Q. State what you saw in that respect?

A. I saw a glass tube—straight tube—inclosing conductors, with a piece of carbon held between the two conductors, which, under the current, was made incandescent.

1029 10 Q. What was the shape of this carbon?

A. It was a straight piece of carbon.

11 Q. A straight carbon pencil was it?

A. It was a slight, slender piece of straight carbon.

12 Q. Did you see any other lamp at that place at that time?

A. None other.

13 Q. Did you see any other form or shape of carbon than the straight pencil?

A. Nothing else than that.

14 Q. Did Mr. Sawyer in your presence or in your hearing refer to any other carbon?

A. No.

15 Q. That is, either arch-shaped or any other form than the straight carbon?

A. I have no recollection of any conversation with regard to anything else than what I saw.

16 Q. Was anything said by Mr. Sawyer in your presence or

hearing with reference to fibrous material or carbonizing fibrous material?

A. No; I recollect no description of the process by which the carbon was manufactured. I simply saw what I saw without any description of its method of production.

17 Q. Were you with the other members of the party who visited this place during the conversation at the interview with Mr. Sawyer?

A. Yes; the conversation was general.

18 Q. And all in your presence, was it?

A. As to that I cannot remember distinctly. It is possible that something may have been said which I did not hear. My best recollection is that the conversation was general, and that we were all together.

19 Q. Did you see more than one single lamp?

A. I saw various forms. I recollect now that one lamp that had a piece of carbon parallel with the sides of the tube, and in other cases it was at right angles with the sides of the tubes. These two forms I recollect.

20 Q. You saw several lamps, then?

A. Yes; several lamps—quite a number.

1030 21 Q. But these pieces of carbon were in all instances straight?

A. Yes, sir.

22 Q. Of what size were they?

A. They were quite short; I should think half an inch, perhaps.

23 Q. How thick were they; what diameter?

A. That would be difficult for me to say. They were quite small; perhaps as large as—no; I don't think I can give any illustration of its size. They were small, but not exceedingly slender.

24 Q. You can give us some idea.

A. I don't think of anything to compare it to that would fix it.

25 Q. Of course, we understand it is a mere estimate that you make of the diameter.

A. It might possibly have been a sixteenth of an inch.

26 Q. Was anything said by Mr. Sawyer in your presence or in the presence of the gentlemen who accompanied you—Mr. Lowery and the others—in reference to carbonizing fibre or carbonizing paper or any other material?

A. Nothing of that sort was spoken of in my hearing.

27 Q. Well, if it had been, do you think that you would have remembered it?

A. I certainly should.

28 Q. Please look at Complainant's Exhibit — which I now show you, and state whether the lamp designated "Sawyer-Man electric lamp," shown in said exhibit correctly shows and illustrates the lamp you saw on the occasion of your visit to the shop of Mr. Sawyer, as you have stated.

A. That is as I recollect it.

29 Q. Did you see any other kind of a lamp there except the one shown in said exhibit?

A. My impression is I saw one where the strip of carbon ran between the two conductors, across the tube.

30 Q. That is horizontally?

A. Yes; at right angles to the sides of the tubes.

1031 31 Q. Did it differ from the other in any other respect?

A. Not materially in other respects.

Cross-examination by Mr. Broadnax:

32 X Q. Did you have any conversation personally with Mr Sawyer at the time of your visit there?

A. Not that I recollect, except with all the others.

33 X Q. A sort of a general conversation?

A. Yes, sir. Undoubtedly I asked some questions. If I did it was in the presence of the rest.

C. GODDA*D*D.

Sworn and subscribed before me.

WILLIAM T. FARNHAM,
Special Examiner and Notary Public.

R. M. Galloway, being called on behalf of defendant and duly sworn, testifies as follows:

Direct examination by Mr. Donnelly:

1 Q. Give your residence and occupation?

A. I live at No. 68 East Fifty-fifth street, in the city of New York, and my occupation is that of vice-president of the Manhattan Elevated railroad, No. 71 Broadway.

2 Q. Do you remember any occasion when, in company with Mr. Lowery, Mr. Goddard and others, you visited the shop of Mr. Sawyer for the purpose of inspecting an electric lamp?

A. I visited a shop. I don't know whether it was Mr. Sawyer's or whose shop it was. I remember going with this gentleman, with Mr. Dickerson, Mr. Lowery, Mr. Hood Wright, and this gentleman, Mr. Goddard. We had a dinner, I think, beforehand, and went from there to this place.

1032 3 Q. Do you remember the time and the place?

A. I don't remember the place.

4 Q. It was in New York?

A. It was in New York city.

5 Q. Do you remember the year, whether it was about 1878, or about that?

A. It was about that time. I don't remember the exact time.

6 Q. You visited the shop. Did you see an electric lamp there?

A. Yes; there were electric lamps there.

7 Q. How many did you see?

A. I don't remember.

8 Q. Several?

A. I presume there were.

9 Q. Did you inspect them with a view of ascertaining anything

about their construction—the construction of the lamps you saw at that time?

A. I presume I did at that time, for I was interested at that time in knowing what they were.

10 Q. Do you remember the shape or form of the carbon in the lamp, whether it was straight or arched?

A. I do not; I couldn't say what it was.

11 Q. Do you think if you were to see a cut of the lamp you would be able to recall its form of construction?

A. I might try.

12 Q. Please look at the cut which I now show you, Complainant's Exhibit — and which is design-ed "Sawyer-Man electric lamp," and state whether the lamp therein shown and illustrated is substantially like the lamp which you saw on the occasion of this visit with Mr. Lowery?

A. I don't recognize it at all.

13 Q. You don't recall the construction of it?

A. I do not.

14 Q. Do you recognize the carbon?

A. No, sir; I do not.

15 Q. You don't know what kind of carbons you saw?

1033 A. I do not. I have no recollection of it. I simply remember going to see that light as I went to see at different times many others.

16 Q. Do you remember Mr. Sawyer making any statement in regard to carbonizing material, or fibrous material, or anything of that kind?

A. I don't remember hearing any statement made. We were all there to examine a light, and what that light was, or what statements were made in connection — it, I cannot now remember.

R. M. GALLOWAY.

Sworn and subscribed before me.

WILLIAM T. FARNHAM,
Special Examiner and Notary Public.

GROSVENOR P. LOWERY, a witness called on behalf of the defendant and duly sworn, testifies as follows:

Direct examination by Mr. DONNELLY:

1 Q. Please state your residence and occupation.

A. I reside in the city of New York, at 121 Madison avenue, and am a lawyer by profession.

2 Q. Do you remember visiting the shop of William E. Sawyer about the year 1878, and if so, please state when it was and the circumstances attending that visit, as you now recall them?

A. I remember making such a visit, and I remember being accompanied by Mr. E. N. Dickerson and J. Hood Wright. I don't remember Mr. Goddard and Mr. Galloway being there, but have no doubt whatever that it is so. I do not remember the date, but know that it was March 28th, 1879, by a letter written on my behalf and signed by a young gentleman in my office, which is Complainant's

Exhibit "Rockwell-Kent Letter." As to the place, I don't remember it except that it was a shop on the second or some higher 1034 floor of a building somewhere near Canal street, I should think in Centre street, but I do not doubt that it was at 94 Walker street as stated. The shop or premises consisted of about two or three rooms, one of which seemed to be an office, another a kind of workshop, and the third an engine-room. I went there by some invitation, I don't remember whose, but have no doubt it was at the invitation of Mr. William Church from the evidence which Complainant's Exhibit "Rockwell-Kent Letter" gives me. I saw Mr. William E. Sawyer there. The visit was some time in the evening while we were all on our way uptown to our residences. It occurred, I think, at 8 or half past 8 o'clock in the evening. Mr. Sawyer received me and those who came with me, and exhibited to us certainly two or three, and perhaps five or six incandescent electric lamps. I think they were not all burning at one time, because Mr. Sawyer called our attention especially to the fact that he could burn one or more at the same time, and I remember that the lamps were turned on and off. My impression is that they were never all burning at once. I have examined the endorsement on the back of Complainant's Exhibit "Rockwell-Kent Letter," which is stated by Mr. Broadnax to be in the handwriting of Mr. Sawyer, beginning with the phrase, "Friday night they all came."

3 Q. On the occasion of this visit you said you saw several lamps. Please state fully the form of the carbons which you observed in such lamps, as to their being straight or otherwise.

A. They were all straight; I saw nothing in any other form.

4 Q. Was anything said at that time in your presence, or in the presence of these gentlemen who accompanied you, as to carbons of arch shape or horseshoe shape, or being formed or composed of fibrous material?

A. Nothing was said in my hearing in respect to either the shape of the carbons or of the material of which it was composed. The business of the visit, I might say, on the part of Mr. Sawyer was confined entirely to three subjects: One to show that he had a 1035 lamp which gave a light; second, that he could turn on and off these lamps; third, there was reference made in my hearing to some process by which he treated carbons in olive oil, and I have some recollection that Mr. Dickerson went into the adjoining room to see that. I did not go, being at the time entirely uninformed in respect to carbons for lamps. I did not know but this was the way in which all carbons were treated. It did not excite any interest or attention in my mind.

5 Q. Was anything said at that time about carbonization, or modes of carbonization of paper or any other material?

A. Nothing was said about the way in which the carbons were produced except as might be inferred from what I have stated above, that they were treated in olive oil.

6 Q. What was the size of these carbons which you saw in the lamps; that is, their diameter and length?

A. About that my recollection is not very definite, at least concerning the length. I should say they were exceedingly short—stumps; certainly not more than half an inch; so short that when illuminated the effect upon the eye to me was something like a ball of fire. As to their thickness, I have a more clear recollection. I should say that they were an eighth of an inch thick, as large as a large lead in a lead pencil.

7 Q. Please look at Complainant's Exhibit — and particularly at the Sawyer-Man electric lamp therein shown and illustrated, and state whether it correctly shows and illustrates the lamp which you saw on the occasion of your visit, as you have stated?

A. I had seen the cut now shown me in the "Scientific American" of December 7th, 1878, previous to this visit and expected to see a lamp giving the general impression of this cut. This cut represents a finish and grandeur and fineness quite different to that which the actual lamp produced. It appeared to me a rather shabby original for so fine a picture. The parts all seem to me to be larger here than they really were in that other lamp. The incandescent portion seems to me to be longer. There were one or two lamps
also whose incandescing parts were perpendicular to the
1036 plane of the sides of the lamp. That is, across the top connecting the two conductors across the top.

8 Q. Were the parts in the lamps which you saw similar to the parts represented in the cut?

A. Yes, sir. There were very heavy metallic conductors inside the glass tube or lamp chamber.

9 Q. And the carbons in some of the lamps were arranged perpendicularly as shown in that cut?

A. Yes, and some horizontally.

10 Q. On the occasion of this visit, was anything said by Mr. Sawyer in your presence, or in the presence of these gentlemen, in reference to paper carbons, the carbons for the lamps being made of paper or of fibrous material of any kind?

A. Nothing was said in my hearing as to what his carbons were composed of at all. Certainly he never mentioned the word "paper" nor the word "fiber" in my hearing.

11 Q. Did he state to you that he had made any investigation or experiments in that direction?

A. Nothing was said about that in my hearing. He told me that the incandescent part was that carbon. My limited knowledge of carbon was such—in fact it was not anything. Probably my idea of carbon was something black. Where it came from I had not the remotest idea. I know that he did not speak of paper or fiber, because within a few months after that, while the matter was fresh in my memory, I for the first time heard—after the production by Mr. Edison of the first one hundred lamps in December, 1879, that some one claimed that there was something special about using paper or fiber for carbon, and also something special about having it in a horseshoe or curved form.

12 Q. That was long after this visit?

A. It was several months after this visit, but while the matter was still fresh in my memory, and what I remember now is that at

that time I knew that I had not seen any curved-form conductor anywhere except at Edison's laboratory, and I had never heard paper or fiber spoken of as material for a lamp conductor until
1037 about the time Mr. Edison brought out his one hundred paper lamps.

13 Q. After looking at this letter, is your recollection refreshed as to the time and place of this visit?

A. Not at all; but I have no doubt the date of the letter is correct.

Cross-examination by Mr. Broadnax:

14 X Q. Do you undertake to recollect or to know all that Mr. Sawyer said at the time of the visit referred to?

A. No, not at all. He said very little to me. His conversation was addressed to a group of gentlemen, who walked about his shop with him, and to whom he pointed out things. I don't remember that we separated at all at any time, except a general impression that Mr. Dickerson went to look at the olive oil work. I think I can remember whether he did or did not say any particular thing to me that would be suggested; but I do not pretend that my memory will, upon a call like that, bring up everything.

15 X Q. Did you examine the carbons when they were not illuminated?

A. No; I was never nearer to one of the carbons than as one would stand looking at a light burning; at least I don't think so.

16 X Q. State as to the length of time you were at Mr. Sawyer's place of business examining these lamps that you have described.

A. I should be surprised if it were more than from half to three-quarters of an hour; 40 minutes perhaps, and a considerable portion of that time was consumed in the engine-room with Mr. Dickerson, who gave particular attention to the engine—and I think a dynamo machine was there. The question of special interest at that time to Mr. Dickerson and myself being, not whether the light could be obtained by the incandescence of something through which a current of electricity passed, but what expenditure of energy it would cost to get that light and maintain it, a question
1038 entirely of economy; and I think at least a third of the time we were there was spent either in the engine-room or talking about the engine, and I don't think the entire time would exceed three-quarters of an hour.

G. P. LOWREY.

Sworn and subscribed before me.

WILLIAM T. FARNHAM,
Special Examiner and Notary Public.

James Hood Wright, a witness called on behalf of defendant, and duly sworn, testifies as follows:

Direct examination by Mr. Donnelly:

1 Q. What is your residence and occupation?

A. Banker; 23 Wall street, New York.

2 Q. Do you remember on or about March, 1879, visiting any place in New York city in company with Mr. Lowery, Mr. Dickerson, Mr. Goddard and other gentlemen for the purpose of seeing an electric lamp at Mr. Sawyer's place of business; if so, state what you remember about it?

A. I spent one evening in company with Mr. Dickerson, Mr. Lowery, Mr. Goddard, Mr. Galloway, at a place in Walker street. Mr. Sawyer exhibited to us a lamp. I have no means of fixing the date. I don't recollect it.

3 Q. Did you examine or look at this lamp in company with these other gentlemen?

A. Yes, sir.

4 Q. Do you remember what the form of the carbon was, as to whether it was straight or otherwise—the pencil?

A. My recollection is that it was a small straight pencil.

5 Q. What was the length of the pencil and its diameter cross-section?

A. About an inch or an inch and a half in length and
1039 about the thickness of a lead pencil; quite as thick as that;
a little thicker I should say; it might have been a sixteenth
of an inch.

6 Q. How many lamps did you see on that occasion?

A. I do not remember.

7 Q. More than one?

A. Two or three.

8 Q. Were they all alike in construction as to the carbon pencil?

A. My recollection is they were.

9 Q. Was anything said on that occasion in your presence or in your hearing in reference to arch-shaped carbons or carbons made from fibrous material?

A. Nothing whatever.

10 Q. Was anything said in your presence on that occasion about carbonizing fibrous material?

A. No, sir.

11 Q. Was anything said to you about paper carbons—that the carbons in the lamps were made of carbonized paper?

A. No such statement made to me.

12 Q. Look at the cut of a Sawyer-Man electric lamp which I now show you, being Complainant's Exhibit —, and state whether the cut of the lamp therein shown is a correct representation of the lamp which you saw on the occasion of your visit to Mr. Sawyer's place of business.

A. In general form I should say that was similar to the one that I saw.

13 Q. Were you all there together with Mr. Sawyer during the time of your visit, or did you separate?

A. We were sitting in a room together watching the thing, and during the time Mr. Sawyer took me aside in a little room adjoining and I made some inquiry in regard to the nature of the carbon and his reply to me was that it was ordinary carbon dipped in oil.

That was the only remark he made to me in regard to the character of the carbon.

14 Q. Did he have any conversation with any other of the gentlemen present?

A. That I cannot answer.

1040 15 Q. You don't remember?

A. He had some discussion with Mr. Dickerson in regard to some matters that were too deep for me. They were more of a scientific character. I am not prepared to say.

16 Q. Do you remember to what those discussions related, what particular points?

A. There was a discussion in regard to the number of lamps per horse power, or number of revolutions. That was about what was said, as I remember. It was a question of how many horse power he was using and what lamps he was using.

17 Q. Are you pretty clear that there was no discussion as to fibrous material or paper carbons?

A. I heard none.

Cross-examination by Mr. BROADNAX:

18 X Q. Will you undertake to remember all that Mr. Sawyer said to you in his conversation with you?

A. I do not think our conversation amounted to a great deal more than that, except the general conversation which was addressed to everybody present.

19 X Q. Did you examine these lamps when they were not illuminated?

A. No, sir; they were all illuminated, I think, at the time.

By Mr. DONNELLY:

20 X Q. Do you remember how long you were there examining these lamps?

A. I should imagine an hour or more, or an hour to an hour and half, I should think spent in the room.

J. HOOD WRIGHT.

Sworn and subscribed before me.

WILLIAM T. FARNHAM,
Special Examiner and Notary Public.

1041 *Testimony in Reply, Taken under Order of Court of March* 18, 1889, *Reopening the Testimony.*

Testimony in reply, taken on behalf of complainant before William T. Farnham, special examiner herein, for final hearing, pursuant to the 67th rule of the U. S. Supreme Court, in equity, as amended.

NEW YORK, *March 27th*, 1889.

Attended pursuant to annexed notice. Present: Amos Broadnax, Esq., and Thomas B. Kerr, Esq., for complainant, and Grosvenor P. Lowrey, Esq., and Walter K. Griffin, Esq., for defendant, and the testimony of witnesses on behalf of complainant herein was commenced as follows:

ALBON MAN, being called on behalf of complainant and duly sworn, testifies as follows:

Q. A. What is your name, age, residence and occupation?

A. Albon Man; age, 62 years and upwards; residence, 118 Putnam avenue, Brooklyn; occupation, lawyer. I am also interested in electrical development.

Q. B. Are you the same Albon Man that testified on behalf of complainant in a certain suit in equity pending in the circuit court of the United States for the southern district of New York No. 3553, between The Consolidated Electric Light Co., complainant, and The Edison Electric Light Co. and Thomas A. Edison, defendants?

A. I am.

Q. C. How recently have you read your testimony in that case?

1042 A. Within the last week or so.

Q. D. I place in your hands a printed copy of your testimony in that case. Please to examine it, and state if you recognize it as your testimony?

A. I do; it is a printed copy of my testimony that I have read and referred to in my last answer.

Q. E. Is your testimony in that case, as there printed, a correct copy of the testimony given by you in that case?

A. It is, with certain verbal corrections, of which I have made notes, and which appear in the paper I now produce, and with the exception of some other slight typographical or clerical errors, or errors in orthography which do not change the sense or meaning (or at least the sense or meaning is apparent in the printed copy), of which I have not made note.

Q. F. Upon what page of this printed record does your testimony begin, and on what page does it terminate?

A. It commences on page 304, and ends on page 924.

Q. G. Are the several answers made by you to the questions propounded to you as printed in that book, true, and would you, if the same questions were propounded to you, again make the same answers?

A. They are true to the best of my knowledge, recollection and belief. I notice nothing therein to correct, except the errors I have before mentioned. I should make the same answers now as I made then, unless I should find myself mistaken as to any particular to which I testified in details, by subsequent light being thrown upon the subject as to which I testified.

Q. H. As you are now informed, do you find anything in the answers given by you in this testimony that you want to change, excepting, as pointed out in these notes of correction presented by you?

A. I do not.

1043 Notes of correction offered in evidence, and marked "Complainant's Exhibit Man's Correction of the Deposition as

Printed Given by Him in Case 3553," and the examiner is requested to correct the printed deposition in conformity with these notes.

Q. I. Are you willing to, and do you, as a matter of fact, adopt your deposition in case 3553 in said southern district of New York, as printed in this book, as your deposition in this case?

A. Yes, sir; with the corrections I have noted.

Counsel for complainant offers the said deposition of the witness and the exhibits referred to therein as in case No. 3553 in the southern district of New York, in evidence in this case, and the same is marked "Complainant's Exhibit Albon Man's New York Deposition, March 27, 1889."

Complainant's counsel give defendant's counsel notice that he shall now proceed to examine the witness, continuing from the end of his deposition in the New York case.

Albon Man's New York Deposition.

NEW YORK, *April* 14, 1887.

Parties met pursuant to agreement.

Appearances: Messrs. Broadnax & Bull, for complainant; Messrs. Tomlinson & Dyer, for the defendants.

ALBON MAN, a witness produced on behalf of the complainant, being duly sworn and interrogated by Mr. BROADNAX, testified as follows:

Q. 1. State your name, age, residence and occupation.

A. My name is Albon Man; my residence is 118 Putnam avenue, Brooklyn; I am a lawyer by profession, and my age is sixty years.

1044 Q. 2. Are you actually engaged in the practice of the law, or have you any other occupation?

A. I am engaged in law practice and also in electrical work.

Q. 3. What is the nature of the electrical work upon which you are engaged?

A. The manufacture of electrical motors, storage batteries, and the electric light, with the devising of plans and apparatus for the use of electricity in power and light, and for the methods of producing electrical currents cheaper.

Q. 4. How long since you first turned your attention more especially to electrical work?

A. To electrical work proper in the month of January or February, 1878. Before that time from about the year 1866, I had made electricity a special subject of study for information and pleasure, but not for work.

Q. 5. Since January or February, 1878, about how much of your time has been given to electrical work, and to what extent have you followed up the progress of the application of electricity, more especially to electric lighting and other kindred subjects?

A. During all the year 1878, and up to the spring of 1879, I was actively engaged in electrical work for electric lighting with Mr.

William E. Sawyer. From that time forward until the fall of 1882, I was not actively engaged in any electrical work; but since that time until the present I have been a director of the Consolidated Electric Light Company, and have taken an active interest in its work, but not myself participating in the doing of any work, only acting in an advisory or directing capacity. For the past two years or more I have been president of the River and Rail Electric Light Company, and have given a good share of my time to the electrical work of that company.

Q. 6. Are you the same Albon Man whose name is mentioned as
joint inventor and patentee, in the patent in suit, No.
1045 317,676, dated May 12, 1885, and also in the letters patent of
the United States 205,305, dated June 25, 1878; reissued letters patent No. 10134, dated originally June 25, 1878—the reissue being dated June 6, 1882; also letters patent No. 229,476, dated June 29, 1880; also letters patent No. 210,152, dated November 19, 1878; also letters patent 211,262, dated January 7, 1879; also letters patent 229,335, dated June 29, 1880; also letters patent 210,809, dated December 10, 1878; all of which appertain to the practical application of electricity to electric lighting and to apparatus appertaining to the production of electric lights and the regulation thereof?

A. I am. I have taken out one or two patents beside these, myself, appertaining to the same subject.

Q. 7. Referring now to the patent in suit, a copy of which I place in your hands, please to read the first claim of that patent and state when the invention or improvement covered by that claim was made.

A. In the spring of 1878, in the month of March or April.

Q. 8. Was that invention actually reduced to practice at that time?

A. It was.

Q. 9. What kind of fibrous or textile material was used by yourself and Mr. Sawyer in reducing that invention to practice?

A. At that time, March or April, 1878, principally paper and wood of different kinds, and probably jute and manilla. As to the jute and manilla my recollection is not so distinct in regard to their use in March and April, 1878, as in the months of September and October, November and December, 1878, all of them, we used paper, a great variety of woods, jute, manilla, cotton threads, broom corn, and a great variety of other substances of fibrous or textile material; and the broom corn, as I now recollect, we also used in the
spring, 1878. I think jute and manilla were also used in
1046 the spring. The paper and wood were positively used in
the spring, but I am not so certain of the jute and manilla.

Q. 10. Please to enumerate some of the different kinds of wood you used in the spring of 1878, and also the different kinds of paper used by you during the same time?

A. First, as to the woods; we carbonized a great variety of woods in the spring of 1878, among which were willow, maple, birch, elm, hickory, lignum-vitæ, poplar, and others that I do not recollect distinctly. We got all we could find. I remember one thing that we did in the spring of 1878, but I do not remember the material. We carbonized some endogenous woods, but what they were I do not recollect. We had a particular object in doing it. I do not recollect whether we used any canes, but we did use what strikes me as some of the palms; but I do not recollect what. Whether it was reeds, or cocoanut or palm woods, or what it was I do not recollect. All I know is we did it. The fibres of such woods interlace, and we had an idea that such a wood might make a stronger carbon. The fibres of endogenous woods, to some extent, interlace.

Now, as to the papers: we carbonized a great variety of them, but fell back on ordinary white blotting paper, and I should say manilla paper, and we got some good strong bond paper, linen papers—pure linen papers—and ordinary blotting paper. We used a good deal of bristol-board and a good deal of drawing paper. We had ordinary drawing paper and also cards; we cut up cards; we used a card paper; but, as I say, we fell back upon ordinary white blotting paper which was nearly pure cell*olus*e.

Q. 11. Referring now to the carbons made by you and Mr. Sawyer, of wood, in the spring of 1878, please to state how you made those carbons, and of what form you made them.

A. At first we carbonized the wood en masse and sawed and cut straight pencils of carbon out of them, and turned rings out
1047 of the charcoal on a lathe by first turning up a cylinder,
boring it to make it a tube, and cutting a ring off from the end of the tube so formed. After a few experiments of this kind, we adopted the plan of cutting the wood down substantially to the size of the carbon we desired and bent it to shape and then carbonized it. Some of the wood that we used was already in fine filaments or strings—such as excelsior, used as a packing material and for stuffiing cheap mattresses. It only required to be smoothed up, softened and bent before carbonization. Some of the wood was in the form of veneers, cut extremely thin in sheets, from which we cut out the shapes we wanted, and then smoothed them up and carbonized them. The forms were straight pencils, loops and arches.

Q. 12. As to the paper, how did you make your carbons of that?

A. At first we carbonized the paper in sheets; sometimes several sheets stuck together and pressed, from which, after carbonization, we cut out pencils and arches. After making a few carbons in this way, we cut out of the paper before carbonization various forms—straight pencils with enlarged ends, straight pencils with pointed ends, arches and loops, some of the arches having angular forms in them, some of them waving forms, some of them small crosses and stars in their length; and after cutting them into shape we placed them in boxes and crucibles in powdered carbon or plumbago, or both, in alternate layers of the carbon powder and of the papers or other substances to be carbonized, until the boxes were filled. They were then pressed down, covered up and the covers fastened down, then placed in the fire and heated until carbonized. After being carefully cooled, the boxes were opened and the carbon taken out.

The wood carbons were carbonized in the same manner.

We frequently worked the carbons down and smoothed
1048 them off after taking them from the box. We also soaked
them in sugar in some instances, and frequently when we
did so recarbonize them in a box or crucible.

I have omitted to state that the ends of paper and wood carbons in the loop and arched forms were usually enlarged where they were to be attached to the conductors, but not always. In some of the wood carbons that we made of thin veneers, I think of rosewood and mahogany, we worked the wood down into extremely thin and ten-ous sheets on a lap, or fine emery paper, cemented to a lap, and put several of the sheets together, in some instances with glue and in some instances with sugar, so that the fibre of the wood would run in different directions, and after they were dried would cut pieces for carbonization of all kinds and shapes from them.

By the word "lap," I mean a smooth, even-surfaced face plate, on which the carbons were laid and worked. In some instances we used plate glass for a lap, or face plate.

Q. 13. Please to describe a little more fully how you arranged the wood and paper for carbonization in the boxes, and describe more fully the boxes themselves?

A. We used at first iron boxes about three by four inches in size and two inches deep, with iron covers. These were mostly of heavy wrought sheet metal, with cover. Some of the first were too thin, and we burned them up. We also had one or more of cast iron, with cover. We used these boxes up, and then I got a sand crucible to do it in with cover. We at first simply wired the boxes and covers together by winding them with wire. Afterwards, we luted them with fire-clay in the angles and around the cover. We also luted on the covers of the crucibles, leaving a small orifice in each case for the escape of gases.

We began the preparation for putting the carbons in by putting a layer of powdered carbon or plumbago in the bottom of the box or crucible and pressing that down smooth and hard. We then
put in the articles to be carbonized, sometimes bending the
1049 paper or wood in the shape we wanted it, and pressing it
into the carbon edgewise. We then sifted more powdered
carbon or plumbago into the box or crucible, until the articles were covered, when we again pressed it down and smoothed it off; packed in some more articles in the same way, sifted on more carbon, pressed it down, smoothed it off; put in more articles, and so on until the box was filled, the final layer being a thick layer of powdered carbon pressed down solid, on to which the cover was pressed down.

Q. 14. What, if any other method, did you use in carbonizing these wood or paper carbons?

A. Well, by way of experiment, we filled the paper before it was cut to the size that we wanted it, with plumbago, and polished it, rubbed it down and pressed it, and then cut it to size and put it into our lamps in an atmosphere of hydrocarbon, and passed a current through it to carbonize it. We also, by way of experiment, filled the paper with sugar of lead and other mineral salts of easy reduction—I think one of them was nitrate of silver—soaking them in solutions of the salts, and after drying them and exposing them to an atmosphere of some sort, to partially reduce the mineral salts, to make them conductors we carbonized them in the same manner in the atmosphere of hydrocarbon, but these were only experiments, and we did but little of it.

The first experiment with paper was made in the open air by filling a crease in the paper with plumbago and passing the current through it. Afterwards we filled the paper with plumbago, pressed it, cut it into strips, passed the current through it and burned it up. These were our first experiments made in March, 1878. This was followed at once by the carbonization in boxes, as I have already described; that being the plan adopted in April, 1878, of making our carbons.

Q. 15. Please to give, as near as you can, the lengths and sizes of carbons made by you, as you have described?

1050 A. The carbons that we made of excelsior were as fine as those I now produce, which is a little less than the thirty-second of an inch in diameter. The broom corn was about the same size as that I now produce, or a little less. Our carbons were from that size or less up to an eighth of an inch. The different sizes varied in length, for the reason that we had not sufficient electro-motive force to force a current through the smaller carbons and heat them up to incandescence. The longest were about two inches, possibly over two inches; and the shortest were down to, I should think from recollection, a quarter of an inch. I should think somewhere about a quarter of an inch. Those we made from willow twigs were split and shaved down, the pith being taken out, and the bark off and only the wood used. With the exception of the excelsior, our wood carbons were wider than they were thick, and our paper carbons were usually wider than their thickness. They were from a sixty-fourth of an inch up to a twentieth of an inch in thickness. Possibly some of them were thinner than a sixty-fourth, where made of single sheets of paper. The excelsior which I now produce is in bad condition, and that which we used was selected, as was also the broom corn, the specimens being merely produced to give an idea as to the size and kind of material. I also produce samples of manilla fibre and of broom corn, such as we carbonized.

The specimens of excelsior, manilla, and broom corn, produced by the witness are offered in evidence, and are marked—

"Complainant's Exhibit No. 26, Excelsior, Broom Corn and Manilla, produced by Albon Man, New York, April 14, 1887."

Q. 16. What, if any, means did you take to keep the carbons in shape during their carbonization?

A. At first, we tied them in shape with very fine wire wherever they were bent. Where they were cut into shape of loops or arches, they did not require that. When they were bent in, they
1051 required fastening: sometimes they were fastened by being pressed into the powdered carbon. Subsequently, in the fall,

we got a block of carbon and bent them over that and fastened them to the block with clamps, and carbonized them in that way.

Q. 17. What use did you make of these carbons about which you have been testifying?

A. We used them in our lamps for the purpose of making the incandescent conductor of an electric light.

Q. 18. These carbons, as I understand you, you commenced to make in March, 1878, and continued it throughout the fall of the same year, and the winter of the following year.

A. We did, for the same purpose. And we used them for the purposes for which they were made.

Q. 19. What, if any treatment, did you give the carbons subsequent to their manufacture, as you have described?

A. We usually—and almost always—treated them by a process which we patented, of heating them up to high incandescence in an atmosphere of hydrocarbon liquid or gas. That was a process supplemental to the making of the carbon. We frequently, but not usually, used them in our lamps without treatment. I mean by that that a great many more of them were treated than were used without treatment. We got a better carbon by treating them, and intended to practice that method of treating them after having manufactured the carbons. We not only got better carbon, but we were able by that process to regulate its resistance, so as to make the carbon in itself uniform in resistance throughout its length, or nearly so, and at the same time to make one carbon of the same resistance as another.

Q. 20. Why did you make your carbon of various lengths and sizes as you have stated?

A. We were experimenting to ascertain which was the best carbon for us to use, with the means at our command. Where we wanted a carbon of high resistance, therefore, we made it
1052 small and long. Where of low resistance, larger or shorter, or both.

Q. 21. Is that the method usually adopted for obtaining lamps of high or low resistance, the kind of carbon remaining the same?

A. It is one of the methods. The resistance might also be varied in the same material by the carbonization being carried to a higher degree, or at a higher heat, or at a lower heat. The resistance was also varied by the extent and manner of treatment subsequent to the making of the carbon.

Q. 22. What, if any difference, is there in principle between a high-resistance carbon and a low-resistance carbon? I mean carbons of the same material. What is the difference in the making of carbons of a high or low resistance, and what is understood by a high resistance and low resistance? In other words, what is a high-resistance lamp, and what is a low-resistance lamp?

A. To the first part of the question, I would answer that carbons of uniform section and of the same character and density of carbon, vary in resistance, directly as their length. Double the length, double the resistance, other things being equal. Of the same material, the resistance is decreased as the square of the diameter is increased. This is simply an electrical principle, applicable to all substances which are conductors, and is well known to all electricians. I know of no difference in principle as to resistance peculiarly applicable to carbons.

As to the second branch of the question, it is simply to make the material to be carbonized of the proper size and length for the resistance required, and to carbonize and treat it properly. There is no fixed point where a lamp, or the incandescent portion of the lamp, in and of itself, can be said to be of high resistance or low resistance. The resistance may be made anything almost that is required from two or three hundred ohms down to a fraction of
1053 an ohm. The lamp must be made to suit the current applicable. If a current of high electro-motive force is available, then the lamp may have a high resistance corresponding to the electro-motive force. If the current available is one of low electromotive force, the resistance must be reduced until sufficient current will pass through the incandescent conductor to heat it up so as to give the required light.

It has been said that a great economy can be made by using lamps of at least one hundred ohms resistance. I do not think that any fixed resistance is yet determined upon. It is a question of the current available, the proximity of the lamp to the source of electricity, or its remoteness therefrom, and other resistances in circuit, and other circumstances, as well as of resistance. A lamp of very low resistance, even less than an ohm, might be the most economical one, in my judgment, in one position, and for a given amount of light, and with a given current; and a lamp of over 100 ohms might be the better one and most economical one, under other circumstances.

I intend to say that there is no point agreed upon among electricians at which high resistance begins and low resistance ends. The expression is purely comparative.

Q. 23. Referring now to the second claim of the patent in suit, state, if you please, when the invention, or improvement, covered by that claim, was made?

A. In March or April, 1878, at the same time the other was. It was put in practice by Mr. Sawyer and myself at that time at No. 43 Centre street, in this city. It was continued in practice all through our work, so far as I knew in regard to it, up to March or April, 1879, and, as I believe, by Mr. Sawyer from that time forward until the forming of the Consolidated Electric Light Company in the fall of 1882, and from the fall of 1882 by the Consolidated Electric Light Company until this day.

1054 Q. 24. Referring now to the third claim of the patent in suit, when was the invention, or improvement, covered by that claim, made?

A. At the same time, and in the same manner which I have already described.

Q. 25. Referring now to the fourth claim of the patent in suit, please to state when the invention or improvement, covered by that claim, was made?

A. At the same time, in March and April, 1878, and put into operation by Mr. Sawyer and myself at No. 43 Centre street, at that time; and it was continued in use from that time on down, by ourselves and our successors, and it is now in use by the Consolidated Electric Light Company.

Adjourned to Friday, April 15, 1887, at 10 a. m.

NEW YORK, *April* 15, 1887.

Parties met pursuant to adjournment.

Appearances: Messrs. Broadnax & Bull, for the complainant. Messrs. Tomlinson & Dyer, for the defendants.

ALBON MAN.

Examination continued by Mr. BROADNAX:

Q. 26. You have stated in your previous answers, that in the preparation of the paper for carbonization in some instances you saturated, or filled, and rubbed into it pulverized plumbago, and also mineral salts. Please to state definitely why you prepared the paper in that way?

A. I have explained that our first carbonization was done by a current of electricity. The paper was a non-conductor. In order to make it a conductor, so that a current could be passed through it, we filled it and covered it, as I have explained, with pulverized plumbago, simply for the purpose of making it a conductor.
1055 We used the mineral salts for the same purpose, but did not like the mineral salts, and did very little with them.

After having found that the paper filled with powdered plumbago before carbonization became a conductor, we continued in some instances, but not always, nor usually, to fill the paper with plumbago before carbonization in the boxes, in order to reduce the resistance of the loops and carbons, after they were carbonized, so that we could pass a current through them to light them up, as we had no very high electro-motive force dynamos, and no available current of a high electro-motive force.

The practice we adopted in April, 1878, was to carbonize the papers without any such treatment before putting it in the boxes and covering it with powdered carbon or powdered plumbago, as I have explained, to protect them while being carbonized. In other words, we carbonized the paper without any preparation beyond that of cutting it to the desired size or form.

Q. 27. Did you ever treat any carbon made from paper or wood with plumbago after carbonization?

A. No; we never did.

Q. 28. You have stated that it was your usual practice to treat the carbons after carbonization in the presence of hydrocarbon gas—for the purpose of bettering the carbons and equalizing their resistance. Is the process referred to by you the same as that described in your patent No. 211,262, granted January 7, 1879?

A. Yes; it is the same process described in the specification of that patent.

Q. 29. What proportion of this wood and paper carbons, made and used by you, were treated by the process referred to in the patent mentioned in my last question?

A. I could not give any definite proportion. All I can say is it was our usual practice to treat them after carbonization, but 1056 that some of them were used without such treatment. The number of untreated carbons was small in comparison with those that were treated.

Q. 30. Where is Mr. William E. Sawyer now?

A. He is dead.

Q. 31. State, as near as you can recollect, when he died.

A. I should think it was four or five years ago. I think he died in the summer of 1883. It may have been a year later that he died.

Q. 32. Do you know, and if so, please mention them, of any statements in writing to which you can refer, and by which you can fix the date certainly of the making and reducing of the invention to practice covered by the several claims of the patent in suit?

A. There was an agreement between Mr. Sawyer and myself, contained in a small memorandum book which has been mislaid, or lost. That agreement was dated February 15, 1878, and was referred to by me and quoted in my testimony in the interference between Thomas A. Edison and Sawyer and Man, about the invention of the patent in suit. Its exact words are given at page 201 of a certified copy of Sawyer and Man's supplemental proofs in that interference. The agreement was in the words and figures following:

"Advances to William E. Sawyer on account of experiments in electric lighting, made by Albon Man, and not to exceed in amount $250, and to be returned by Sawyer within fifteen months from date, in case that Man is not satisfied to go on after seeing result of preliminary experiments, for which these advances are made. Dated February 15, 1878. (Signed) W. E. Sawyer." I quote the above from the book referred to.

In addition to this agreement there followed a second agreement, dated March 19, 1878, which I now produce.

1057 The agreement is offered in evidence by complainant's counsel and marked "Complainant's Exhibit No. 27, agreement between Sawyer and Man, March 19, 1878."

The WITNESS: There was also an agreement between Mr. Sawyer and me about these same inventions, dated May 11, 1878, which I also produce.

The agreement is offered in evidence by complainant's counsel and marked "Complainant's Exhibit No. 28, agreement between Sawyer and Man, May 11, 1878."

The WITNESS: These agreements are handed to me by Mr. Broadnax, counsel to the complainant, for production in evidence here, the same having been, and still are, in his custody.

Counsel for defendants consents that typewritten copies of these agreements may be substituted for the originals and used in evidence with the same force and effect as the originals, counsel for the complainant agreeing to produce the originals in case any exigency may arise, making it necessary to do so.

Q. 33. In whose handwriting is the agreement of March 19, 1878?

A. In my own.

Q. 34. It is signed by you and Mr. Sawyer?

A. It is.

Q. 35. Mr. Sawyer signed it in your presence?

A. He did.

Q. 36. In whose handwriting is the agreement of May 11, 1878?

A. In the handwriting of William E. Sawyer.

Q. 37. And that is also signed by you and Mr. Sawyer?

A. It is. It was signed by him in my presence. That agreement of the 11th of May, 1878, it is proper to say, was prepared by Mr. Sawyer himself, and upon his own suggestion, made long be-
1058 fore the date of the agreement. He talked with me about it often, and said he would prepare such a paper, and did so, and we both signed it.

Q. 38. Do these agreements refer to, and include the invention covered by the patent in suit?

A. The first agreement of February 15th, 1878, refers to inventions of Mr. Sawyer alone, and would only cover this matter had it been the sole invention of Mr. Sawyer. The second agreement of the 19th of March, 1878, does not, in exact words or terms, refer to the invention which is the subject-matter of this suit; but prior to this, before the 19th of March, 1878, experiments had been made in the matter. At the time of the third agreement, dated May 11, 1878, the invention had been completed, and is included in that agreement, and was intended so to be.

Q. 39. The paper of May 11, 1878, mentions three joint inventions, namely: Electric lamps, regulators for electric lights and electric lighting systems, and other apparatus and inventions now under consideration. Under which of these heads was included the invention covered by the patent in suit?

A. Under both of them. At the time the paper of May 11, 1878, was made, we had already completed our electric lamp, our regulator, and our lighting system, and were considering further improvements upon them, and the carbon which makes the principal subject-matter of the patent in suit and the combinations covered by the several claims, had also been made before that agreement, and were mostly completed before the end of March, as I now recollect it; certainly before the end of April, 1878. I started in with Mr. Sawyer, with him as sole inventor; but Mr. Sawyer producing nothing practical, I commenced to work with him, and from that time we worked together in the production of these inventions. We worked together from the 6th or 7th of March, 1878, that being the date when we went to No. 43 Centre street. But the realization

that what was produced and done was a joint invention, or
1059 joint inventions, as matter of law, did not come to us until
after the execution of the agreement of March 19, 1878. It was the consideration of the subject-matter of taking out patents referred to in that agreement that brought us to consider the legal question that what was produced was, as matter of fact and law, joint invention.

Q. 40. Is it or not true that from the time that you and Mr. Sawyer started in to work upon electric lighting, at No. 43 Centre street, in the early part of March, 1878, the inventions made and patented by you and him jointly were the joint productions of both of you working together for a common end?

A. It is true that they were our joint productions, as I have already stated.

Q. 41. Can you produce any incandescent electric lamp, or part of such lamp, made in the spring of 1878, in which these carbons were used, about which you have been testifying, of filaments of paper and wood?

A. I now have and produce a glass globe of an incandescent electric lamp which I myself had made at a glass factory in the eastern district, Brooklyn, in the latter part of March, or first of April, 1878, and which I have had in my possession, first as an individual, and second as president of the Electro Dynamic Company, until the spring of 1879, when I took it into my own possession as a sample of one of our globes. It has remained in my possession ever since that time until recently, when I brought it and gave it to Mr. Broadnax, the complainant's counsel. The lamp is peculiar in having a particular size and shape, but more particularly from the fact that the flange of the lamp was made of a separate piece of glass and put on in a melted state upon the globe proper.

In the month of April or May, 1878, and before we left 43 Centre
street, we got a mould for making the flange upon the glass
1060 at the same time as the making of the globe, and ceased to
have the flange put on with a separate piece of glass.

I distinctly recollect the use of the paper, wood and other fibrous carbons in the form of lamp, the globe of which I produce. We did not have any lamp globes made after leaving 43 Centre street, in which the flange was made of a separate piece of glass fused onto the globe.

The lamp globe produced by the witness is offered in evidence by complainant's counsel, and is marked "Complainant's Exhibit No. 29, globe of lamp produced by Albon Man, April 15, 1887."

Adjourned to Saturday, April 16, 1887, at 1 o'clock p. m.

NEW YORK, *April* 16, 1887.

Appearances: Messrs. Broadnax & Bull, for the complainant. Messrs. Tomlinson & Dyer, for the defendants.

Parties met pursuant to adjournment.

ALBON MAN.

Examination continued by Mr. BROADNAX:

Q. 42. I understand from your testimony that the inventions covered by the patent in suit were made and embodied in the lamp that is referred to in the paper of May 11, 1878, as one of your joint inventions previous to the making of that paper. Am I correct in my understanding in that particular?

A. You are.

Q. 44. How long before this paper was made were the inventions of the patent in suit reduced to an operative condition as part of an incandescent electric lamp?

A. The carbons being the subject-matter of controversy in this suit, made of paper, wood and other fibrous substances, were
1061 made and put into the lamps and used, to the best of my recollection, some time in the latter part of March. It may have been the fore part of April, 1878.

Q. 45. And the lamp globe that you have produced here and put in evidence as Complainant's Exhibit No. 29, is a part of such incandescent electric lamp, as I understand you?

A. It is.

Q. 46. What kind of a bottom was used in connection with, or as part of the enclosing chamber of this lamp?

A. At first the bottoms were made of plate glass perforated to admit the passage of the conductors. This was an expensive method, and we at once got a mould for making the bottoms with perforations through them directly from the glass pots in the glass factory. And after we got that mould, which was in March, I think, 1878, we used the glass bottoms made with the moulds. They were similar to the one I now produce, but of a size adapted to the lamp Exhibit No. 29, which I have produced.

Q. 47. Can you produce any of the glass bottoms suited in size to lamp Exhibit No. 29, referred to in your last answer?

A. I do not know. I think so. I will look, and if I can find any, I will produce them. I had some.

Q. 48. State, if you know, who made this glass globe, your Exhibit No. 29.

A. I had globes like those made at two glass factories in the eastern district, Brooklyn. I cannot identify which one, nor can I give the names of the owners of the factories at present. I might find them.

Q. 49. State, if you know, whether this globe, Exhibit No. 29, was blown directly from the pot in the glass factories.

A. It was. I was present at the making of a great number of the globes. I waited at the glass factories to have them blown and made, and saw them made.

Q. 50. After you and Mr. Sawyer went to 43 Centre street,
1062 in March, 1879, did you and Mr. Sawyer make any lamps wholly of glass in which the leading-in conductors were sealed in the closing chamber of the lamp by fusing the glass upon

the conductors, and in which the glass chamber was sealed by the fusion of the glass?

A. Mr. Sawyer did have some of the bottoms fused to the globes of our lamps.

Q. 51. State, if you recollect, when Mr. Sawyer did this and how he did it.

A. In the fall of 1878, while we were at 94 Walker street, Mr. Sawyer got a glass-blower, who had his place directly opposite to ours in Walker street, to fuse some of the bottoms onto the lamps, and fuse glass tubes into the bottoms. The interiors of the lamps were set up, and the glass tubes fused in with the conductors in the glass tubes before the bottoms were fused onto the globes. The bottoms were fused onto the globes after the interior part of the lamp was set up. Mr. Sawyer also had some of our lamps blown in which there were no bottoms separate from the globe, but the conductors were led through the glass of the globes and fused in them, the works of the lamp being set up inside it, before this operation was performed.

Q. 52. As I understand you, Mr. Sawyer, in making these lamps, first made the leading-in conductors, and fixed upon them the illuminating conductor, or incandescent portion, and then after inserting these parts into the globe of the lamp, fused the glass around the leading-in wires, and then fused the tube into the globe for filling and exhausting?

A. Yes, sir; that is right. That was the way with some of them, but in some of them, he first fused the conductors through the bottom, which was a separate piece of glass, and then fused the bottom to the globe.

Q. 53. In that way, as I understand you, an all-glass lamp having its several glass parts fused together was obtained?

1063 A. Yes.

Q. 54. And the leading-in wires fused in the glass?

A. Yes.

Q. 55. How many of such lamps were made or caused to be made?

A. I do not know. Only a few.

Q. 56. Were any of them put in operation?

A. Yes, sir; some of them were in the shop at 94 Walker street.

Q. 57. State, if you know, the name of the glass-blower who made these lamps.

A. I do not know.

Q. 58. Were those lamps made in the latter part of 1878, or in the beginning of 1879?

A. They were made in the fall of 1878, before Mr. Lawrence Meyers came to the shop to stay.

Q. 59. Do you know what became of those lamps?

A. I do not; I think Mr. Sawyer took them.

Q. 60. In the manufacture of your lamps, was it your practice to grind the bottom of the lamp upon, or to the bottom of the globe of the lamp?

A. The bottom and flange of the globe were first ground accurately true upon a lap or face plate. They were then ground together until they were accurately fitted so as to be positively air-tight, and to preserve a vacuum within the lamp without anything further, without any cement, or anything of the kind.

Q. 61. Why did you prefer to make your lamps in that way rather than to fuse the bottom to the lamp?

A. We preferred to make them in that way, for the reason that we could take them down and put them up as often as we pleased, and restore the incandescent portion of the lamp, without injury to the rest of the lamp.

Q. 62. Was it common knowledge with you and Mr. Sawyer, that is, was it a thing well known to you both at the time you
1064 were making these lamps, that the bottoms of the lamps could be fused to the globe as well as ground to the bottom of the enclosing chamber?

A. We not only knew that the bottoms could be fused onto the lamps, and the conductors fused through the walls of the globe or its bottom, but we had had such experience in regard to the matter ourselves, in having the globe of the lamp itself, which was broken, mended, by putting the piece back and fusing it in by the glass-blower. Further than this, we both knew of the common use of Geissler tubes in which the conductors were led through and fused into the walls of a glass chamber in which a vacuum existed or was produced. One of the lamps referred to in my testimony in the interference case with Edison as to this patent, was broken. It was an exhibit in this case. I took it to Mr. Hahn with the piece that had been broken out of it, and he fused the piece in again, restoring the globe of the lamp. This was while we were at 43 Centre street.

Q. 63. Do you wish me to understand that the idea of making the enclosing chamber of the lamp wholly of glass, and having its several parts fused together, was a thing well known to both Mr. Sawyer and yourself, but that you preferred to make your enclosing chamber wholly of glass, having its two parts ground together, instead of fused together, for the convenience of taking the lamp apart and renewing the carbons, or any other part of it in the enclosing chamber?

A. I do; that is exactly what I mean. The fusing of glass together was old and well known, and the fusing of conductors through glass was old and well known. Sawyer and I frequently discussed the subject-matter of fusing instead of grinding and fitting the parts together.

Q. 64. Is it true, as a matter of fact, that it was well known to both you and Mr. Sawyer that it was a common thing to make glass enclosing chambers wholly of glass, having their several parts either fused or ground together, as might be considered most expedient.

1065 A. Yes, sir; it was known in this way. We, both of us, knew of the ordinary receivers of air pumps in which the vacuum is produced, and in which the bottom being of glass, the bell jar was ground and fitted to it; and our method of making the lamp was a mere matter of preference. We both knew of the fusing of the several parts of a glass vessel together, and of the fitting of them together, and we adopted as our ordinary practice the fitting of them together in preference to fusing them together for the reason I have stated.

Q. 65. Please to state exactly what your usual practice was in sealing your lamps so as to maintain a vacuum in the enclosing chamber, or an atmosphere of attenuated inert gas?

A. As I have said, we accurately fitted the parts together, so that a vacuum would be pretty well maintained, in the lamp with nothing further done. We then placed Canada balsam, the exudation from the blisters of the balsam fir tree, upon the glass, very slight in amount, and rubbed the glass parts together with the balsam between them, until they were perfectly transparent, in the same manner as achromatic telescope lenses are made. We then firmly clamped the pieces together and covered the junction with melted wax, or other substance, to exclude all air from it. We then inserted the whole base of the lamp in a cup of melted wax and allowed it to cool so as to exclude all possible air getting at the base of the lamp.

Q. 66. By this method of sealing, did you, as an actual fact, get an enclosing chamber in which you could maintain a high vacuum?

A. We did.

Q. 67. For an indefinite period of time?

A. Yes; so much so that when we took our lamps down it was difficult to separate the parts.

1066 Q. 68. In the use of your lamps, made as you have described, did you experience any difficulty in the sealing of the lamp from the heat generated by the incandescent burner?

A. We did not.

Q. 69. How long did you succeed in getting your lamps to burn continuously or periodically in 1878?

A. For hours, days and weeks; I have testified fully in regard to that matter in the interference case between ourselves and Mr. Edison about this invention, and I have nothing further to add to that testimony; it is correct to the best of my recollection, and I make my testimony on that subject in that interference my answer to your question.

Q. 70. In your last answer you have referred to an interference between yourselves and Mr. Edison. I place in your hands a certified copy of the testimony on behalf of Sawyer and Man in that case; please to take it and state between what pages of that record your testimony is to be found.

A. In the original case my testimony is to be found on pages two to twenty-five, both inclusive, and also on pages 101 to 106, both inclusive, of the same record. In the supplemental record, my testimony is to be found on pages thirty-five to sixty-three, both inclusive.

Q. 71. State whether you have recently read that testimony, and if so, whether you find it correct and true, and whether or not you desire to make any additions to or alterations of that testimony.

A. It is correct and true to the best of my recollection, except in one particular. On page twelve of the original record, in answer to cross-question 42, it appears by the record that I stated, "We moved there (meaning 43 Centre street) on the 6th or 7th of February; of that there is no doubt." The word February is either a mistake of the printer or a *lapsus lingua* of mine. It should be changed to March, so as to read, "We moved there (meaning to 43 Centre street) on the 6th or 7th of March, 1878; of that 1067 there can be no doubt." I then had in my possession a letter from Mr. Sawyer, of the same date as the day we moved to Centre street, referring to the securing of that place, and requesting me to come there, which enables me to positively fix the date. I have read the testimony recently, and I should testify to the same effect to-day, if called upon to do so, as I testified then, according to the best of my recollection.

Q. 72. Referring now to your testimony as given in the interference is that testimony, in so far as it bears upon the date of the making of the incandescent conductor of carbonized paper, applicable and pertinent to the date of the making of such conductors of other fibrous or textile material about which you have testified?

A. It is. The work was done as one whole, and at about the same time in the spring of 1878, and was continued in the fall and winter following.

Q. 73. What was the decision of the Commissioner of Patents in the interference?

A. The Commissioner awarded priority of invention to Sawyer and Man.

Q. 74. Please to produce, if you can, a certified copy of the Commissioner's decision in that interference.

A. I now do so. Copy offered in evidence and marked "Complainant's Exhibit No. 30."

Q. 75. Were you acquainted with William Sawyer, one of the witnesses who testified in the interference?

A. I was.

Q. 76. State, if you know, where he is?

A. He is dead. He was the father of William E. Sawyer.

Q. 77. And the father and son are both now dead?

A. The father and son are both now dead.

Adjourned to Monday, April 18, 1887, at 1 o'clock p. m.

1068 NEW YORK, *April* 18, 1887.

Appearances: Messrs. Broadnax & Bull, for the complainant; Messrs. Tomlinson & Dyer, for the defendants.

Parties met pursuant to adjournment.

ALBON MAN.

Examination continued by Mr. BROADNAX:

Q. 78. Referring to the invention claimed by the patent in suit, what advantage was obtained in incandescent electric lighting by such improvements?

A. By the invention of the patent in suit we obtained a pure homogen-ous carbon burner of exactly the length, form and size we wanted it, a burner that had also the necessary tenacity and density, and one in which the electrical resistance necessary to insure success could be exactly regulated; the production of an illuminating conductor for an incandescent electric lamp having these properties all united in it was a great improvement in electric lighting, as by it, it became possible, taken in connection with other improvements made by us, to make an incandescent electric lamp that was practically permanent; a lamp that cast no shadows, and in which the burner could expand and contract without injury to itself or the lamp.

An illuminating conductor having the properties I have pointed out was a new article at the time we made the invention, and it forms the essential feature of the patent in suit and makes an element in each and all the claims, and upon this element all the claims of the patent depend for their novelty; and upon a carbon burner having these properties depends the practical success of the incandescent electric lamp of to-day.

Q. 79. To what degree of perfection did you and Mr. Sawyer reduce this invention in the spring of 1878?

1069 A. We made a thoroughly operative incandescent electric lamp, having a carbon burner possessing the properties I have specified; and we made a number of such lamps in the fall of 1878 and the winter following; and we also made arrangements to have such lamps manufactured at once upon a commercial scale. The manufacture and introduction of our invention, however, was not carried out until later on by other parties, but not because the lamp as made by us in 1878 was not practical or operative. The failure to manufacture and introduce our invention at the time or immediately after it was first made was due to causes wholly outside of the invention of the lamp in which it was embodied; I do not mean that we did not afterwards make a better lamp by availing ourselves of better workmanship and by perfection of details already embodied in the lamp, but the lamp embodying these inventions which we made in the spring of 1878 was a thoroughly operative lamp.

Q. 80. I place in your hands Complainant's Exhibit No. 21, being Edison's incandescent electric lamp, and I also place in your hands the admission of complainant's counsel as to the manner in which that lamp is made. Please state whether or not, as a matter of fact, that lamp made upon the plan described in that admission embraces and includes an incandescent conductor for an electric lamp of carbonized fibrous or textile material, and of an arch or horseshoe shape.

A. It does.

Q. 81. Please to state whether or not that lamp embraces and includes the combination substantially of an electric circuit and an incandescent conductor of carbonized fibrous material included in and forming part of said circuit, and a transparent hermetically sealed chamber in which the conductor is enclosed.

A. When put into use it does.

1070 Q. 82. Please state whether or not that lamp embraces and includes an incandescent electric lamp composed of the following elements in combination: First, an illuminating chamber made wholly of glass, hermetically sealed, and out of which all carbon-consuming gases have been exhausted or driven; second, an electric circuit conductor passing through the glass walls of said chamber and hermetically sealed therein; third, an illuminating conductor in said circuit and forming part thereof within said chamber, consisting of carbon made from a fibrous or textile material, and having the form of an arch or loop.

A. I cannot know from the appearance of the lamp that the air has been exhausted from it sufficiently or completely, or that it is filled with gas inert to carbon at high incandescence. But taking the defendant's admission as the fact in regard to these things, together with the fact that it would not be an operative electric lamp unless the air were properly exhausted, or it were filled with proper gases replacing the air, and taking his admission as to the character of the carbon contained therein, I answer it does.

Q. 83. In the manufacture of the incandescent conductors for your electric lamps as you have described, did you, as a matter of fact, cut your blanks for carbons to size and shape before carbonizing them, in the year of 1878 and subsequently?

A. We did, ordinarily.

Q. 84. Why did you do that?

A. Because, first, the material before carbonization was more easily worked than afterwards. Second, we selected paper, because it was already reduced to size in one dimension, and its fibres were nearly all in one plane. We cut the wood and other vegetable material so as to have the fibres run in the direction of length of the conductor, as far as practicable, and to reject any imperfect portion of the wood or paper, and, so far as other fibrous material was concerned, to get that which would be perfect after carbonization.

1071 It was impossible to make such selection as to quality of material or disposition of the fibres if the material were carbonized in mass. Third, because by these means we were able to get a pure carbon by the use of these materials cut to shape, without flaws or cracks, with which we were troubled in endeavoring to carbonize in mass, and afterwards to reduce to size and shape; and also because the carbonization of the small incandescent conductors was more perfect and uniform where they were cut to size and shape before carbonization than could be made from substances in mass.

And besides that, it was a very difficult and painstaking work to reduce the carbons to uniform size and of proper tenuity after carbonization. We succeeded in doing it, but our failures were many compared with one success. And even when we succeeded the conductors were deficient in uniformity and homogen*ie*ty. We decided that it was too expensive and unsatisfactory to work them down after carbonization.

Q. 85. What success did you meet with in making these fibrous carbons from willow twigs split up and the pith and bark removed, as you have stated, and bent to shape?

A. We made and used them a good deal, and they made very good lamps. The same is true of the excelsior.

Q. 86. How did the large carbons differ, if at all from the small carbon made of the same material?

A. They differed in size, length and resistance, as I have said. They did not differ in their properties as carbon incandescent conductors.

Q. 87. You say you experienced no difficulty in the sealing of your lamp from the heat generated by the lamp; why then did you use the soapstone disc just below the incandescent conductor?

1072 A. We used the soapstone discs in our first lamps as a mere matter of precaution. At first our lamps did not last as well as we wanted them to. We did not know to what particular cause, of many possible causes, to attribute this to. We suspected one might be the radiation of heat to the part where the lamp was sealed, by which the sealing might be rendered imperfect, thus admitting air to the chamber of the lamp. To avoid this heat radiation we introduced the soapstone disc and the spirally formed conductor, by which means we avoided the heating of the base of the lamp, which was objectionable not only as regards the sealing of the lamp, but also the handling of it. We thought it a good device and patented it. We subsequently ascertained that it was not necessary, and ultimately left it out.

Q. 88. In answer to question twelve you say that in some cases you stuck several thicknesses of paper together before carbonization. Why did you do that?

A. When we wanted a thick carbon we stuck together several thickness- of the paper. When we wanted a thin or fine carbon we made it of a single thickness, or a less number of sheets stuck together.

ALBON MAN.

Direct examination closed.

Subscribed and sworn to before me this 27th day of June, 1887.

JOHN A. SHIELDS,
Examiner, etc.

Upon the conclusion of the foregoing examination-in-chief, defendant's counsel enters the following objections to the question mentioned in each objection, and it is consented that said objections shall have the same force and effect as if made upon the conclusion of each of said questions:

Q. 7. Objected to as calling for a conclusion, and it is insisted that the witness must state what was done by him and Sawyer, which it is asserted constitutes the making of the invention, and witness must define what the invention so alleged to be made is.

1073 Q. 8. Objected to as calling for a conclusion, and it is insisted that the witness must state the facts which it is claimed constitutes a reduction to practice.

Q. 9. Objected to upon the grounds that the question assumes that the invention was reduced to practice and does not call for any fact or facts which show such a reduction to practice; and further that the question calls for a conclusion of the witness as to what was "used," whereas inquiry should be made as to the facts alleged to constitute a use.

Q. 10. Objected to as calling for a conclusion, and defendant's counsel insist that it is entirely improper to ask the witness as to the kinds of wood used, but must ask the witness concerning the facts upon which the alleged use is based.

Q. 16. Objected to as irrelevant and immaterial.

Q. 17. Objected to as calling for a conclusion, and not as to any facts.

Q. 19. Objected to as irrelevant and immaterial.

Q. 21. Same objection, and as calling for a conclusion.

Q. 22. Objected to as irrelevant and immaterial.

Q. 23. Objected to as calling for a conclusion, and defendant's counsel insist that the witness must be asked concerning the facts alleged to constitute the making of the invention; and further, that witness must be compelled to define what the invention of the second claim is.

Q. 24. Same objection.

Q. 25. Same objection.

Q. 27. Objected to as irrelevant and immaterial.

Q. 28. Same objection, and as calling for a conclusion.

1074 Q. 39. Objected to as incompetent, and that the papers must speak for themselves.

Q. 42. Objected to as calling for a conclusion and not asking for any facts.

Q. 44. Same objection.

Q. 49. Objected to as incompetent, irrelevant and immaterial.

Q. 50. Same objection.

Q. 51. Same objection.

Q. 52. Same objection.

Q. 53. Same objection.

Q. 54. Same objection.

Q. 55. Same objection.

Q. 56. Same objection, and as calling for a conclusion.

Q. 62. Same objection as to Q. 49.

Q. 63. Objected to as calling for a conclusion, and as incompetent, irrelevant and immaterial.

Q. 64. Same objection.

Q. 66. Objected to as calling for a conclusion.

Q. 67. Same objection.

Q. 68. Same objection.

Q. 69. Objected to as incompetent, irrelevant and immaterial, and as not calling for any testimony concerning lamps in which the invention of the patent in suit was employed.

Q. 71. Objected to as incompetent, irrelevant and immaterial, and further that the testimony in the interference referred to cannot be made a part of the testimony-in-chief in this case by reference and general corroboration.

Q. 72. Objected to as calling for a conclusion and not as to any facts, and as entirely incompetent, irrelevant and immaterial, and upon the further grounds stated in objection to Q. 71.

Q. 78. Objected to as incompetent, irrelevant and immaterial, and as calling for a conclusion, and, further, as not defining what the invention in suit is.

1075 Q. 79. Same objection.

Q. 80. Objected to as incompetent, and as calling for a conclusion and not for any facts.

Q. 81. Same objection.

Q. 82. Same objection.

Q. 83. Objected to as incompetent, irrelevant and immaterial.

Q. 84. Same objection.

Q. 85. Objected to as calling for a conclusion and not for any facts.

JUNE 27TH, 1887.

Met pursuant to agreement.

Present, counsel as before.

Cross-examination by Mr. TOMLINSON:

X Q. 90. Who prepared the original application for the patent in suit?

A. I do not recollect; I think a Mr. Baldwin had something to do with it, whether he prepared it or not, I can't say.

X Q. 91. Where did you execute the application?

A. I can't recollect.

X Q. 92. Did you and Mr. Sawyer execute it at the same time and before the same officer?

A. I think not at the same time, whether it was before the same officer or not I could tell better by looking at the papers.

X Q. 93. What makes you think that you and Mr. Sawyer did not execute the application at the same time?

A. My recollection of the matter.

X Q. 94. Please to state what you recollect on this subject that gives you this opinion?

A. My recollection is that Mr. Sawyer executed the paper first, and then it was brought to me and I executed it.

X Q. 95. Did you know of its preparation prior to its being brought to you?

1076 A. Yes, I think so.

X Q. 96. Do you know whether you did or not?

A. That is my recollection.

X Q. 97. Had the preparation of this application been a matter of consultation between you and Mr. Sawyer prior to its preparation?

A. Yes, sir.

X Q. 98. Was the application prepared by a lawyer or solicitor of patents, and if so, by whom?

A. I think the draft of the application was made by Mr. Sawyer and myself, or some minutes with reference to it, that Mr. Baldwin, who is a patent solicitor and attorney at Washington, prepared the application, or had it prepared, I don't know which, from the draft or minutes which Mr. Sawyer and I prepared.

X Q. 99. Did you have any interview or consultation with Mr. Baldwin with regard to the application before it was prepared?

A. Yes, sir.

X Q. 100. How many, should you think?

A. At this distance of time I can't recollect more than one.

X Q. 101. As many as three or four?

A. It may be, I don't know.

X Q. 102. Was Mr. Sawyer present at these interviews?

A. No, sir; I think not.

X Q. 103. Where did these interviews take place?

A. In New York.

X Q. 104. At whose office?

A. The first was at my office, No. 3 Mercer street, another at the office of the Electro-Dynamic Light Company, No. 11 Nassau street, still another, and I think several in the Tribune building.

X Q. 105. At whose office in the Tribune building?

A. Mr. Cheever's—Charles A. Cheever.

1077 X Q. 106. Were these all anterior to the preparation of the application?

A. Yes, all these that I have spoken of.

X Q. 107. Having specified three interviews with Mr. Baldwin, and having said several others may have taken place at the Tribune building, are you not now quite confident that more than one took place?

A. Yes.

X Q. 108. Did you retain Mr. Baldwin to prepare the application, or was he retained by some one else?

A. I did not retain him, but I think it would be considered that he was retained by the Electro Dynamic Light Company, by this I mean that I did not retain him personally; I probably did so for the Electro Dynamic Light Company.

X Q. 109. I do not understand your last answer; did you, in person, see Mr. Baldwin, or retain him either for yourself or on behalf of others?

A. I made a bargain with him in regard to the matter for the Electro Dynamic Light Company.

X Q. 110. Was this at your first interview with him?

A. No, sir; I think not.

X Q. 111. What I desire to know is whether Mr. Baldwin had been spoken to by others in this matter before you saw him, or whether his connection with the matter originally came from you?

A. I think Mr. Baldwin was employed at the suggestion of Mr. Cheever.

X Q. 112. Was this before you had seen Mr. Baldwin?

A. The suggestion, I think, was before I had seen Mr. Baldwin, or at the time I first saw him.

X Q. 113. What was Mr. Cheever's connection with the matter?

A. Mr. Cheever wanted an exclusive right for the invention from the Electro Dynamic Light Company that owned it, reserving only the right of the Electro Dynamic Light Company itself to use it, as I recollect, and it may be that he wanted the whole right, I cannot recollect at this time. 1078

X Q. 114. Are you speaking of a time anterior to the preparation of the application?

A. Yes, sir.

X Q. 115. From whom did Mr. Cheever first hear of the invention?

A. I think from me, but I do not know.

X Q. 116. When did he first hear of it from you?

A. Some time before this application was made, how long I can't recollect.

X Q. 117. Did you have more than one interview with Mr. Cheever?

A. Yes, I saw Mr. Cheever several times, not in reference to this subject-matter; this subject-matter came up incidentally at first, in talking with Mr. Cheever about the matter of electric lighting; he called on me at my office a number of times, he was interested in the Jablockoff patent, and was endeavoring, as he represented, to form a combination of electric lighting interests.

X Q. 118. How long before the application was filed did you tell Mr. Cheever about this invention?

A. About a month or two, it may have been more.

X Q. 119. A month or two is your best recollection?

A. Yes. It was in the fall preceding this application.

X Q. 120. Had Mr. Cheever heard of this invention from others, or were you the first to tell him of it?

A. As far as I now recollect I was the first to tell Mr. Cheever of it, though since you called attention to the subject-matter, it seems to me possible that he had seen Mr. Sawyer before I spoke of the subject-matter to him, and may have also heard it from Mr. Sawyer.

X Q. 121. But is it your recollection that you were the first to inform him of the invention, and that he had not heard of it from others?

1079 A. My recollection in regard to the matter is just this, that Mr. Cheever first came to me with a letter of introduction from a friend, and that by an appointment then made and continued he came to my office to see me several times, to talk about electric lighting matters, and that I very fully explained to him at these times many of the inventions which Mr. Sawyer and I had made, among others the subject-matter of the patent in controversy. I remember that at some of these interviews he spoke of matters that Mr. Sawyer had told him about, whether this was one or not I can't recollect, I simply recollect that I told him of it.

X Q. 122. Do you recollect now whether you were the first to inform him of this invention, or whether he had heard it from others first?

A. I cannot, but my impression is that I told him of it first, still I cannot be certain of it.

X Q. 123. Who gave you this letter of introduction to Mr. Cheever?

A. I should think either Mr. Wm. Man, my cousin, or my uncle, Mr. A. P. Man, I don't recollect which.

X Q. 124. You say in your 111th answer that you think Mr. Baldwin was employed at the suggestion of Mr. Cheever, how did Mr. Cheever come to suggest the employment of counsel?

A. Through an arrangement he had made with the Electro Dynamic Light Co.

X Q. 125. What was the arrangement, and when was it made?

A. It was made some little time prior to the application for the patent, I cannot give the exact agreement between Mr. Cheever and the Electro Dynamic Light Co. without the papers before me, and I don't know where they are.

X Q. 126. Was there an agreement in writing between Mr. Cheever and that company?

A. Yes, I think so.

1080 X Q. 127. Do you know where that agreement is?

A. I do not.

X Q. 128. When, and in whose possession did you last see it?

A. I don't recollect.

X Q. 129. Were the papers of the Electro Dynamic Light Co. preserved?

A. They were at that time, yes, sir.

X Q. 130. When was this agreement last in possession of the company?

A. That I don't know.

X Q. 131. Who has the papers of that company now?

A. I don't know, only as to some of them.

X Q. 132. Who, on behalf of the company, conducted the negotiations resulting in this agreement with Mr. Cheever?

A. The directors of the company.

X Q. 133. Which of the directors?

A. I think all of them.

X Q. 134. Mention their names.

A. Mr. Laurence Myers, Mr. Jacob Hays, Mr. Wm. Hays, Mr. Hugh McCulloch, Mr. Horace Little (I think he was a director at the time, I am not certain), Mr. Sawyer, Mr. Thomas Wallace, myself, Mr. H. L. Judd, no other names occur to me at present.

X Q. 135. Which of these gentlemen, to your own knowledge, conducted these negotiations with Mr. Cheever?

A. Written propositions were sent to the company from Mr. Cheever. The trustees met and considered them, and answered them, and the result was finally an agreement between the company and Mr. Cheever.

X Q. 136. Which of these gentlemen to your own knowledge personally saw Mr. Cheever?

A. I think they all saw him, I think he was present at that meeting.

1081 X Q. 137. Did you have any interview with Mr. Cheever on this subject?

A. Yes, sir; I should think so.

X Q. 138. Do you remember what the substance of this agreement was?

A. Not very fully, I remember some of it.

X Q. 139. You say in your 124th answer that Mr. Cheever came to suggest the employment of counsel through an arrangement with the company, what was there in this arrangement which gave to Mr. Cheever the right or opportunity to make this suggestion?

A. I have already explained that Mr. Cheever was endeavoring to secure the right to use the invention or some part of it of the subject-matter of this patent in controversy. He sought to have the patent prepared and obtained by his own counsel, as I suppose any one would under those circumstances.

X Q. 140. Was there anything in this arrangement which gave Mr. Cheever the right to select counsel?

A. My impression is that there was, I cannot be certain at this length of time.

X Q. 141. How long before the application was filed was this arrangement made?

A. I do not know. I can give my best recollection in regard to it.

X Q. 142. What is your recollection?

A. That, a few days before the application was prepared for filing, this agreement was entered into, perhaps a week, perhaps less, perhaps more.

X Q. 143. The application for the patent in suit was filed January 9th, 1880, and was verified January 8th, 1880. How long was the application prepared before it was filed?

A. I think it was completed on the same day that it was verified.

X Q. 144. Was it prepared on the same day?

A. That I don't know. The minutes for the application
1082 made by Mr. Sawyer and I were made previous to the day of execution.

X Q. 145. Was this agreement with Mr. Cheever at about the time of the interviews you had with Mr. Baldwin to which you have referred?

A. No; prior to any interview with Mr. Baldwin; but whether the written agreement was dated at aboat that time I don't know. The actual agreement was made prior to that time.

X Q. 146. What was there in the subject-matter of this agreement which made Mr. Cheever desire to employ his own counsel?

A. I can't answer in any other way than I have answered it in my 139th answer.

X Q. 147. Was Mr. Cheever, as stated by you, desiring to secure the right to use this invention? and was his desire to employ counsel due to the fact that he wished to employ counsel in whom he had confidence?

A. I assumed such to be the fact.

X Q. 148. Did Mr. Cheever contemplate going into the business of electric lighting?

A. He was already engaged in the business of electric lighting.

X Q. 149. What rights did this contract give him?

A. The right to use this invention on the payment of a certain sum of money within a specified time.

X Q. 150. How extensive was the right, both territorially and as to his right to assign to others?

A. I can't recollect the exact details of the agreement. My impression is that he was to have the right to use the invention and have the right to license others to use it throughout the United States. Not the whole invention, but some specified portions.

X Q. 151. Was his right exclusive as against the company?

A. I don't recollect; my impression is that it was not ex-
1083 clusive against the company, but I think the company was
not to license anybody else. I may be mistaken about its not being exclusive.

X Q. 152. Within what time was Mr. Cheever to make the payment you have referred to?

A. I can't recollect the exact time. It was perhaps sixty days.

X Q. 153. Was the time fixed by days, or upon the happening of some event?

A. No, sir; it was a fixed time, not depending on any contingency.

X Q. 154. What was the sum he was to pay?

A. My recollection, one hundred thousand dollars.

X Q. 155. Did he ever pay the money and acquire his rights?

A. No, sir; he allowed it to lapse.

X Q. 156. Did his rights lapse on the expiration of the period named in the contract, or was the contract time extended?

A. I do not recollect any extension; still, I could not swear that there was not any extension.

X Q. 157. Did this contract include the other patents to Sawyer and Man?

A. No, sir.

X Q. 158. You say his right was of a specified portion of the invention; what portion?

A. My recollection of the matter would be that his rights were to be confined to paper carbons.

X Q. 159. Do you know why Mr. Cheever did not consummate this contract?

A. I do not.

X Q. 160. Do you know who was the first person to whom Mr. Cheever broached the subject of the purchase of this right, and who was the person who first broached the subject to him?

A. I think I do.

1084 X Q. 161. Who?

A. I think he first broached the subject to Mr. Sawyer.

X Q. 162. Did he approach Sawyer or Sawyer him?

A. I don't know.

X Q. 163. Who procured the signature of Thomas Wallace to the paper concurring in the appointment of Mr. Baldwin as the attorney in charge of the application? I refer to the paper dated January 9th, and witnessed by you?

A. I don't know. It must have been done by a resolution of the board of directors. I do not recollect the paper.

X Q. 164. At the time this application for a patent was signed, to wit, January 8th, 1880, had not you and Mr. Sawyer quarreled?

A. Before this time we certainly disagreed; I don't think we ever quarreled.

X Q. 165. Was not the Eastern Electric Manufacturing Company formed on the 17th of January, 1880?

A. I have no personal knowledge of the matter, but the certificate of incorporation appears to have been filed on that day.

X Q. 166. Was not that company organized by Mr. Sawyer hostile to the Electro Dynamic Light Co. and the Sawyer and Man interest?

A. I so understood it, and believe that to be the fact.

X Q. 167. Is it not true, then, that at this time, to wit, January, 1880, Sawyer was hostile to the Electro Dynamic Light Company and to the Sawyer and Man interest?

A. I think it is.

X Q. 168. Had not, at this time, your association with Mr. Sawyer as an experimenter, and your personal relations with him ceased?

A. My associations with him as an experimenter had ceased. My personal relations with him had not, if you mean by personal relations personal intercourse.

1085 X Q. 169. Did you not at this time know him to be a man capable of dishonest and dishonorable acts?

A. I believed him to be then, especially at such times as he was under the influence of liquor.

X Q. 170. When did Sawyer and Man cease their experimental work?

A. About March, 1879?

X Q. 171. About when was the last application of Sawyer and Man for a patent prior to the application in suit filed?

A. I can't recollect.

X Q. 172. Had the filing of this application any connection, or was it prompted in any way by the publication in December, 1879, of Mr. Edison's experiments?

A. Yes, I think it had something to do with the filing of this application, in this way: During all the fall of 1879, the Electro Dynamic Light Co. had been trying to get Mr. Sawyer to unite with me in application for patents, this among others. He had refused to do so, except upon conditions not satisfactory to the company; and I think the fact of the publications of Mr. Edison had to do with Mr. Sawyer's consenting to make this application. In fact, I know that; I know the argument was used with Mr. Sawyer by myself when things appeared in the papers claiming what Mr. Sawyer and I had personally invented, that if we laid still and did not make application for them that patents would be granted to others.

Adjourned till Tuesday, the 28th inst., at 1 p. m.

1086 TUESDAY, *June* 28, 1887.

Met pursuant to adjournment.

Present counsel as before and the cross-examination of Mr. MAN proceeded as follows:

Counsel for complainant*s* objects to the cross-examination taken yesterday, June 27, 1887, on the ground that the cross-examination is not pertinent or relevant to anything brought out in the examination-in-chief, and is not in fact cross-examination, and gives defendant's counsel notice that in such examination he makes the witness his own, and that he shall insist on his right to cross-examine the witness upon any matter brought out by the examination that does not pertain to the matter brought out on the examination-in-chief, and counsel further objects on the ground that none of the matter brought out by the examination of yesterday has any pertinency or relevancy to any issue in the cause, and gives defendant's counsel notice of the motion to strike it out.

Counsel for defendant consents that this objection and notice shall have the same force and effect as if made when the questions were asked.

X Q. 173. How long a time elapsed between your first seeing Mr. Baldwin in regard to this application and the filing of the application?

Same objection and notice.

A. I can't recollect definitely.

X Q. 174. What is your best recollection?

Same objection.

A. My best recollection would be, a day or two from that to a week prior to the day of the execution of the application, which was one day prior to the filing.

X Q. 175. Was not the arrangement with Mr. Cheever made prior to your seeing Mr. Baldwin?

Same objection and notice.

1087 A. I can't recollect.

X Q. 176. Do you recollect how Mr. Baldwin came to be in New York at this time?

Same objection and notice.

A. I don't know as I ever knew in regard to it, except that he told me he was attending to other business beside this, and went out to keep appointments therein.

X Q. 177. Did not Mr. Cheever tell you, or write you, that he would telegraph Mr. Baldwin to come on at once?

Same objection and notice.

A. I don't remember.

X Q. 178. If he had so written you, do you think you would have remembered it?

Same objection and notice.

A. I might, or I might not.

X Q. 179. Did Mr. Cheever ever write, or state to you immediately prior to the filing of this application that he was anxious to have it get in the office before the Edison patent was issued?

Same objection and notice.

A. I don't know. I do know that he was not as anxious to have it filed as I was.

X Q. 180. Will you swear that he did not so state to you?

Same objection and notice.

A. I have already said that I did not know.

X Q. 181. Will you swear that you did not know, prior to the filing of this application, that Mr. Cheever's object in getting control of the invention, and in preparing and filing the application, was to get an interference with what he, Mr. Cheever, supposed to be a pending application of Mr. Edison's?

Same objection and notice.

1088 A. I will swear that it was my object and intent to get the application for the patent filed at the earliest day possible, for fear that there might be other applications by other parties, and especially Mr. Edison, already filed in the Patent Office, and I think that both Mr. Cheever and I frequently discussed this matter, and both intended that if any such application were on file to get in interference with it.

X Q. 182. Did you not know that it was Mr. Cheever's purpose to try and sell this application and invention to the Edison Electric Light Co.?

Same objection and notice.

A. No, sir; not especially to the Edison Electric Light Co.

X Q. 183. Did you not know that he intended trying to sell the application and invention to the Edison Electric Light Co., or to others, for a sum larger than the hundred thousand dollars mentioned in his option?

Same objection and notice.

A. No, sir, I did not; on the contrary, it was fully understood, so far as I was concerned, that the application should be prosecuted. It was not to be sold as an application to anybody, as I understood it, but I did fully understand that the invention might be sold by Mr. Cheever, and that he expected to make money in buying it. The only object that I could understand in Mr. Cheever's taking hold of the matter was to make money out of the invention.

X Q. 184. Let me ask you right here whether, since the last session, you have been informed that I have seen Mr. Cheever and had access to his books, letters, papers and memoranda?

Same objection and notice.

A. No, sir, I have not; but I have been informed that you have made application for such purpose, and I expected that you would do so.

X Q. 185. When did you get this information?

1089 Same objection and notice.

A. I got it to-day, but I expected that you would make such application from the outset and in course of your examination.

X Q. 186. Do you remember asking Mr. Cheever, prior to the preparation of this application, and when he made you the conditional offer of a hundred thousand dollars, whether he represented the Edison people or intended to sell to the Edison people, and his replying that he would sell it wherever he could get the most money for it?

Same objection and notice.

A. I recollect at several times asking Mr. Cheever whether he was the agent of, or represented the Edison people, and also asking him whether he represented, or was agent for the United States people, or what was known as the Maxim people. I think it highly probable that this was in reference to other transactions with Mr. Cheever mainly, though possibly with reference to this transaction. I don't recollect distinctly the answer which you propose as made by Mr. Cheever, but think it highly probable, and if Mr. Cheever should say so, I should believe that he made that answer.

X Q. 187. Is it true that before this application was filed you knew Mr. Cheever's object to be to sell out the invention to parties other than the Sawyer and Man interest?

Same objection and notice.

A. Of course I expected that he would sell it, or give licenses to use it.

X Q. 188. Is it not also true that you knew that he thought that the most likely purchaser would be the Edison Company?

Same objection and notice.

A. The fact is that I strongly suspected that Mr. Cheever was the agent of the Edison Company in the transaction.

1090 X Q. 189. Were you not very early disabused of any such suspicion?

Same objection and notice.

A. On the contrary, I was led to believe, and still believe, that it was a manœuvre of the Edison Company, and I will add right here that one or more patents of Sawyer and Man abroad were sold through parties representing themselves as acting for foreign capitalists interested in electric lighting, and it subsequently turned out that the sale was made to Mr. Edison and Mr. Swan, or the companies they represented.

Defendants' counsel moves to strike out all after "I will add right here" as irresponsive.

X Q. 190. Manœuvre of the Edison Company to do or get what?

Same objection and notice.

A. To secure for themselves this invention and the patent therefor.

X Q. 191. And you thought, and think Mr. Cheever was acting for the Edison Company in this behalf?

Same objection and notice.

A. I answered before that I was led to believe, perhaps I should have said suspect that he was acting for the Edison Company, and had some encouragement from them in the matter. That suspicion has never been removed.

X Q. 192. Then, was it your opinion at that time, and is it your opinion now, that Mr. Cheever was acting for and in the interest of the Edison Company?

Same objection and notice.

A. I cannot express it more clearly or succinctly than I have already done. I will say that I thought then that such might be the fact, and I have seen no reason to change my opinion.

1091 X Q. 193. Well, now, what do you mean, that you think he was at this time acting for the Edison Company, or that you did not so think?

Same objection and notice.

A. I mean just what I say, that I suspected it, and didn't know what to believe fully, sometimes I think I believe it, and sometimes I was in doubt, and am in doubt to-day.

X Q. 194. If Mr. Cheever represented the Edison Company, what object could he have had in trying to stop the issue of Mr. Edison's patent by applying for a patent on this alleged invention?

Same objection and notice.

A. A great many people, including Mr. Cheever, knew what Sawyer and Man had done in this matter, and if the Edison people knew it nothing was more natural than that they should desire to control it.

X Q. 195. Question repeated.

Same objection and notice.

A. If the invention of Sawyer and Man were older and better, and he represented the Edison Company, they would control their own application and could also carry on this application without controversy. Mr. Cheever as their agent, might properly be following out their instructions in that particular to prevent future contests, or on the other hand he might be seeking to make money for himself alone.

X Q. 196. In this connection, let me ask whether you were aware of the efforts of Mr. Cheever and Mr. Baldwin to obtain surreptitiously from the Patent Office the position and status of Mr. Edison's applications?

Same objection and notice.

A. No, sir.

X Q. 197. Are you quite confident of that?

Same objection and notice.

1092 A. I am.

X Q. 198. Do you think it possible that you may not be mistaken?

Same objection and notice.

A. I am quite confident of it.

X Q. 199. Are you confident that Mr. Cheever never wrote you on this very subject, and prior to the filing of this application?

Same objection and notice.

A. No, I am not.

X Q. 200. Do you mean he may have so written you on this subject?

Same objection and notice.

A. He may have written me, but the substance of his letters I have not in mind and know nothing about it.

X Q. 201. In this connection let me also ask whether Mr. Cheever did not inform you by letter, that, owing to a depression in the Edison stock, he could not sell out then, and ask you for a further extension until there was another Edison boom?

Same objection and notice.

A. I do not recollect it.

X Q. 202. Are you confident he did not so write you?

Same objection.

A. I have no recollection, that is all I can say.

X Q. 203. Do you wish to be seriously understood as seriously thinking that Mr. Cheever was acting for the Edison Company, and in its interest?

Same objection and notice.

A. I mean to be understood as saying as I did before, that I suspected it, sometimes believed it, and that the suspicion has never been removed from my mind.

X Q. 204. As you now know that I have seen Mr. Cheever
1093 and the papers that he has, I desire to ask whether you now
adhere to the statements made by you yesterday, and which
I shall point out? Are your answers to the 108th and 109th questions true?

Same objection and notice.

A. I think so; I think they are right. Perhaps the word "bargain" may be stronger than I intended. I had an understanding with him.

X Q. 205. Is your answer to question 117 true. I refer particularly to where you said "this subject came up incidentally at first"?

Same objection and notice.

A. Yes, that is my recollection of it.
X Q. 207. Are your 118th and 119th answers true?

Same objection and notice.

A. That is my recollection of it. You will understand me as speaking from recollection only. I don't know anything more about it than I did then.
X Q. 208. Are your 132d to 138th answers, inclusive, true?

Same objection and notice.

A. My recollection is that Mr. Cheever was at the meeting of the directors at this time in reference to this subject-matter, I may be mistaken about it.
X Q. 209. Have you any personal objection to Mr. Cheever's furnishing to the counsel for the defendant his various papers and letters relating to this subject?

Same objection and notice.

A. I have no personal objection. So far as the matter of the business of the company is concerned, I might have objections; that, I could tell better after looking at the papers. In regard to matters not relating to this suit, I object, on general principles, to my correspondence with other people, or their letters to me being produced.
1094 X Q. 210. Have you any personal objection, provided it be proper evidence, to the entire truth in regard to this matter being told by whoever may know it?

Same objection and notice.

A. I have no objection personally to the whole truth in regard to any matter pertinent to the issues in this case being told. In regard to confidential matters between myself and other people, not pertinent to this issue, I have objections.
X Q. 211. In all these questions, are you willing that the court should determine the question of pertinency?

Same objection and notice.

A. The court will ultimately determine the question of pertinency, and I will adhere to my opinion in regard to the pertinency of the matters sought to be introduced here, and the opinion of the counsel for complainant, and will endeavor to keep out matters that are not pertinent.

Mr. Cheever, who is now present, produces certain papers in his possession in one bundle, to be cared for by the examiner as Mr. Cheever's agent, and to be returned to Mr. Cheever at his request, counsel for both parties to have access to the same while in the examiner's possession until recalled by Mr. Cheever.

Adjourned until Thursday, the 30th inst., at 1.30.

THURSDAY, *June 30th*, 1887.

Met pursuant to adjournment.

Present, counsel as before, and the cross-examination of Mr. MAN continued as follows:

X Q. 212. Since Mr. Cheever produced his papers at the last sitting, have you read the same, and have you also read what purport to be copies from his letter books of letters written by him to you in December, 1879, and in the year 1880?

1095 Objected to as incompetent, irrelevant and immaterial, and not cross-examination, and notice of motion to strike out this question and answer is hereby given.

A. I glanced at the package of papers which was left in the possession of the examiner by Mr. Cheever at the time they were handed to him at the last session and cursorily read parts of some of them. I have this morning read over what purported to be extracts from Mr. Cheever's letter book of letters from him to me and other people, including W. E. Sawyer and Mr. Baldwin.

X Q. 213. Did you have any personal acquaintance with Mr. Cheever before he called on you in relation to this alleged invention?

Same objection and notice.

A. I have already stated the manner and time of my becoming acquainted with Mr. Cheever, to the best of my recollection. The question assumes that he called upon me with reference to this invention. Such is not my recollection of the fact, and I do not think that the subject-matter of the invention was a matter spoken of by either Mr. Cheever or myself for some little time after he first called upon me, and then, as I said before, my recollection is that it was mentioned by me to Mr. Cheever incidentally. I had no acquaintance with him before his first calling upon me with a letter of introduction.

X Q. 214. Please look at the paper that I hand you, and state whether it is in your handwriting, and whether it was sent by you to Mr. Cheever.

Same objection and notice.

A. The paper referred to is a letter dated January 5, 1880, to Charles A. Cheever, Esq., it is in my handwriting, signed by me.

Defendant's counsel offers the letter just shown witness in evidence, and the same is marked, "Defendant's Exhibit Man-Cheever Letter," January 5, 1880, June 30, 1887.

1096 Exhibit objected to as incompetent, irrelevant and immaterial, and not cross-examination, and same notice is also given.

Complainant's counsel stipulates that a copy of the exhibit just offered in evidence may be received in evidence with the same force and effect as the original, and subject to the same objections and notice.

X Q. 215. This letter says:

"Yours of this morning received."

Have you in your possession the original letter to which you in this exhibit refer?

A. I do not think I have.

X Q. 216. Will you make a search for the letter referred to, and let me know the result of such search at the next sitting?

A. Yes.

X Q. 217. Please look at the paper I now hand you, and state whether you remember receiving a letter from Mr. Cheever similar to this, and, if you can, whether this is a copy of the letter referred to in Defendant's Exhibit Man-Cheever letter.

Same objection and notice.

Defendant's counsel in looking over the papers given by Mr. Cheever at the last session to the examiner, notices that an original telegram which forms part of said papers has been removed, and requests the examiner to state on the record every fact within his knowledge in regard to the removal of the same.

The examiner states that on yesterday afternoon, about three o'clock, Mr. Bull, one of complainant's counsel, came to examiner's office, and said that Mr. Cheever desired to see his papers in examiner's charge, for the purpose of removing such as were confidential; that examiner, alone, thereupon took the package of papers to Mr. Cheever, whereupon Mr. Cheever looked over the same 1097 and detached therefrom a paper, which appeared to be a telegram, and thereupon handed the remaining papers back to the examiner.

A. I recollect receiving letters from Mr. Cheever during the fall of 1879, and the year 1880. I recollect generally the subject-matter of Mr. Cheever's letters, not, however, to identify by a copy any particular letter, or the contents of any particular letter. If the paper produced is a copy of a letter sent by Mr. Cheever and received by me. I do not think it is the letter of Mr. Cheever referred to by me in my letter to him of the 5th of January, and last put in as exhibit in this case. I do not identify this as the copy of a letter received by me.

X Q. 218. Between now and the next sitting will you look carefully among your papers to see if you have the following letters to you from Charles A. Cheever, substantially as follows:

1. A letter dated January, addressed to you and signed by him, and stating in substance as follows:

"Please bear in mind that the sale of Sawyer light invention, as talked of between us on Saturday last, it is of the utmost importance that I should have the refusal from your company at a very early date. You are, of course, aware the only chance of getting a large price for it is by taking advantage of the present boom on the subject, I hope to hear from you as to progress.

"If the Edison excitement dies out before you give me a chance to take action, the object of my present customer will be frustrated to a great degree, and it is doubtful if he would want it at all.

"Yours truly, CHARLES A. CHEEVER."

2. A letter addressed to you, dated September 30, 1880, and signed by him, stating in substance as follows:

1098 "I note Mr. Baldwin's request in his letter of September 27th, that you furnish him with a full memoranda as to the facts of this invention, especially, exactly what was done with the carbonized paper itself. I will have you do this in writing, include what you told me verbally yesterday and such of the facts as occur to you, and send the same to me, that I may familiarize myself with it and send the same to Mr. Baldwin.

"Yours truly, CHARLES A. CHEEVER."

3. A letter addressed to you, dated July 24, 1880, and signed by him, stating in substance as follows:

"I have information from a party who has recently visited Menlo Park that there will be shortly another electric light boom. I wish to see you in regard to the matter of our horseshoe patent application and other points in regard to the matter. Please call on me between twelve and two either Monday or Wednesday of next week. I shall be out of town Tuesday, am obliged to leave my office early every afternoon in order to reach Rockaway.

"Yours truly, CHARLES A. CHEEVER."

4. A letter addressed to you, dated June 22, 1880, and signed by him, stating in substance as follows:

"I heard from Mr. Baldwin some days ago that it would probably be necessary to appeal the examiner's decision in the horseshoe application, but that there was no hurry in the matter, he would let us know in time and defer acting immediately, understanding that he wished not to incur expense in the matter.

1099 Is there anything new in the matter I spoke to you about some days ago?

"Yours truly, CHARLES A. CHEEVER,
"Per W. S. C."

5. A letter addressed to you dated Feb. 26, 1880, signed by him, and stating in substance as follows:

"I enclose herewith lithograph copy of the ∩ form electric lamp. This is taken from the patent-application drawing; I thought perhaps you would like to have it with your copy of the papers. I understand Mr. Church has kept you posted as to my operations. I have not heard from Mr. Sanders since day before yesterday.

"Yours truly, CHARLES A. CHEEVER."

6. A letter addressed to you dated Jan. 26, 1880, signed by him, and stating in substance as follows:

"Dear Sir: Would your company like to light a large building by electric light of your system? The building at present spends about twelve hundred dollars per annum for gas, and would pay same for electric light. Should like to see you on the subject.

"Yours truly, CHARLES A. CHEEVER."

"I haven't heard from you in answer to mine of the 20th."

7. A letter addressed to you dated May 12, 1880, signed by him, and stating in substance as follows:

"Dear Sir: How long before we may expect to see the new lamps completed? If you will let me know the prospect I will be obliged.
Do you not think it would be a good plan to secure the Hol-
1100 comb regulator if it can be done on proper terms? Holcomb
also has patents on generators which I believe are good. It strikes me he would be a good man to take charge of manufacturing lamps; possessing, as he does, intelligence, electric knowledge and persistency.

"I shall be out of town to-morrow, Thursday, but would like to see you Friday, if it would be convenient to call.

"Yours truly, CHARLES A. CHEEVER."

8. A letter addressed to you March 27, 1880, signed by him, and stating in substance as follows:

"Dear Sir: I have heard nothing more from Mr. Sanders in regard to your matters since the telegram sent to you day before yesterday.

"Since I saw you I have been thinking over the question of electric light exhibition, and am very much convinced of the importance of preparing for one. Can you not arrange with Wallace to have a consultation with him on the subject at my office some time Tuesday next, March 30th; I shall be away on Monday. At such a consultation we could canvass the various aspects of the case and see what was best. If Mr. Wallace would come with a memorandum as to what he had on hand in the way of apparatus which could be put in working shape in that order, it would be of assistance to us in making our plans. I think my electric knowledge is sufficient to take charge of putting up connections, and I know of an old assistant whom I had in telephone business who will work in it with me. At any rate, do not, please, leave Sawyer in charge.

"Yours truly, CHARLES A. CHEEVER."

"I shall be here only till 3.30 to-day. Let me know what you think of the above."

1101 9. Letter addressed to you dated Jan. 20, 1880, signed by him, and stating in substance as follows:

"Dear Sir: I enclose herewith copy of patent just received from Mr. Baldwin; you will observe that all mention of the Ω form is left out. Mr. Baldwin says the horseshoe and fibrous application of Edison is held for interference by the Patent Office. I have developed a new claim from Sawyer for which he applied for a patent within the last two weeks. Have you heard of it? I have a sketch of it. You had better call and see me; it is rather important.

"Yours truly, CHARLES CHEEVER."

10. Letter addressed to you dated Jan. 7, 1880, signed by him and stating in substance as follows:

"DEAR SIR: I enclose herewith a formal letter addressed to your company in regard to continuance of time for me in the arch-form electric matter. I rely on your kindness to more fully explain my views to your associates.

"I have been considering the idea of a combination, or amalgamation of all electric light interests, as suggested by you, and the more I think of it the more I like it. I shall have a plan of operations in the matter to submit to you within a few days. In the meantime I should like to have a written statement from you as to the various points you claim to control, and a list of patents on which you base your claims. I have set agents, who will not be recognized as coming from me, at work to get an idea of some of the other parties whom we will want to join with me.

"Yours truly, CHARLES A. CHEEVER."

1102 11. Letter addressed to you dated Jan. 5, 1880, 5 p. m., signed by him, and stating in substance as follows:

"I have been considering the matter proposed by you. I think perhaps the parties whom I have may be persuaded that it is for their interest to carry out your idea after a little time, but not at a day's notice, as they will wish to investigate the matter; this will take a little time. In regard to the particular lamp they want, *i.e.*, the Edison one, as talked of between us, after they have looked it up and are ready to come to a conclusion, as a 'bird in the hand is worth,' etc., I think it best to sell them what they want now, and then negotiate with them for the balance afterwards. You can get more selling a thing in two parts than we could in one lot. I have just seen Mr. Church; he says Sawyer has promised to do all in his power to help us along. I hope you will be ready to give a definite answer by to-morrow afternoon. I should prefer having my own lawyer draw the application for the horseshoe Edison patent, if we buy the invention. He will come to New York on telegraphic notice from me.

"Yours truly, CHARLES A. CHEEVER."

12. Letter addressed to you dated January 7, 1880, signed by him, and stating in substance as follows:

"I enclose copy of your letter to me of this date.

"Yours in haste, CHARLES A. CHEEVER."

Question objected to—

1st. Upon the ground that it has not been proved that any such letters were written by Charles A. Cheever or received by Albon Man.

2d. That it is not relevant or material or competent in any issue in this case, and

1103 3d. That it is not cross-examination, and notice is given by complainant's counsel that a motion will be made to strike it out, this question and answer.

A. If I am furnished with a list of them, yes.

Defendant's counsel requests the examiner to furnish the witness with a copy of the question at the earliest possible moment.

X Q. 219. If you find you have the letters mentioned in my 218th question, or any of them, will you produce the same at the next hearing?

A. I will be governed by the advice of counsel in regard to the matter.

X Q. 220. Will you bring the letters before the examiner at the next hearing, if you find them, or any of them, so that they may be here for such disposition as may be proper?

A. I will, if so advised.

Counsel for defendant request counsel for complainant to instruct the witness, in case he finds the letters referred to, or any of them, to bring them before the examiner at the next sitting, in order that they may be here present, in custody of the witness, for such disposition as may be proper.

Counsel for complainant declines to instruct the witness as requested by defendant's counsel, unless defendant's counsel can show that such letters have been written by Mr. Cheever and received by the witness, and show upon record that such letters are in some way pertinent and material upon some issue in this case.

X Q. 221. You have stated you would make search and see whether you had such letters, and you have heard read the request of defendant's counsel, and the reply of complainant's counsel. Now, if as a result of such search you find said letters, or any of them, will you produce them here at the next hearing?

A. That remains to be seen.

1104 X Q. 222. Do you decline to state now whether you will or will not produce them?

A. If I find that I have any such letters, and am instructed by counsel to do so, I will produce them. I have no personal objection in producing such letters if I have them, but I am almost certain that I have none.

X Q. 223. In making this search should you find any letters from Mr. Cheever other than those mentioned in my question, will you make a note of the date of such letters?

A. Yes.

X Q. 224. Does your letter to Mr. Cheever of June 5, 1880, refresh your recollection as to when you first made Mr. Cheever's acquaintance? You have stated that you made his acquaintance through his calling upon you with a letter of introduction from your cousin, Mr. Wm. Man, or your uncle, Mr. A. P. Man. In this letter you say:

"After seeing my cousins, I feel better acquainted with you."

Objected to as incompetent, irrelevant, immaterial and not cross-examination, and notice of motion to strike out.

A. It confirms me as to the accuracy of my recollection with regard to the time when I formed Mr. Cheever's acquaintance, as a considerable time prior to the writing of this letter.

X Q. 225. What do you mean by "considerable"?

Same objection and notice.

A. Some weeks prior, possibly more than a month.

X Q. 226. What did you mean by saying in this letter that after seeing your cousins you felt better acquainted with Mr. Cheever?

Same objection and notice.

A. Before this time I frankly told Mr. Cheever that I wanted to know more about him and what his associations were before talking with him further, and he referred me to my cousins, Frederick and Wm. Man.

1105 X Q. 227. Then, immediately prior to this letter, you did not know Mr. Cheever well?

Same objection and notice.

A. Not so well as I wanted to.

X Q. 228. To what did you refer in this letter when you state, "I am at work in regard to the matter to get our people together and answer you," and what was the "large project" you had to propose in place of your (Mr. Cheever's) proposition?

Same objection and notice.

A. I do not remember whether the proposition I was to answer was a proposition on his part with reference to the particular invention in this case, or a proposition with reference to all the patents and inventions of the Electro Dynamic Light Co. He made request in regard to fixing price upon all such patents and inventions, and also as to the invention now in interference, and I can't tell at this time which I referred to. The larger proposition, to which I referred, was the making of Mr. Cheever the instrument or agent for the consolidation of all electric light interests, a project which I deemed would result to the benefit of all parties by avoiding extensive litigation between them, and it was in reference to this matter that I wished to know more about him before talking with him further.

X Q. 229. From this letter it appears that Mr. Cheever had made you a proposition at this time, now what was this proposition to which you in this letter refer as his, it also appears in the letter that you had a "larger" project to propose in place of his proposition; now tell me specifically what this proposition was.

Same objection and notice.

A. I do not so read the letters. The words I use in the letter are,

"Yours of this morning received, and I am at work in regard to the matter to get our people together and answer you."

1106 I refer again to a "project" in place of your proposition the word "proposition" as used here does not imply necessarily anything further than a request to fix a price upon patents and inventions. I do not think in point of fact Mr. Cheever had made an offer for either at this time, for the whole or for any single patent or invention, but if he had the word "proposition" would refer to that.

X Q. 230. You have not been called upon to construe a paper you have never seen before, but you are shown one of your own letters in regard to a transaction in which you took an important part. You either do or do not understand your own letters. I don't want you to quibble on words and phrases, but to tell me, if you know what you meant, and to what you referred in this letter when you speak of "your" (Mr. Cheever's) proposition. If you don't know what you meant, say that, but answer my question?

Same objections and notice.

A. I repel with the scorn it deserves the base and unworthy intimation of quibbling, I think it unworthy of counsel, and utterly uncalled for. I have answered the question fully and entirely, and until some reasonable and proper question is asked me, I refuse to answer further.

X Q. 231. Upon now reading your letter, have you any recollection as to whether Mr. Cheever had stated anything to you which you could have described properly as "your" (Mr. Cheever's) proposition?

Same objection and notice.

A. Yes.

X Q. 232. Was there any matter in——

The witness here says, "I had not finished my answer." Witness continues his answer.

He had stated before this time to me in substance that he was in a position to make a sale of the patents and inventions of the Electro Dynamic Light Co., and that he desired either to sell 1107 them to others or purchase them for himself. He had proposed to me that the company should employ him to make a sale or sell them to him and make a price for them at which they would sell.

Defendant's counsel says that he will move to strike from the record the entire answer of the witness, beginning with "He had stated" as irresponsive.

X Q. 233. Was there any matter in regard to which you were at work on in getting your people together and answer Mr. Cheever?

Same objection and notice.

A. Undoubtedly there was, or I would not have said so in my letter.

X Q. 234. In my 229th question, I asked "What was this proposition to which you in this letter referred as his?" I also stated that it appeared in the letter that you had a larger project to propose in place of his proposition, and requested you to tell me specifically what this proposition was, to which you replied "The word 'proposition' as used here does not imply necessarily anything further than a request to fix a price upon patents and inventions. I do not think in point of fact Mr. Cheever made an offer at this time for the whole or for any single patent or invention, but if he had the word 'proposition' would refer to that." I did not, and do not understand that this answer was anything more than a carefully guarded statement as to what the word might mean, and a more carefully guarded concealment of what you thought them really to mean. If I am mistaken, I regret the severity of my language, but I adhere to my opinion, all I am anxious to know is, first, whether you remember now, not argumentatively or speculatively, but remember what you meant and intended to have Mr. Cheever understand by this letter. I ask this question courteously, and request you to answer categorically?

Same objection, and further that the question has been already fully answered.

1108 A. After reading the letter, I do remember what I intended Mr. Cheever to understand by that letter.

X Q. 235. You have stated that there was a matter at which you were then at work getting your people together. You state here in this letter that you "shall perhaps have a larger project to propose in place of your (Mr. Cheever's) proposition." I understand the fact to be that Mr. Cheever called upon you with the sole view of purchasing the alleged invention, and that you subsequently made to him the proposition that a consolidation of all the electric light interests would be desirable. In other words, at the time this letter was written, his sole proposition was as I have stated, and that the scheme to work at consolidating all the electric light interest eminated from you. Now, I wish to be fair to you, and I show you what purport to be copies of Mr. Cheever's letters to you at, and prior to the date of your letter to him, in which he appears to have written prior to January 5th, as follows:

"Please bear in mind that the sale of Sawyer light invention, as talked of between us Saturday last, it is of the utmost importance that I should have a refusal at a very early date. You are of course aware that the only chance of getting a large price for it is by taking advantage of the present 'boom' on the subject. I hope to hear from you as to progress. If the Edison excitement dies out before you give me a chance to take action, the object of my present customer will be frustrated to a great degree, and it is doubtful if he would want it at all."

I understand what I have just read to be the letter to which you replied in the exhibit; I have also what purports to be a letter to you from Mr. Cheever, dated January 5th, at 5 p. m., in which he says:

"I have been considering the matter proposed by you, I think perhaps the parties whom I have may be *pursuaded* to carry 1109 out your idea after a little time, but not at a day's notice, as they will wish to investigate the matter, this will take a little time. In regard to the particular lamp *i. e.*, the Edison one, as talked of between us, after they have looked it up and are ready to come to a conclusion as 'a bird in the hand is worth,' etc. I think it best to sell them what they want now, and then negotiate with them for the balance afterwards. You can get more selling a thing in two parts than we could in one lot. I have just seen Mr. Church; he says Sawyer has promised to do all in his power to help us along. I hope you will be ready to give a definite answer by to-morrow; I should prefer having my own lawyer draw the application for the horseshoe Edison patent if we buy the invention. He will come to New York on telegraphic notice."

You have stated that you knew what you meant by your letter of January 5th, was not the matter at which you were at work, this alleged invention, and did you not mean by "your" proposition, Mr. Cheever's proposition to get a refusal for it and to apply for a patent. And was not the "larger project" you had to propose the consolidation of the electric light interests?

Objected to—

1st. For the reason that none of the so-called letters quoted from by counsel are in evidence.

2d. That there is no proof in the case that such letters were ever written by Mr. Cheever or received by witness, and

3d. That there is no evidence that witness' letter is in response to the first letter quoted from by counsel in the nature of a proposition from Mr. Cheever. So that if the witness' letter, which is in evidence, is in response to any proposition to Mr. Cheever it could not be in response to that letter. Counsel objects on the further ground, as before, that the question is not pertinent to any 1110 issue in this case, competent or material, and not proper cross-examination, and counsel gives notice of motion to strike out this question and answer, and further objects to the question that it draws false inference from the so-called letters quoted from, and is misleading to the witness.

A. I think undoubtedly the "large project" to which I had reference in my letter of January 5th was the employment of Mr. Cheever in the matter of consolidating all electric light interests. My recollection does not confirm your statement of your understanding or opinion that Mr. Cheever first came to me to purchase this invention alone, but generally with reference to electric lighting matters, but as I cannot know what was in Mr. Cheever's mind or what his intentions were, except by what passed between us, I cannot know but that the purchase of this invention was his sole object. I can only know that other matters were proposed and talked of between us before the subject-matter of this invention came up. I do not think that Mr. Cheever's alleged letter to me first quoted by you is the one to which I replied in my letter of January 5th. The matter of selling all the patents of the electric light Co., and of selling the invention in controversy here, had been a subject of consideration before and up to the time of the writing of my letter of January 5th, it is possible that my letter of January 5th had reference solely to the proposition or plan to sell only the invention, the subject-matter of this controversy, but inasmuch as other propositions or plans were in hand at the same time, in my previous answer I simply wished to say that in my judgment, and according to the best of my recollection, my letter of January 5th did not have reference solely to the sale of the invention in controversy here, but rather reference to the whole subject-matter that had gone before and conversations previously had between Mr. Cheever and myself. I am confirmed in this view of the case from 1111 the fact that I yielded at last to the idea of selling this invention alone, for the reason that my co-inventor, Mr. Sawyer, was thereby induced to sign the application for the patent, which he had up to that time refused to do. I will add that in my own mind it is a matter entirely unimportant whether this letter had reference to the sale of one or the whole of the patents, and I only make the distinction for accuracy's sake, and because it accords with my recollection.

Defendant's counsel gives notice that he will move to strike out all that portion of the witness' answer near the conclusion thereof, and beginning "I am confirmed in this view of the case," as irresponsive.

Adjourned till Friday, July 1st, at 11 a. m.

FRIDAY, *July* 1*st*, 1887.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. MAN proceeded as follows:

X Q. 236. Since the last sitting, have you made careful search among your papers to ascertain whether you had the letters from Mr. Cheever to which I referred in my question yesterday?

A. I have.

X Q. 237. Have you found such letters, or any of them?

A. I have not.

X Q. 238. Did you find any letters from Mr. Cheever to you?

A. None whatsoever.

X Q. 239. Has your search been so careful that you are satisfied that the original letters sent by Mr. Cheever to you cannot be found or produced by you?

A. I may have some letters subsequent to the year 1880, 1112 but I do not think I have. I am confident that I have none of, or prior to, the year 1880 in my possession, and am very positive that I have none relating in any way to the subject-matter of this controversy.

It is stipulated between the counsel for the respective parties hereto, that defendants' counsel be allowed to treat the copies of Mr. Cheever's letters to Mr. Man, made from Mr. Cheever's letter book, and now in possession of counsel, in all respects as the original letters written by said Cheever to said Man, it being understood that the correctness of these letters as copies be hereafter verified by comparison with Mr. Cheever's letter book, and that Mr. Cheever be connected with the writing of the same, said copies to be compared with Mr. Cheever's letter book by the examiner and certified to by him as correct.

Adjourned till Tuesday, the 5th inst., at 11 a. m.

NEW YORK, *July* 5, 1887.

Parties met pursuant to adjournment.

Present: Counsel as before.

The examiner here states that on Saturday, the 2d inst., he attended at the office of Mr. C. A. Cheever, 13 Park row, with the copies of the letters handed to him by Mr. Tomlinson at the last session, and that there compared said copies with the letter books of said Cheever, and that said copies as now corrected by the examiner are true and correct copies from said letter books and of the whole of said letters as copied in said books.

Examiner also says that at the request of complainant's counsel, as made at the last session, he asked Mr. Cheever to restore the telegram heretofore detached by him to the set of papers now in the custody of the examiner, as the agent of Mr. Cheever, for the purposes of this examination, as heretofore appears on this record, but that Mr. Cheever declined to do so, saying substantially, 1113 that it related to confidential matters between himself and Mr. Baldwin, said telegram being referred to in statement of defendant's counsel immediately following cross-question 217.

X Q. 240. Please look at the letters I now hand you and state whether you remember receiving the same from Mr. Cheever at about the time of their respective dates.

Question objected to as being incompetent, irrelevant and immaterial upon any issue in this case, and not cross-examination. And complainant's counsel gives notice to defendant's counsel that all this testimony brought out from this question, and all of the foregoing questions and answers to and of the witness in his examination-in-chief as defendant's witness, and that he shall insist upon his right to treat the witness as defendant's witness in his re-examination of him, and that he will move in due time to strike out the deposition in so far as it pertains to this so-called cross-examination.

A. I remember receiving letters from Mr. Cheever during the period included in the dates of these so-called copies. I remember the subject-matter of some of the things spoken of in these copies; I do not remember the letters otherwise.

X Q. 241. Have you any substantial doubt that letters of which these are copies were written by Mr. Cheever and received by you?

Same objection and same notice.

A. I have no doubt that all of them were written by, or for Mr. Cheever at his dictation and copied in his letter book. The only doubt I have about my receiving them, or his sending them, is that sometimes he told me on meeting me that he had written letters to me, but thought better to call upon me instead, in the morning as he came down town on the way to his office, and having talked with me, I did not receive his letters, I suppose he did not send them; whether these copies are any of those I don't know.

1114 X Q. 242. I do not understand from your answer whether you have any doubt as to receiving these letters, or not; can you not answer me categorically whether you have any doubt as to having received them?

Same objection and notice.

A. I have doubt as to my having received all of the letters, for the reasons stated in my last answer; it is highly probable to my mind that I received most of them, and I cannot say that I did not receive all of them, nor can I say that I did.

X Q. 243. Are you able to point out which of these letters you have doubts concerning receiving?

Same objections and notice.

A. I am not.

Defendant's counsel offers in evidence the following letters from Charles A. Cheever to Albon Man as follows:

Letters dated January and marked Defendant's Exhibit "Cheever-Man Letter of January."

Letter dated January 5, 1880, and marked Defendant's Exhibit "Cheever-Man Letter of January 5, 1880."

Letter dated January 7, 1880, and marked Defendant's Exhibit "Cheever-Man Letter of January 7, 1880."

Letter dated January 7, 1880, and marked Defendant's Exhibit "2d Cheever-Man Letter of January 7, 1880."

Letter dated January 20, 1880, and marked Defendant's Exhibit "Cheever-Man Letter of January 20, 1880."

Letter dated January 26, 1880, and marked Defendant's Exhibit "Cheever-Man Letter of January 26, 1880."

Letter dated February 26, 1880, and marked Defendant's Exhibit "Cheever-Man Letter of February 26, 1880."

1115 Letter dated March 27, 1880, and marked Defendant's Exhibit "Cheever-Man Letter of March 27, 1880."

Letter dated May 12, 1880, and marked Defendant's Exhibit "Cheever-Man Letter of May 12, 1880."

Letter dated June 22, 1880, and marked Defendant's Exhibit "Cheever-Man Letter of June 22, 1880."

Letter dated July 24, 1880, and marked Defendant's Exhibit "Cheever-Man Letter of July 24, 1880."

Letter dated September 30, 1880, and marked Defendant's Exhibit "Cheever-Man Letter of September 30, 1880."

Each and all of the foregoing letters objected to as incompetent, irrelevant and immaterial upon any issue in this case, and not cross-examination, and notice of motion is given to strike them out.

The witness states that of the above letters he has no doubt of having received the one dated June 22d, 1880, and the one dated July 24th, 1880, as he holds in his hands the originals of these letters produced to him by plaintiff's counsel, having been previously given to plaintiff's counsel by me years since, and left in his possession until now.

It is stipulated between counsel that the letters just put in evidence are the copies of the letters compared by the examiner, and referred to in his statement made upon the record at the commencement of this session.

Defendant's counsel offers in evidence the following:

No. 1. Telegram from W. D. Baldwin to Chas. H. Cheever, dated January 6th, 1880, and the same is marked Defendant's Exhibit "Baldwin-Cheever Telegram, January 6, 1880."

1116 No. 2. Telegram from Wm. D. Baldwin to Chas. A. Cheever, dated January 6, 1880, and marked Defendant's Exhibit "2d Baldwin-Cheever Telegram of January 6, 1880."

No. 3. Telegram from Baldwin, Hopkins & Peyton to Chas. A. Cheever, dated January 7, 1880, and marked Defendant's Exhibit "Baldwin, Hopkins & Peyton-Cheever Telegram of January 7, 1880."

No. 4. Telegram from Wm. D. Baldwin to Chas. A. Cheever, dated January 5, 1880, and the same is marked Defendant's Exhibit Baldwin-Cheever Telegram of January 5, 1880.

No. 5. Telegram from Chas. A. Cheever to William D. Baldwin, dated January 6, 1880, and marked Defendant's Exhibit Cheever-Baldwin Telegram of January 6, 1880.

No. 6. Telegram from William D. Baldwin to Chas. A. Cheever, dated January 7, 1880, and marked Defendants' Exhibit Baldwin-Cheever Telegram of January 7, 1880.

No. 7. Press copy of letter from Wm. D. Baldwin to Thomas Wallace, pres't of the Electro Dynamic Light Co., dated January 8, 1880; and the same is marked Defendants' Exhibit "Baldwin-Wallace Letter of January 8, 1880."

No. 8. Memorandum signed by Chas. A. Cheever, and witnessed by William D. Baldwin, and dated January 8, 1880; and the same is marked Defendant's Exhibit "Memorandum of Agreement of January 8, 1880."

No. 9. Letter of Amos Broadnax to Charles A. Cheever, dated January 8, 1880, and the same is marked Defendant's Exhibit "Broadnax-Cheever Letter of January 8, 1880."

No. 10. Letter of Arnoux and Hochausen to Charles A. Cheever, dated January 9, 1880, and the same is marked Defendant's Exhibit "Arnoux and Hochausen-Cheever Letter of January 9, 1885."

1117 No. 11. Bill dated February 1st, 1880, electric lamps, "horseshoe," to Charles A. Cheever, treasurer, for $344.04, and the same is marked Defendant's Exhibit "Horseshoe Cheever Bill of February 1st, 1880."

No. 12. Bill from Hopkins, Baldwin and Peyton to Charles A. Cheever, dated February 1, 1880, for $302.81, and the same is marked Defendant's Exhibit "Hopkins, Baldwin and Peyton-Cheever Bill."

No. 13. Letter from William D. Baldwin to Charles A. Cheever, dated April 27, 1880, and the same is marked Defendant's Exhibit "Baldwin-Cheever Letter of April 27, 1880."

No. 14. Letter from William D. Baldwin to Charles A. Cheever, dated April 27, 1880, and the same is marked Defendant's Exhibit "Baldwin-Cheever Letter of April 27, 1880."

No. 15. Letter from William D. Baldwin to Charles A. Cheever, dated April 29, 1880, and the same is marked Defendant's Exhibit "Baldwin-Cheever Letter of April 17, 1880."

No. 16. Letter from Frank L. Pope to Charles A. Cheever, dated May 12, 1880, and the same is marked Defendant's Exhibit "Pope-Cheever Letter of May 12, 1880."

No. 17. Letter from William D. Baldwin to Albon Man, dated September 27, 1880, and the same is marked Defendant's Exhibit "Baldwin-Man Letter of September 27, 1880."

No. 18. Letter from Albon Man to Charles A. Cheever, dated December 12, 1880, and the same is marked Defendant's Exhibit "Man-Cheever Letter of December 12, 1880."

Each and all of the foregoing exhibits are objected to upon the ground that none of them is proved to be letters, papers, or telegrams written or sent by the parties mentioned in them, or received by the parties to whom they are addressed; and upon the further grounds that they are incomplete, irrelevant and immaterial
1118 upon any issue in the case, and upon the further grounds
that they are not proper cross-examination—not referring to anything brought out by the examination-in-chief—and notice is given of motion to strike them out of the record. Said exhibits are further objected to upon the ground that no connection or privity is shown between the complainant in this action and these letters or exhibits, and the writers, senders or receivers of them. And complainant's counsel demands that defendant's counsel states upon the records how these exhibits, or any of the exhibits put in by him, or any of the testimony given by the witness upon his so-called cross-examination, is pertinent, relevant or material upon any issue in this cause, or how his examination of the witness is in any sense a cross-examination, and upon his failing to do so, he gives him notice that he will instruct the witness not to answer any questions appertaining to said exhibits, and requests the examiner to certify the whole of the witness' deposition to the court, and will thereupon submit to the court whether the witness must answer, and whether the so-called cross-examination is in fact a cross-examination, and whether it shall stand as part of the testimony in the case, or shall be stricken out.

Complainant's counsel submits the witness for cross-examination, and the witness will answer fully upon any matter brought out in the examination-in-chief. This entry is made upon the record in the absence of the witness.

In response to the request of counsel for complainant, counsel for defendant state that they propose to show:

1st. That the invention forming the subject-matter of the patent in suit was never in fact made by Sawyer & Man, and

2d. That if made it was abandoned by them, and that upon such defenses the testimony referred to is material.

1119 Counsel for complainant, in view of the response made by defendant's counsel, consents that the examination proceed, but does not waive his objection to the testimony on the ground that it is not cross-examination, or that it is pertinent, relevant or material or competent upon any issue in this case, but insists upon his objection, and gives notice of motion to strike out the matter objected to.

Adjourned till Wednesday, the 6th inst., at 11 a. m.

NEW YORK, *July 6th*, 1887—11 a. m.

Parties met pursuant to adjournment.

Present, counsel as before.

X Q. 244. Defendant's Exhibit "Memorandum of Agreement of January 8, 1880," the agreement made with Mr. Cheever in regard to the invention in controversy?

Same objection and notice.

A. The paper shown me appears to be solely a memorandum of Mr. Cheever's. It conforms substantially in terms to the agreement between Mr. Cheever and the Electro Dynamic Light Co., according to the best of my recollection of that bargain. It has reference to the whole or a part of the subject-matter of the controversy in this action.

X Q. 245. Were you aware of Mr. Cheever's telegraphing Mr. Baldwin to come on here to New York to prepare the application?

Same objection and same notice.

A. I do not recollect, but I think it probable that Mr. Cheever told me that he had done so, or would do so.

X Q. 246. Were you aware of Mr. Cheever's efforts to ascertain the status in the Patent Office of Mr. Edison's applications for patents?

Same objection and notice.

1120 A. I was not, except that it seems to me that Mr. Cheever was anxious as I was myself to get this application filed before any patent should issue to Mr. Edison or anybody else for this invention, and I think I knew that Mr. Cheever was watching each issue of patents as it was published.

X Q. 247. Did you know, or have any reason to believe or suspect that Mr. Cheever was endeavoring to ascertain the situation or condition of Mr. Edison's application for patents?

Same objection and notice.

A. I did not know, or have any reason to suspect that Mr. Cheever was seeking any information in any way, in regard to Mr. Edison's application or the applications of any others for their inventions in any surreptitious manner, nor to obtain any information which he might not legally and properly obtain, and have from the Patent Office, or from other sources. I did know that Mr. Cheever was very closely watching and trying to obtain information about all inventions having reference to electric lighting, and his information upon the subject was very great, and seemed to me to come from the inventors themselves (including Mr. Edison's) very largely.

Defendant's counsel moves to strike out the answer of the witness as irresponsive.

X Q. 248. Did you know, or have any reason to believe or suspect that Mr. Cheever was endeavoring to ascertain the status of Mr. Edison's applications in the Patent Office?

Same objection and notice.

A. If you mean by this, applications not yet resulting in patents or issues made public, no.

X Q. 249. Did Mr. Cheever show you, or ever inform you of the
telegrams from Mr. Baldwin or from Baldwin, Hopkins & Peyton,
Defendant's Exhibits "Baldwin-Cheever Telegram, January 6,
1880." 2d, Baldwin-Cheever Telegram of January 6, 1880. Bald-
win, Hopkins & Peyton-Cheever Telegram of January 7,
1121 1880. Baldwin-Cheever Telegram, January 5, 1880. Bald-
win-Cheever Telegram of January 7, 1880.

Same objection and notice.

A. I don't think I ever knew or heard of any of these telegrams, further than I think Mr. Cheever told me that Mr. Baldwin, of Washington, would represent the application for the patent.

X Q. 250. Mr. Cheever wrote you on January 20, 1880, Mr. Baldwin says that "the horseshoe and fibrous application" is held for interference by the Patent Office. When you received this letter did this strike you as a peculiar fact for Mr. Baldwin to know?

Same objection and notice.

A. I don't know that I received the letter in the first place; in the second place, if I received it then I have no recollection of how it struck me. In the third place, it does not now strike me as anything peculiar or singular.

X Q. 251. Had you known of the telegrams concerning which I have asked you, would you have considered the action of Mr. Baldwin, in endeavoring to ascertain the condition or position of the Edison application as peculiar and improper?

Same objection and notice.

A. It would depend upon whether Mr. Baldwin was trying to find out what he had no right to know, or of what he had a right to know.

X Q. 252. Did you know then, or do you know now, whether a person can properly obtain from the Patent Office, knowledge of what an inventor has applied for a patent upon or the condition of his application?

Same objection and notice.

A. I do not think that my information then or now is very accurate as to what is kept secret by the Patent Office or what is public. I did, however, then know, or believed I did,
1122 that parties other than the applicant for the patent, had a right to know and be informed by the Patent Office under certain circumstances as to at least parts of what was sought to be patented, and perhaps the whole.

X Q. 253. Under what circumstances could parties other than the applicant obtain information, in your judgment?

Same objection and notice.

A. Parties to interference, parties who had filed caveat upon the same subject-matter, and perhaps, though I am not certain, parties seeking to be put in interference with known or publicly claimed inventions.

X Q. 254. What do you mean by "known or publicly claimed inventions"?

Same objection and notice.

A. I mean the inventions of those who publish the facts of their inventions and of claiming patents for them, or of having made applications for patents for them. In other words, I see no reason for the Patent Office keeping secret which parties themselves make public and advise others of.

X Q. 255. If, prior to the filing of any application by Sawyer & Man, you had known that Mr. Baldwin was endeavoring to obtain from the Patent Office information as to what Mr. Edison had applied for patents on, or the condition of such application, would you have considered his action improper?

Same objection and notice, and further objection that the question is purely hypothetical, and based upon a state of facts not proved to exist, and directed to a person who confessedly has no knowledge of the patent laws; could not know what was improper and what was proper. Moreover, as a matter of fact, that it was strictly proper for Mr. Baldwin to ask the examiner any question he chose, and to take his answer and make such use of it as was proper in the practice of his business.

A. It would depend entirely upon the circumstances of the case. I might think it entirely proper or the reverse.

1123 X Q. 256. If, prior to Sawyer & Man filing the application for the patent in suit, you had known that Mr. Baldwin was endeavoring to ascertain from the Patent Office whether Mr.

Edison had an application for a horseshoe conductor, or a fibrous carbon, and what the state and conditions of such applications were, would you have considered his conduct proper?

Same objection and notice.

A. Without pretending to know or decide whether Mr. Baldwin's action was proper or not, it strikes me that the fact that prior to this time, Mr. Edison had made publication claiming such inventions, and at the same time the publications in regard to his applications for patents were inserted in the newspapers of the day, that it would be entirely proper for Mr. Baldwin being employed, or about to be employed, to prosecute an application for a patent for the same matter, to seek information at the Patent Office as to whether any patent had been issued, or was about to issue for the same matter to Mr. Edison, and to ask questions at the Patent Office in regard to the same, understanding that the examiner and Patent Office officers would withhold such information as was not proper to be made public or to be communicated to Mr. Baldwin under the circumstances, and that it would be entirely proper for Mr. Baldwin to make use of the information so obtained, and communicate it to those who had employed him.

X Q. 257. If, then, you had known that Mr. Baldwin had obtained from the Patent Office information to the effect that the application of Mr. Edison had not passed for issue, you would not have considered his action in getting this information improper?

Same objection and notice.

A. Not necessarily. He could have asked the examiner whether any patents had passed to issue to Mr. Edison lately, and if 1124 the examiner had said no, as seems to me he properly might, the information would have been properly obtained by Mr. Baldwin, and under other conceivable circumstances Mr. Baldwin might have properly obtained this information; but it nowhere appears that this information, or any information, was obtained by Mr. Baldwin from the Patent Office, or through the Patent Office, or that it was not voluntarily communicated to him by Mr. Edison or his agents.

X Q. 258. Now, I understand that you do not know, and never did know, what Mr. Baldwin did, so far as obtaining information from the Patent Office is concerned. Is this correct?

Same objection and notice.

A. I do not know now, and I do not recollect that I ever knew, and I do not believe that I ever did know what Mr. Baldwin did in the matter of obtaining information from the Patent Office, or elsewhere.

X Q. 259. In your 256th answer, you say that "prior to this time (referring to the Sawyer and Man application), Mr. Edison had made publications claiming such inventions." What inventions did you refer to?

Same objection and notice.

A. I referred to the loop-form of carbons, particularly as connected with paper carbons.

X Q. 260. What publications do you refer to?

Same objection and notice.

A. Prior to this time different people came to see me, stating that they had been out to Menlo Park and seen Mr. Edison's electric lamps exhibited there, and described them, and told me the shape and character of the carbons as they had seen it and been told about it at Edison's exhibition at Menlo Park. I do not now remember in detail the publications in the newspapers and magazines, except the one you have referred to—the New York Herald of December 21, 1879; but it seems to me that there were others besides that.
1125 Certainly other papers were publishing about it, possibly copies or extracts from the New York Herald.

X Q. 261. Please to tell me all you remember concerning the preparation for the application of the patent in suit, beginning with the time when you first saw Mr. Baldwin, stating fully what you did in connection with the matter?

Same objection and notice.

A. The final preparations on Mr. Baldwin's coming here of the application was by his taking up for the specifications what Mr. Sawyer and I had told Mr. Cheever, and probably also Mr. Baldwin, before that time, about the making and use of the invention. My recollection is that prior to Mr. Baldwin's coming, which was on the 7th or 8th of January, 1880, a meeting of the directors of the Electro-Dynamic Light Co. was held, at which Mr. Sawyer was present. My recollection is that Mr. Cheever was either present at the meeting or was communicated with during its progress. At that meeting Mr. Sawyer consented to unite in an application for the patent, and to assign it to the Electro-Dynamic Light Co., and a memorandum of the claims to be contained in the patent was made out by me and approved by Mr. Sawyer. Mr. Baldwin was furnished with this memorandum in regard to the claims, and went on to prepare the application for the patent. Mr. Sawyer was not present, nor was I, during the preparation of the application. During the day I was sent for to come to Mr. Cheever's office, and told that Mr. Sawyer had refused to execute the application, claiming that it was not what had been agreed upon between him and me. I then sent to Mr. Sawyer the memorandum that had been made between himself and me, the same as given Mr. Baldwin, I think; and sent word to him that I would execute the application if he would. My recollection is that he made some slight alteration in the memorandum which I sent to him, returned it to me, stating again that the claims were not according to that memoran-
1126 dum. I cannot recollect for a certainty, but think he sent some other paper back, of claims which he proposed. Sawyer sent word that if the papers were brought back to him, and he liked them, he would sign them, and wanted Mr. Cheever or Mr. Baldwin, or both of them, to come and see him. I went away for

my counsel, Mr. Amos Broadnax and Mr. William Man, to advise with me and Mr. Thomas Wallace in regard to the matter. Mr. Wallace came to Mr. Cheever's office; Mr. Wm. Man, Mr. Broadnax and myself also went there; new papers were prepared or the others amended. Mr. Cheever and Mr. Baldwin, I think, and a notary public, went to Mr. Sawyer. I cannot be certain about Mr. Cheever going, but that is the best of my recollection. It may have been Mr. Cheever's man who had been to see Mr. Sawyer before with the notary public.

They were gone a long time. Meanwhile, Mr. Broadnax, Mr. Wm. Man and myself remained, and Mr. Wallace went away, leaving the matter in our hands. The parties finally returned with the application executed by Mr. Sawyer, but not in the precise form in which they took it away. I took the application, and, after consultation over it with Mr. Broadnax and Mr. Wm. Man, I executed it and swore to it before a notary, and gave it to Mr. Cheever or Mr. Baldwin or both of them. Before I went, I required from Mr. Cheever or Mr. Baldwin that the application should be filed immediately. Upon receiving their assurance that it should be done, and that I should be advised by telegraph of its filing the next day from Washington, Mr. Broadnax, Mr. Wm. Man and myself left.

X Q. 262. Do you know what has become of the memorandum of the claims for the patent prepared by you and approved by Mr. Sawyer, and referred to in your last answer?

Same objection.

A. I gave them to Mr. Broadnax.

1127 X Q. 263. Who informed you that Mr. Sawyer had refused to execute the application, claiming that it was not what had been agreed upon by him and you, as stated in your 261st answer.

Same objection.

A. Mr. Cheever and Mr. Baldwin, or both of them, orally.

X Q. 264. By whom did you send to Mr. Sawyer the memorandum of the claims prepared by you, with the word that you would execute the claims if he would?

Same objection.

A. I don't know who the messenger was; I think it was an oral message.

X Q. 265. Who brought you back word from him that the claims were not according to this memorandum?

Same objection.

A. I think the same messenger.

X Q. 266. Do you remember whether you executed the application in Mr. Cheever's office?

Same objection.

A. I think I did.

X Q. 267. Do you know what the occasion was of Mr. Baldwin writing to Mr. Wallace the letter of January 8, 1880, "Defendant's Exhibit Baldwin-Wallace Letter of January 8, 1880"?

Same objection.

A. I think it was a requirement of the Electro-Dynamic Light Co., in order that Mr. Baldwin should be the attorney of the company, and to make it clear that the company had a right to substitute another attorney at any time, and to control the prosecution of the application.

X Q. 268. Were you cognizant at the time of the writing of this letter?

Same objection.

A. I think so.

1128 X Q. 269. Were you the person who requested the writing of the letter?

Same objections.

A. I don't know whether I or Mr. Wallace required it to be written.

Adjourned till Thursday the 7th inst., at 1 p. m.

THURSDAY, *July* 8, 1887.

Met pursuant to adjournment.

Present, counsel as before, and the cross-examination of Mr. MAN continued as follows:

X Q. 270. Were you the active person in the negotiation with Mr. Cheever?

Same objections and notice.

A. I was one of them.

X Q. 271. Between the time that Mr. Cheever first saw you in regard to purchasing the alleged invention, and the day on which the application for a patent was signed, had you seen Mr. Wm. E. Sawyer in regard to the matter?

Same objections and notice.

A. Yes, I think so; that is my recollection.

X Q. 272. How many times should you say?

Same objection and notice.

A. Two or three times, perhaps.

X Q. 273. Was the sale of the invention to Mr. Cheever discussed between Mr. Sawyer and you?

Same objections and notice.

A. My recollection is that it was.

X Q. 274. Did Sawyer tell you he had seen Cheever?

Same objections and notice.

A. I do not recollect.

X Q. 275. Did you tell Sawyer you had seen Cheever?

Same objection and notice.

A. I think so.

1129 X Q. 276. Did you tell him the purpose of Mr. Cheever's call upon you?

Same objections and notice.

A. I do not remember the exact conversations between Mr. Sawyer and myself. They had reference generally, first, to Mr. Sawyer's uniting with me in an application for a patent for this invention; secondly, to Mr. Cheever's being desirous of obtaining the invention or some part of it; and thirdly, after Mr. Cheever had given an intimation more distinctly, that he desired to buy, and the price he would be willing to pay, the consultation had reference to the claims to be made in an application for a patent. In such a consultation it must have been spoken of, or understood between us, that we had both seen, or conferred with Mr. Cheever.

X Q. 277. Did Mr. Sawyer show you the letters he had received from Mr. Cheever?

Same objections and notice.

A. I have no recollection that he did, and think and believe he did not.

X Q. 278. Have you any reason to think that anything was concealed from Mr. Sawyer, or is it your understanding and recollection that he was cognizant of Mr. Cheever's negotiations, and understood his purposes so far as you understood it?

Same objections and notice.

A. I have no reason to think that anything was concealed from Mr. Sawyer which I understood or knew. I don't think Mr. Sawyer knew, and I don't think I then knew of any negotiations or correspondence of Mr. Cheever with other parties than Mr. Sawyer, the Electro-Dynamic Light Co. and myself. In other words, Mr. Cheever was not in the habit of disclosing, and certainly did not to me, very much of his plans, purposes or negotiations with other people.

1130 X Q. 279. You understood, after seeing Mr. Cheever, did you not, that he was not proposing to buy the invention himself, but wanted a refusal to buy it, expecting to sell it to others.

Same objections and notice.

A. After I first saw Mr. Cheever, how long I can't remember, I understood Mr. Cheever was desirous of purchasing the invention himself, and associating others with him in interest in the matter.

X Q. 280. Are you speaking of a time subsequent or prior to the application?

Same objection and notice.

A. Prior. It is proper to add that Mr. Cheever declined, before the option of purchase was given to him, to tell me what he would do with the patent to be obtained for the invention.

X Q. 281. Do you mean to state that prior to the filing of the application you did not understand that Mr. Cheever desired an option, and expected to sell the invention to parties other than himself?

Same objection and notice.

A. I did understand that Mr. Cheever expected to interest other parties, but I got the idea that Mr. Cheever himself intended to remain interested.

X Q. 282. Did you understand that he expected to sell the invention for a price larger than his option?

Same objection and notice.

A. No. I understand that he expected to make money out of the transaction, whether by selling the invention at a larger price as a whole without retaining any interest in it or by interesting others with him to make money out of the interest he should retain. I do not know, nor did not know whether he expected to retain his interest in the invention, such as he could do and obtain the money to pay for it from the other parties interested, but I got the idea
that he expected to personally be interested in or have a
1131 share of the invention or rights under it; at the same time
I did fully understand that Mr. Cheever could, if he saw fit to do so, sell the patent and not retain any interest in the invention.

X Q. 283. What did you understand Mr. Cheever to mean by his letter, Defendant's Exhibit "Cheever-Man Letter of January, 1880," by his statement that to "sell the Sawyer light invention it is of the utmost importance I should have the refusal," and by the further statement that "the object of my present customer would be frustrated to a great degree, and it is doubtful if he would want it all," if the Edison excitement dies out before you give me a chance to take action?

Same objection and notice.

A. I understand that Mr. Cheever would not want to buy it or wanted me to think he would not want to buy it.

X Q. 284. Is that the best answer you can give to my question?

Same objection and notice.

A. I might add more to it.

X Q. 285. Was this letter the first suggestion from Mr. Cheever that he had a customer for the invention?

Same objection and notice.

A. I don't know; it was not the first suggestion that he had parties who wanted to be interested in the matter, or whom he could interest in the matter.

X Q. 286. It would seem from this letter that on the Saturday previous to its date, you and Cheever had been talking of the sale of the invention by him (Cheever). Is such your recollection of the fact?

Same objection and notice.

A. Yes.

X Q. 287. It appears that on January 7th, Cheever sent you a formal letter addressed to your company in regard to a continuance of time in the arch-form electric matter. To what did this continuance of time refer?

Same objection and notice.

1132 A. The letter dated January was written I think by Mr. Cheever to me on Thursday or Friday, probably Friday, of the week prior to my letter to him of January 5th, and had reference to a conversation which took place the Saturday previous to his writing the letter in which the subject-matter of the sale to him was discussed. I think that there must have been some understanding between Mr. Cheever and the Electro Dynamic Light Co., that he would make definite proposition at some time prior to an elapsing time which he had in mind while writing the letter of January 7, and that he wanted more time in which to make his proposition or to carry it out. My impression is that the first idea was that Mr. Cheever should pay the money down at the time of the making of the application, but I am not certain of this.

X Q. 288. Prior to January 7, had you or the Electro Dynamic Light Co. given Mr. Cheever any time in which to do anything with this invention?

Same objection and notice.

A. It would appear by the letter that we had, or had told him that if he did certain things by that time it would probably be accepted.

X Q. 289. Have you any recollection in regard to this subject?

Same objection and notice.

A. Yes

X Q. 290. It would seem from this letter that you understood Mr. Cheever's views, for he asks you, when asking for a continuance of time, to explain his views to your associates. Now does this letter refresh your recollection, and, if you remember, please state the time and for what purpose Mr. Cheever desired a continuance, and who prior to January 7th had given him this time?

Same objection and notice. Counsel for complainant instructs the witness not to deduce or infer anything that may appear on the face of the letters, but to state only what he recollects.

1133 A. I recollect that prior to the refusal which was given to Mr. Cheever by the Electro Dynamic Light Co., on the 8th or 9th of January, other negotiations for the sale of the inventions in controversy had been had with Mr. Cheever, by which he was to take some action or do something, what I do not distinctly recollect, by some fixed time. My impression is, it was to pay some money and make a definite proposition to the company.

X Q. 291. Was there any meeting of the board of directors of the Electro Dynamic Light Co. between January 1st and January 8th, 1880?

Same objections and notice.

A. My recollection is that there was.

X Q. 292. Where are the minute books of the company?

Same objection and notice.

A. I don't know.

X Q. 293. In whose possession did you last see them, and when?

Same objection and notice.

A. I don't remember.

X Q. 294. After the application for the patent was filed, did Mr. Baldwin continue to have charge of it until Mr. Broadnax was substituted?

Same objection and notice.

A. I think so.

X Q. 295. Were you aware, prior to January 8, 1880, of Mr. Cheever's having made any contract with Mr. Sawyer?

Same objection and notice.

A. No, sir.

X Q. 296. Were you aware at the time of the Herald article of December 21st, 1879?

Same objection and notice.

A. I believe I was.

1134 X Q. 297. Were you aware of the article published in Scribner's Monthly for February, 1880, at the time of its publication?

Same objection and notice.

A. I do not remember, but I think it probable.

Defendant's counsel offers in evidence a copy of the N. Y. Herald, of December 21, 1879, containing an article on Mr. Edison's electric light invention, and the same is marked "Defendant's Exhibit Herald Article of December 21, 1879, July 8, 1887."

Defendant's counsel also offers in evidence Scribner's Monthly, for February, 1880, and the same is marked "Defendant's Exhibit Scribner's Monthly, July 8, 1887."

Exhibits objected to as irrelevant, incompetent, immaterial, and not proper cross-examination, and not proved as having been published.

X Q. 298. Were you aware at the time, or did you read at the time, the publication in the New York Sun of December 22, 1879, of the article entitled "Electrician Sawyer's challenge to Electrician Edison"?

Same objection and notice as to last question.

A. I think that I was, Mr. Sawyer, I think, calling attention to it soon after its publication.

X Q. 299. Did you read at the time, or were you aware of the publication in the Sun of January 5, 1880, of the article entitled, "Mr. Edison challenged by Mr. Sawyer"?

Same objection and notice.

A. I do not remember now.

X Q. 300. Did you read at the time, or were you aware of Mr. Sawyer's letter to the Herald, headed: "Sawyer on Edison and the Herald," and published in the Herald on December 24, 1879?

Same objection and notice.

A. My attention was called to that article.

1135 X Q. 301. Were you aware at the time, or did you read Mr. Sawyer's letter to the Herald of January 5, 1880, headed "78 Walker street"?

Same objections and notice.

A. I don't know; I don't recollect.

X Q. 302. Did you read Mr. Sawyer's letter, or were you aware of the publication of such letter addressed to the editor of the Herald, January 6, 1880, and entitled "Mr. Sawyer's exhibitorium"?

Same objection and notice.

A. I don't recollect.

X Q. 303. Were you aware at the time of its publication, or did you read Sawyer's book on electric lighting?

Same objection and notice.

A. I saw the book some time after its publication. I glanced at the book, but never read it, to the best of my recollection.

X Q. 304. Did you, prior to the application for the patent in suit, have any conversation with Mr. Sawyer regarding these publications, or any of them?

Same objection and notice.

A. My impression is that I did, in regard to the first one mentioned, that of the Sun, of December 22, 1879, or of the one in the Herald of December 24th, or both of them. I don't recollect any conversation in regard to the others.

X Q. 305. These two articles that you remember conversing with Mr. Sawyer about, had you read at the time of the conversation?

Same objection and notice.

A. I think so, perhaps not at the first allusion to them. It may have been part of the same conversation.

X Q. 306. Did Mr. Sawyer in these conversations give you to understand that the letters thus published had been written by him?

Same objection and notice.

1136 A. I think Mr. Sawyer asked me if I had seen the paper. My impression of the conversation is that I learned from him that he had caused their publication.

X Q. 307. After the formation of the Electro Dynamic Light Co. on July 11, 1878, did that company have ample means at its disposal to apply for and obtain patents for such inventions as you thought of value?

Same objection and notice.

A. I think it did; certainly by the 1st of September or October following it had.

X Q. 308. Had Sawyer & Man jointly ample means with which to apply for patents on inventions regarded by them as valuable, prior to the formation of the company?

Same objection and notice.

A. I had. Mr. Sawyer had not.

X Q. 309. During your connection with Sawyer, up to the first part of 1879, what were your habits with reference to applying for patents, separately, or you and he jointly?

Same objection and notice.

A. Some were applied for in our joint names, some in the name of Sawyer alone, and I think some, perhaps only one, in my own name, according to the advice of counsel, and the manner of invention whether joint or separate, I don't recollect.

X Q. 310. Were you diligent in applying for your patents on such inventions as were made?

Same objection and notice.

A. I don't think we were.

X Q. 311. Had you not ample means of obtaining such patents as you desired to apply for?

Same objection and notice.

A. No, not at first. Mr. Sawyer was to pay for taking out the patents, and had not much means, and was very economical in his expenditure for patents.

1137 X Q. 312. After your association with Mr. Sawyer, were not you and he amply able to pay for taking out such patents as you thought necessary?

Same objection and notice.

A. I was able to pay for any patent that I wanted to take out; Mr. Sawyer was not.

X Q 313. How about Sawyer and Man jointly?

Same objection and notice.

A. As to Sawyer and Man jointly, we promptly applied for what we considered the main patents. A fixed sum was agreed upon to be paid to Mr. Sawyer, out of which he was to pay for the patents. He was poor, and objected to taking out many patents, and said that after the company was organized all the patents that we needed could be taken out, and they were. I could have personally paid for patents at any time, but did not feel inclined to do so under these circumstances other than we did.

X Q. 314. Am I correct in understanding that upon making inventions which you considered of controlling importance, you promptly applied for patents for the same?

Same objection and notice.

A. Our first applications for patents were made from the 10th to the 15th of May, 1878, as I recollect, and from that time forward until some time in June we made applications for what we then thought the most important things that we had invented from the time we went to work together in February previous, but we knew we were not applying for all, and our judgment as to what were the most important things, in the light of subsequent events, might not be deemed very good.

X Q. 315. After the formation of the Electro Dynamic Light Co., was that company to pay for the taking out of patents?

Same objections and notice.

A. Yes, sir; such as were taken out after its formation?

1138 X Q. 316. Did Sawyer's objection to taking out patents on inventions that were considered of minor importance by reason of his poverty, apply to that company?

Same objection and notice.

A. No, I don't think it applied to that company, that is, I don't mean that it was objecting to taking out patents.

X Q. 317. Am I correct in understanding that the company had ample means to patent such inventions as you or Mr. Sawyer thought desirable?

Same objection and notice.

A. Yes, as soon as arrangements for money were made, which was not until September or October, 1878.

X Q. 318. After that period were they not amply able to apply for and obtain such patents as were considered valuable?

Same objections and notice.

A. Yes, sir.

Adjourned till Monday the 11th inst., at 11 a. m.

MONDAY, *July* 11*th*, 1887.

Met pursuant to adjournment.

Present, counsel as before, and the cross-examination of Mr. MAN continued as follows:

X Q. 318*a*. What is your present recollection as to whether, under the arrangement with Mr. Cheever, the Electro Dynamic Light Company were to have a right to use the invention?

—. ——.

X Q. 318*b*. Was this expressed in the written agreement?

Same objections and notice.

A. My recollection of the matter is that the Electro Dynamic Light Company were to have the right to use the invention, or some part of it, by an understanding with Mr. Cheever.

Same objection and notice.

1139 A. My impression is it was not. My recollection is not clear about it, though.

X Q. 318*c*. Are you quite positive you signed the application at Mr. Cheever's office?

Same objection and notice.

A. Yes, that is my recollection of it.

X Q. 318*d*. Do you now remember who procured the signature of Mr. Wallace to the paper assenting to the appointment of Mr. Baldwin as attorney, witnessed by you and dated January 8th?

Same objection and notice.

A. I don't recollect.

Defendant's counsel offer in evidence letters patent No. 205,144 to Sawyer & Man, dated June 18, 1878, and applied for May 16, 1878, and the same are marked Defendant's Exhibit Sawyer-Man Patent No. 205,144, July 20, 1887.

Also letters patent 205,303, to Sawyer & Man, dated June 25, 1878, applied for May 31, 1878, and the same is marked Defendant's Exhibit Sawyer-Man Patent 205,303, July 20, 1887.

Also letters patent No. 205,305, to Sawyer & Man, dated June 25, 1878, application filed May 25, 1878, and the same is marked Defendant's Exhibit Sawyer-Man Patent No. 205,305, July 20, 1887.

Also letters patent to Sawyer & Man, No. 210,152, dated November 19, 1878, application filed Oct. 19, 1878, and the same is marked Defendant's Exhibit Sawyer-Man Patent No. 210,152, July 20, 1887.

Also letters patent to Sawyer & Man No. 210,809, of December 10, 1878, application filed November 5, 1878, and the same is marked Defendant's Exhibit Sawyer-Man Patent No. 210,809, July 20, 1887.

Also letters patent to Sawyer & Man, No. 211,262 of January 7, 1879, application filed October 17, 1878, and the same is marked Defendant's Exhibit Sawyer-Man Patent 211,262, July 20, 1887.

1140 Also letters patent to Albon Man, No. 227,118 of May 4, 1880, application filed March 31, 1880, and the same is marked Defendant's Exhibit Albon Man Patent 227,118, July 20, 1887.

Also letters patent to Sawyer & Man, No. 229,335, dated June 29, 1880, application filed November 29, 1878, and the same is marked Defendant's Exhibit Sawyer-Man Patent No. 229,335, July 20, 1887.

Also letters patent to Sawyer & Man, No. 229,476 of June 29, 1880, application filed June 25, 1878, and the same is marked Defendant's Exhibit Sawyer-Man Patent 229,476, July 20, 1887.

X Q. 319. When did you first meet William E. Sawyer?

A. Some time in January, 1878, at my house in Brooklyn.

X Q. 320. How did this meeting come about, and at whose introduction?

A. I think through Gen. E. L. Hayes, and perhaps William H. Church.

X Q. 321. State what led to your introduction to Mr. Sawyer, and with what object the introduction was brought about?

A. I had been talking to Mr. Hayes, my neighbor, about electricity, and especially the subject of electric lights; he had come to know Mr. Sawyer, or to know of him, as I understood, through Mr. Church. One, or both of them called upon me and obtained permission to bring Mr. Sawyer to see me; I think first, upon the plea that we were mutually interested in the general subject of electricity, and that it would be interesting to know one another, and might be mutually advantageous.

X Q. 322. Do you mean to be understood that your introduction to Mr. Sawyer was bought about solely by a desire to make personally acquainted two gentlemen interested in the general subject of electricity?

1141 A. So far as I was concerned, yes; I have reason to believe that Mr. Sawyer hoped, by means of the introduction, to obtain financial assistance from me in carrying out some plans he had in mind.

X Q. 323. Please state what those plans were.

A. A plan, or plans for electric distribution, and some system of arc lighting; I do not think I ever got a definite idea of his exact plans in reference to arc lighting, but he had, before he came to see me, taken out a patent, or patents for electrical distribution.

X Q. 324. Was that his entire plan as you then understood it?

A. I do not recollect anything else.

X Q. 325. So far as Mr. Church or Mr. Hayes were concerned, were they at this time aware that Sawyer's object in meeting you was for the purpose of securing your financial assistance for perfecting or developing the plans referred to?

A. I don't know; I suppose so, or something like that, or that I might advise him or direct him to others, but Mr. Church knew that I would not interest myself in any way in the scheme he outlined to me of arc lighting, as I told him so.

X Q. 326. In the interview between yourself and Mr. Sawyer, when he was presented to you by Mr. Church, did he explain to you any plans of his in which he desired your assistance, or did your conversation have *on* reference to business matters?

A. Mr. Sawyer brought with him some diagrams showing his plans of electric distribution and explained them to me, and also spoke of some ideas that he had in regard to electric lamps, and we talked upon that and general electrical subjects, during the course of which I said to him that I did not want to interest myself in the subject, especially in the then present condition of electric lights; the light of which he talked being the arc light; in
1142 the course of the conversation I had taken occasion to state
that Mr. Church had told me that he (Sawyer) having heard of my interest in electrical subjects had hopes that I would interest myself or introduce him to others who would take interest in his projects; he in some measure or in some way assented to this, and said anyway whether I interested myself with him or not he was glad to talk with me. The subject of incandescent electric lights was introduced by me, and I asked Mr. Sawyer what he knew in regard to the subject-matter; he referred to the experiments he had made, and referred especially to those of Lodyguine and King and some others of whom I had heard; we discussed their attempts, and I expressed the opinion that that was the true method of electric lighting, and the only one suitable for interior illumination, and that arc lights were only fit for out of doors and large places; I think Mr. Sawyer at this interview, or at one immediately afterwards within a day or two, told me that he thought he could make an incandescent lamp or permanent lamp, as we called it, in which I had expressed great interest, and then told me he was going to try it. I certainly intimated to him that I might be willing to interest myself in a project of that kind financially, in connection with his system of distribution and other plans of which he had talked, and of which I talked with him.

X Q. 327. When, after the interview referred to in your 326th answer, did you next see Mr. Sawyer, and where?

A. We met almost every day after our first interview at my house; several times at my house, and afterwards at my office in New York.

X Q. 328. What caused these interviews?

A. An appointment at each meeting for a subsequent meeting.

X Q. 329. Was Mr. Sawyer endeavoring to interest you financially in the development of his plans?

A. Yes; both that and to discuss plans with me—plans relating to electric lighting by incandescence.

1143 X Q. 330. Did these plans relate to the invention of a lamp by Sawyer, or to the securing of financial aid for the conduct of experiments in that direction?

A. Mr. Sawyer wanted to make experiments; wanted my advice and assistance as to the apparatus for the experiments, and wanted that I should advance the money for the experiments and be interested in whatever should grow out of them; whether he came to me solely for the purpose of money considerations, after the first I could not know, except that he did not so express himself, but was on the contrary continually asking advice and suggestions from me. I had suggested the matter of incandescent lighting at first, and he seemed very much taken with it.

X Q. 331. As I understand you in your first interview with Mr. Sawyer, he desired your financial assistance in developing his plans of distribution and electric lamps, which you understood to be arc lights, and that you refused your co-operation, stating that you did not believe in arc lights in the then condition of the art, but that you did believe in incandescent lamps of the type of those made by Lodyguine and King, and that you would be willing to further any plan for the development of his system of distribution in the development of those lamps. Am I correct in so understanding you?

A. I do not mean to be understood in the exact manner of your statement in the question.

X Q. 332. In what respect is my statement incorrect?

A. I simply meant to say that I intimated to Mr. Sawyer that I did not want to be interested in his plans as he then presented them to me, and that they had reference to a system of distribution, and of arc lamps in which I had no confidence for purposes of interior illumination and general use in the then condition of the art. I did not commend any type of lamp like Lodyguine's or King's, and only intimated to Mr. Sawyer, after his saying that he
1144 thought he could make a permanent lamp, that I might possibly take an interest in such a thing.

X Q. 333. Is it, then, true that Sawyer stated to you that he thought he could make a permanent or incandescent lamp, and that you intimated to him that you might aid him financially in his enterprise?

A. Substantially, yes, to some small extent, upon condition that I saw any probability of success in his experiments proposed, or to be proposed.

X Q. 334. Is it also true that, after this interview, Mr. Sawyer was continually calling on you, endeavoring to secure your financial aid for the conduct of experiments on incandescent lamps?

A. Your question implies what is true, and what is not true. Mr. Sawyer was calling upon me to get my views of his projects with reference to the experiments of which he wanted and expected me bear the expense. So far as this expense was concerned, he was seeking my financial aid; so far as he was seeking criticism, advice and suggestions from me, he was not. However, this continued but a short time, when, seeing some prospect of success, I agreed to bear the expense of experiments which were immediately commenced.

X Q. 335. When was the agreement made, and was it *it* in writing?

A. I cannot give the exact date, and I do not recollect whether the matter was put in writing at first or shortly afterwards. It was put in writing about the time it was made.

X Q. 336. Have you that agreement, or a copy?

A. I have neither the original nor a copy, and neither is within my control. The agreement as referred to, is in my examination-in-chief; it is dated February 15, 1878, and is quoted in my examination-in-chief, in answer to question 32.

X Q. 337. At what place were experiments first performed
1145 relating to incandescent lamps after the making of the agreement referred to?

A. My recollection is at No. 43 Centre street, New York city.

X Q. 338. Had any experiment been conducted prior to the experiments conducted at No. 43 Centre street?

A. Yes; I think one, and that may have been subsequent to the making of the agreement referred to. I am not positive.

X Q. 339. What was the experiment referred to? Where, and by whom was it performed?

A. At the Coal and Iron Exchange, corner Church and Cortlandt streets, New York city. The experiment consisted in heating up a piece of platinum, or a piece of carbon, I am not sure which, in a bottle filled with ordinary illuminating gas from the gas main, by means of an electric current, and was performed by Mr. Sawyer, assisted by myself. I think Mr. George Sawyer, his brother, was present part of the time, but I am not sure; if he were present, that was all.

X Q. 340. How did you come to be a witness of, or a participant in this experiment?

A. By prearrangement with Mr. Sawyer.

X Q. 341. Please to state what was said by Mr. Sawyer, and fully, what led to your going to the place referred to, to witness or take part in this experiment?

A. I do not recollect the words of the conversation at this time, but only the substance of what took place, that was: In the absence of a laboratory, we could not make any gas; we had no means — exhaustions; no means of preserving a vacuum, or partial vacuum, if obtained; no dynamo for the production of electricity, and under the circumstances, our thoughts reverted to the ordinary gas used for illumination, which by its pressure, could be kept flowing through the vessel to the exclusion of the atmospheric air. Mr. Sawyer said that there was an old bat-
1146 tery at his office which he thought we could rig up to get a current, so we drew diagrams of the holders for the carbon, and Mr. Sawyer's father, who was a machinist, made the holder and cap for the neck of the bottle. Mr. Sawyer himself rigged up the old battery, and when he had got it ready I went down to his place the same day, after office hours, and he and I tried the experiment.

X Q. 341*a*. Do you mean to say that the subject-matter of this experiment had been a matter of discussion between yourself and Mr. Sawyer?

A. I do.

X Q. 342. And that you and he had discussed the general character of the lamp which was made and tried?

A. Yes, I do.

X Q. 343. Is it not the fact that you went to the Coal and Iron Exchange on the day mentioned rather to see a lamp which Mr.

Sawyer had made, and wished to show you, than to take part in the experiment?

A. That is not a correct statement of my recollection of it. It is true, that when I went to the place I did not expect or intend to take any part in the experiment personally, but it is true also, that the whole matter was planned, discussed and talked over between Mr. Sawyer and myself before the experiment was made. It is also true that I considered the matter as a whole, Mr. Sawyer's matter, and not mine, although I had advised and planned with him about it.

X Q. 344. When you went there, was the so-called lamp already put together and charged?

A. No, sir; nor was it there when I got there.

X Q. 345. Please state all that was done, so far as this so-called lamp was concerned, by yourself and Mr. Sawyer on the day and at the place referred to.

A. I think Mr. Sawyer's brother, George, came to my office, and told me that his brother would like to have me call upon
1147 him, giving me his place in the Coal and Iron Exchange,
after I got through with my business, according to some previous arrangement. At all events, I went, found Mr. Sawyer and his brother there; but none of the apparatus ready. Sawyer set his brother George to filling the battery, busied himself in hunting around for some of the apparatus, I forget what, perhaps some of the rubber tubing or wire, that was to be used. I was in a hurry, and he sent George off somewhere to get the holders and cap. To hasten matters, I took hold and filled the battery. George was gone so long that Mr. Sawyer went down after him, and brought back the cap, with its holder, and a bottle. I think George did not return with him. The thing was crude and unfinished. There was no stop-cocks; so we tied up the rubber tubing, connected to the inlets and outlet tubes of the lamp, if it may be called a lamp. After allowing the gas to flow into and out of the bottle until the air was all driven out it was filled with gas. Then we turned on the current, and heated up the incandescent conductor between the holders, and I think we repeated the operation twice or possibly three times, until we finally melted the junction between the incandescent portion and the holder, when the thing went out.

X Q. 346. Please make a drawing of the so-called lamp to which you have referred?

A. I do.

X Q. 347. Were the globes of the shape shown by you?

A. I think it was a Florence flask about that shape. There was only one, and I think I got it for Mr. Sawyer. By that shape, I mean the shape of Florence flask.

X Q. 348. What was the size and character of the incandescent conductor?

A. Its size, according to my recollection, was about one-sixteenth of an inch, possibly a little larger in diameter, or possibly
1148 less, and from five-eighths to three-fourths of an inch in length.
My impression is that it was a broken, angular splinter of gas-retort carbon.

X Q. 349. What was the object of this experiment?

A. There were two objects. The first was to see an incandescent lamp, the next was to ascertain whether hydrogen gas would be a suitable substance with which to fill the lamp to prevent the consumption of its illuminating part, and at the same time be safe from explosion; the explosive property of hydrocarbon gas, which we used, being the same practically as pure hydrogen when either is mixed with air; we used the hydrocarbon gas; we could not get hydrogen conveniently.

X Q. 350. Aside from the desire to see an incandescent lamp, am I correct in understanding that the sole object of this experiment was to ascertain if an explosion would occur when burning the conductor to incandescence in any atmosphere of hydrogen or hydrocarbon which contained atmospheric air?

A. Yes, in substance; that we wanted to know how carefully, and to what extent the air would have to be driven out by the hydrogen or hydrocarbon gas to prevent, first, the destruction of the carbon by burning, and second, explosion.

X Q. 351. How long did the conductor remain incandescent in the experiment referred to?

A. Not more than ten or fifteen minutes at a time, I should think.

X Q. 352. How many times was the conductor incandescent?

A. I cannot recollect; several times, and the thing was refilled more than once.

X Q. 353. Was the same carbon used each time?

A. No, sir. I think separate splinters of carbon were used.

X Q. 354. And the flask refilled each time new carbon was used?

1149 A. Yes, sir.

X Q. 355. What was the occasion of changing the carbon, or refilling the flask?

A. I think the carbon fell out of the holders.

X Q. 356. What time did you get to the office of Mr. Sawyer, and how long did you remain there on the day in question?

A. I cannot recollect with accuracy, but my impression would be that I got there between 4 and 5 o'clock, and left there between 7 and 8.

X Q. 357. Am I correct in understanding that the experiment to which you have referred was the only experiment performed prior to your going to Centre street?

A. I have no recollection of taking part in any other experiment than that before going to Centre street.

X Q. 358. Did you witness any other, or learn of any other?

A. No, sir; I have no recollection of hearing or seeing any other experiment.

X Q. 359. Did you or Mr. Sawyer hire the room in Centre street? Do you remember what rent was paid, and whether you paid rent from the time you took the room?

A. I do not recollect whether the arrangements were made by Sawyer or myself, or by both, for hiring the room, but think Sawyer looked it up and engaged it. I paid the rent; am under the impression that rent did not commence with the commencement of occupation, but only after some time elapsed. I do not recollect what the rent was.

X Q. 360. What gives you the impression that your rent did not date from the time of occupancy?

A. The fact that at first we had no power, and had no machinery to run by power, and used a dynamo which was in the cellar below us, and which belonged to Arnoux & Hochausen, and over which we had no control, or its running. Also that arrangements
1150 for power and fitting up the room were made by the owner
or his representative after we went there. I think our occupation at first was by favor to us from the owner or his agent or representative to allow us to avail ourselves of the use of the dynamo, and in hopes that we would hire the room which was vacant.

X Q. 361. How soon after you went there did the payment of rent date from?

A. I can fix it with no certainty whatever. It may have been a week or ten days, and I think that most probable. Or it may have been only one or two days, or up to 20 or 22 days.

X Q. 362. Did you take a lease of the premises for any specific period?

A. I do not think we took a lease. We simply paid money and took a receipt for it, or simply paid it without a receipt, making a memoranda of it.

X Q. 363. Did you agree*d* to take the room for any definite time?

A. I cannot recollect, but am under the impression that we paid for it month by month, for so long as we wanted it.

X Q. 364. Do you mean so far as any obligations on your part to the lessor were concerned you could leave at the expiration of a month or two months or any period you saw fit?

A. Yes; and I think the landlord could compel us to leave at the expiration of any time for which we had paid.

X Q. 365. Did you pay your rent by the month, or how?

A. I do not know, but am under the impression we paid oftener, and in advance.

X Q. 366. Is it your impression that if there was any occupancy without the payment of rent it was merely for a few days prior to some well-established rent day?

1151 A. Yes, or to the usual day of payments by tenants in that building, of which there was a large number.

X Q. 367. Have you any receipts or papers, checks or check stubs, or memoranda showing during what period rent was paid, and if so, will you produce them at the next sitting?

A. I do not think I have any, but will look for them, and if I find any produce them.

X Q. 368. What arrangements for power and fitting up the room were made by the owner? Describe in detail what fitting up was done.

A. Some shafting and pulleys were put up, floors mended, windows fixed, doors closed off, work-benches put up, partitions run, some or nearly all of which was done by the owner, and some at our expense.

X Q. 369. Are you quite positive that there were no pulleys and shafting in the room when you first occupied it?

A. No. I am quite positive that there were pulleys and shafting in it, but additional pulleys were put up, and the same or other shafting was taken down, adjusted or rehung, so that we could get power from it.

X Q. 370. Did not arrangements exist in the room prior to your occupancy?

A. I think that the pulleys and shafts that were there were adjusted and in use for power in other parts of the building, and could only be used in this room by disconnecting the power elsewhere in whole or in part.

X Q. 371. If it be the case that you occupied the premises in question for any period without the payment of rent, is it your impression that you occupied them merely so long as it may have taken to make the alterations or repairs referred to?

A. No, sir; but the fact that these things were being done and were necessary before we or anybody else could make use of the premises, together with some dim recollection, makes me
1152 think that the rent did not commence to run for some time after we went there; but as I said before, I am not positive in regard to this.

X Q. 372. When was the experiment in the Coal and Iron Exchange made, and when did you hire the room in 43 Centre street?

A. It is my present recollection that the room in question was hired on the 7th day of March, 1878, but occupied by us on the 6th day of March, 1878, and I believe that the experiments to which I referred as taking place at the Coal and Iron Exchange, took place on the 6th or 7th day of February, 1878. I know it took place prior to the 15th day of February, 1878.

X Q. 373. When did you give up the rooms in Centre street?

A. I forget whether in May or June, 1878. I should have to try and refresh my recollections in regard to it to be certain. This I will endeavor to do.

X Q. 374. Please describe with reference to the room you occupied in Centre street, the basement in which was the machine owned by Arnoux and Hochausen, to which you have referred.

A. As I recollect, our room was on the second floor on the northwest corner of the building. Arnoux & Hochausen's machine was in the basement underneath us, or cellar, I don't know which, with entrance from the court. The wires were run from the machine, on the outside walls of the court, and into a window of our room.

X Q. 375. By what power was the armature of the dynamo driven?

A. By a steam engine.

X Q. 376. Do you mean by a separate steam engine that was placed there for that purpose, or by the ordinary engine in use in the building?

A. I do not think there was a separate engine put in for
1153 the purpose; the armature of the machine, when driven at
all, was connected by a belt, pulleys and shafting driven by
an engine in the building.

X Q. 377. Was this the machine used by you during your stay in Centre street?

A. No, only at first. The first day or two, or three, perhaps.

X Q. 378. What other dynamos, if any, did you have while there?

A. We had two or three of Arnoux & Hochausen make; one built especially for us, and the other, or others, loaned to us by them. A Weston machine or two; some other, possibly a Farmer-Wallace machine, or possibly some other manufacturers'.

X Q. 379. Are you able to state definitely how many, and what machines, you had while at Centre street?

A. No.

X Q. 380. Why are you not able so to state?

A. Because we had a considerable number and variety of machines which we so tried.

X Q. 381. Are there no books, correspondence, papers, or memoranda of any kind, which would show just what machines you had, and where you obtained them?

A. I think not, except an agreement of Mr. William Hayes for the purchase of the one machine of Arnoux & Hochausen, which we bought. The other machines were loaned to us, or sent in on trial.

X Q. 382. Can you state what machines were used by you in Centre street in your experiments, as distinguished from those you merely had on trial?

A. I should think that we principally used Arnoux & Hochausen machines.

X Q. 383. In the months of March, April, May and June, 1878, please state how many makers of dynamos there were from whom machines could have been procured?

A. I don't know.

1154 X Q. 384. You have stated that the Arnoux & Hochausen
machine which you first used was in the basement. Please
state when it was that you first got a dynamo in your room in
Centre street, and from whom you got it.

A. My recollection is that about the time the machine in the basement was taken away, or perhaps before then, we had agreed with Arnoux & Hochausen, or rather Mr. Wm. Hayes had for us agreed with them, to purchase a machine, and that in the meantime, and within a few days after we went to 43 Centre street, they loaned us a machine and kept on supplying us with a machine for most of the time up to the 25th of March, 1878, when the machine bought from them was delivered to us at 43 Centre street.

X Q. 385. What enables you to fix the 25th of March as the date of delivery of the machine to you?

A. I subsequently bought the machine and paid for it, and now have it, and the original bill for the purchase was endorsed over me, and I have it. I now produce this bill.

X Q. 386. Is this the bill of the first machine purchased for you in experiments in Centre street?

A. It is.

The same is offered in the evidence, and it is stipulated between counsel that a fac-simile copy be marked in evidence, and that if either counsel request the original to be produced at the hearing the same will be produced by complainant's counsel, and the same is marked "Defendant's Exhibit Dynamo Bill."

Counsel for complainant objects to the exhibit as not appertaining to anything brought out by the examination-in-chief, and as not pertinent or material to any of the issues of the case, nor as part of a legitimate cross-examination.

Witness adds: I desire to state that this machine may have been delivered prior to the 25th of March, 1878, but was certainly delivered as early as that date.

1155 X Q. 387. What enables you to fix that date as the day of delivery of the machine, or prior to which it was delivered?

A. The bill and my recollection after seeing the bill.

X Q. 388. Have you any memoranda by which you fix this date outside of the bill itself, or is there any circumstance which enables you to fix that date?

A. My recollection is that the machine was to be specially wound; that is was delivered and tried. Mr. Hayes came to see it perhaps immediately, perhaps after some days, and then gave a check to pay for it. I do not know of any other memoranda, and I don't recollect at this moment of any other circumstance.

X Q. 389. What is meant by the words "No. 1," in this bill?

A. I don't know, but suppose it to refer to the character of the machine.

X Q. 390. What is meant by the entry beginning with "May 6th, '78," and ending with "Jacob Hayes," at the bottom of the bill, and is that entry in your handwriting?

A. It means just what it says, and it is in my handwriting except the signature, which was made by, and is in the handwriting of Jacob Hayes.

X Q. 391. How did you come to purchase this machine from Mr. Hayes?

A. Mr. Hayes became one of the stockholders in the organization of the Electr*ic*-Dynamic Light Co., and wanted me to take the machine and pay him for it, and then I think the same money was applied on his subscription for stock.

X Q. 392. Is it your present recollection that the light machine in the basement of the building was removed some two or three days after you went to Centre street?

1156 A. It is; but speaking from recollection after nearly eight years, and the time may have been longer than two or three days or even a week.

X Q. 393. Do you feel quite confident that it was not over a week?

A. I can only say that I think it was not, but it may have been. I am not extremely confident.

X Q. 394. I understand your recollection to be that you went to Centre street, the 6th or 7th of March; that the light machine referred to was in the basement at the time and remained there some two or three days, or possibly a week thereafter, and that the machine mentioned in the exhibit was delivered on the 25th of March? From the time of the removal of the light machine to the delivery of the machine mentioned in the exhibit, what machine, if any, did you have?

A. We borrowed from Arnoux & Hochausen one, two or three machines similar in form to the one we bought of them, but not specially wound for lighting. My recollection is within a day or two after we went into the building, and from that time up to the time when the machine we bought was delivered, and perhaps afterwards. It was one or more of these borrowed machines that we had for use during the period of which you inquire.

X Q. 395. And no other?

A. I don't recollect.

X Q. 396. After receiving the machine mentioned in the exhibit, was any other machine used or tried by you in Centre street?

A. Yes; similar Hochausen machines, also Weston, and I think Farmer & Wallace, but I cannot be certain now, whether the trials of the Weston, and Farmer & Wallace were before the 25th of March, 1878, or after, but I think they were after. We also probably tried another machine, but I don't recollect the maker's name.

X Q. 397. Was any other machine bought by, or for you while in Centre street?

1157 A. I think not. We ordered another and different kind of Arnoux & Hochausen, but I think it was after we left Centre street.

X Q. 398. Can you not state just how many machines you had while in Centre street, either in use or on trial?

A. No, sir.

X Q. 399. Can you state what machines were used in contradistinction to those you tried, but did not use?

A. Yes, mainly we used a large lighting machine which Arnoux & Hochausen had in the basement, the machine referred to in the bill "Defendant's Exhibit Dynamo Bill;" one or more machines similar to the last one mentioned made by Hochausen, but not specially wound; one or more Weston machines, but of these last we made little use.

X Q. 400. Were there machines other than the light machines in the basement placed in your room in Centre street?

A. Yes, sir.

X Q. 401. How were the armatures of these machines driven?

A. By steam power through shafting, pulleys and belting in the room connected by a belt to a pulley in another room.

X Q. 402. Am I correct in understanding that you had no separate engine, but depended on the power in the building, and that the armatures of the machines in your room were belted to pulleys in the building actuated by the steam power in the building?

A. Yes.

X Q. 403. Was any change made in the pulleys and shafting in the room after you went there?

A. Yes, sir.

X Q. 404. Please state what changes were made by you and Mr. Sawyer, or by the direction of either, in the pulleys or shafting?

1158 A. I cannot recollect details, except that we bought one or more pulleys, and I think some shafting and hangers, counter-shaft and apparatus, fast and loose pulleys and belting, and the engineer of the building, I think, put it up, assisted by Mr. Sawyer's father, who was employed by us; possibly part was paid for by the landlord, or may have been furnished by him.

X Q. 405. From whom were the articles mentioned purchased, by whom, and who paid for them?

A. I paid for them. I think they were selected by Mr. Sawyer's father and myself at several machinery places on Centre street and its vicinity.

X Q. 406. Can you not remember, or have you no means of ascertaining, at what places these purchases were made?

A. I cannot now remember, and don't know that I have any means of ascertaining.

X Q. 407. Did you keep any memoranda of expenses incurred by you while in Centre street, or no account of moneys expended?

A. Yes; I kept a memoranda of what I paid out at first as a loan, and after we had an agreement, I think March 19th, or thereabouts, as applying upon our agreement.

X Q. 408. Do you mean that you kept an account of moneys expended by you, showing when, for what, and to whom such moneys were paid?

A. I think not generally, but only of the dates, amounts and what they were for.

X Q. 409. Would the purchase of the things referred to appear in such accounts?

A. The amounts paid by me for things would appear, I think, and I think that the things purchased, but not unfrequently these memorandums would be made by Mr. Sawyer, by my telling him what the things cost.

X Q. 410. How were the accounts kept, in a book?

A. No. No regular accounts were kept. I had a little pass book in which I was in the habit of entering the amounts

1159 paid out, including money given to Mr. Sawyer, but many of the entries in this book covered one entry as expenditure on account of electric lighting, what I paid out for things, and money given to Mr. Sawyer. The object of the book was for my own information, in order that I might keep within the limit of the amount of money which I was to advance under my agreement with Mr. Sawyer.

X Q. 411. What has become of that little book?

A. I don't know.

X Q. 412. When did you last see it?

A. It was used in the Edison interference case, and an extract from it appears in my testimony in that case, and I do not recollect to have seen the book since, and it was then in the hands of Mr. Amos Broadnax, counsel.

X Q. 413. Were the shafting and pulleys mentioned by you put up, and if so, how long did it take to place them in position?

A. Yes, they were put up. I cannot recollect, not long, probably.

X Q. 414. About how long?

A. It was only a small amount of work and may have taken not more than a day or so.

X Q. 415. Please state as nearly as you now recollect, what were the shafting and pulleys and hangers in the room in Centre street when you went there, and what changes in them and additions to them did you make while there?

A. I will give the best of my recollections, but cannot assume them to be accurate. There were one or more shafts in the room driven by the power in the building, on which were several pulleys of different sizes. We put onto one of these shafts an iron pulley of larger diameter than in the room. We also put up one or more pieces of shafting, supported by hangers parallel to the shafting that was in the room and having iron pulleys on it or them, some of
1160 which were fast and others loose; belting between the pulleys on the shaft and means of shifting from fast to loose pulleys, and reverse; belting from the pulleys of the shafts that we put up to the dynamos that we used. I think this was all that might be called machinery that we put up. It seems to me that we had a lathe or lathes which we had in motion by this machinery, but I am not certain.

X Q. 416. What was the object of altering the pulleys and shafting, or adding to those as described in your answer?

A. To give proper speed to dynamos, to enable us to place them where we wanted them in the room, and to start and stop them without interfering with any other machinery in the building.

X Q. 417. Please state how much the alterations and additions made by you diminished or increased the speed you were able to attain.

A. I cannot.

X Q. 418. Can you not approximately?

A. No, sir.

X Q. 419. In making the alteration or additions referred to, were they made with reference to increasing or diminishing the speed which you could obtain directly from the pulleys and main shaft, when you went there?

A. I think they were made partly for obtaining increased speed in the movement of dynamo over what could be obtained by belting directly from the pulleys that were there when we went there, and partly to enable us to control the power and stop and start when we wanted to.

X Q. 420. Who was the engineer that you have mentioned that may have assisted Mr. Sawyer in making these alterations?

A. I do not know as I ever knew his name.

X Q. 421. Was he the engineer of the building, or a person whom you regarded as such?

A. I think he was.

1161 X Q. 422. What machinery, if any, other than pulleys and shafting and hangers referred to did you have in the room in Centre street? By machinery I do not include apparatus.

A. Dynamo machines, I think a lathe or two, and we may have other things, but I do not recollect.

X Q. 423. What makes you now think that you had a lathe or two, when but a few moments ago you could not remember whether you had or not?

A. I meant to express myself both times as in doubt, but at the same time to have expressed a possibility that we may have had them. I have no distinct recollection on the subject.

X Q. 424. Do you recollect any machinery other than lathes which you think you may have had at Centre street?

A. I don't know.

X Q. 425. Please state what tools you had at Centre street.

A. We had a pretty good assortment of drills, files, chisels, dies, screw-taps, hammers, saws, wrenches and other bench tools, with vices, laps, and I cannot recollect what all, also glass-cutters and glass-grinders, grindstones, whetstones, bits, bit-stocks. I cannot recollect all.

X Q. 426. Where did you purchase or get the tools referred to in your last answer?

A. I do not recollect.

X Q. 427. Do you recollect whether they were, in fact purchased?

A. I think some of them were and some of them were not.

X Q. 428. From whom were those that were purchased obtained, or who did the purchasing, and who paid the bills?

A. Can't recollect, except some things from Mr. Frasse, then in Chatham street. He is a well-known toolman. I ultimately paid for everything.

1162 X Q. 429. You have enumerated the machinery and tools which you had at Centre street. Please state what apparatus you had there.

A. We had a very great variety of apparatus, retorts, gas-holders, gas bags, tubes and tubing in glass and metal, stop-cocks, oil and alcohol, and kerosene lamps, gas-heating apparatus, gas-generating apparatus, electrical apparatus, photometer, air pumps, one or more hand metallic, and one or more mercurial exhausting apparatus, operated on the principle of Geissler's pump. I do not know what else, but a great variety of things, among which was a great variety of utensils or apparatus in glass, glass mould, boxes for carbonizing, means of drying gases, deoxidizing gases and purifying gases.

X Q. 430. Define what you described as a gas-heating and gas-generating apparatus.

A. Heating apparatus, operated instead of lamps by burning gas, and apparatus heated up by lamps or burning gas through which gases to be heated were passed. Charcoal furnaces, urged by bellows for heating apparatus. We had several of these heaters of different forms and kinds. Of the gas-generators, I remember we had several for producing hydrogen gas, several for producing nitrogen gas, several for producing carbonic-acid gas, some for producing chlorine and several for producing cyanogen.

X Q. 431. Please to describe the "charcoal furnace" referred to in your last answer.

A. One kind was an ordinary furnace like a tinner's or roofer's furnace; another one like an ordinary household charcoal furnace; another one made long and divided into compartments, on which was supported tubing running lengthwise of the furnace to prevent the tubing from bending when highly heated, similar to like apparatus as sold by chemical-apparatus dealers, but longer and larger; some others of the same kind but of less size. In enumerating these things I desire to be understood as mentioning those 1163 things which come to my mind without attempting to give an exhaustive list, which I do not think it would be possible for me, or anybody else to do, after this length of time, nearly eight years.

X Q. 432. Please to describe what you refer to as a household furnace.

A. It is known as a pail furnace, and can be bought in every establishment for the sale of household articles, used to boil a tea-kettle or heat a flat-iron, or the like, open at the top with a grate inside, an air space under the grate made sometimes of earthware, and sometimes of sheet or cast iron.

X Q. 433. Please state the dimensions and material of the furnace on which tubing was supported.

A. Some eight or ten inches square in cross-section, and from two to four feet long, made of sheet iron with a grate and ash plate under the grate, lined with fire-brick, and with fire-brick or iron partition for supporting the tubing which ran lengthwise of the furnace. In cross-section this fire-box inside, after the bricks were in, would be from three to six inches square; the grate extended the whole length of the furnace, and fire could be built in any compartment, or in all of them; it was fitted with a perforated cover to put on or take off as we chose.

X Q. 434. Please to specify what electrical apparatus you had while in Centre street.

A. We had several galvanic batteries; some standard resistances, galvanometers, electric lamps, dynamos, thermo-electric battery, ordinary electroscopes. I do not recollect anything else at present; we had electro-magnets and electric coils, switches and cut-outs, regulator, two or three devices; I don't know what else.

X Q. 435. The electric lamps, switches, cut-outs and regulators

1164 mentioned in your last answer were not apparatus which you bought, or took to Centre street for the purpose of making experiments, but were made there by you in the course of your experiments. Am I correct?

A. Yes.

X Q. 436. Have you now enumerated all the apparatus which you now remember you had in Centre street, and are you quite sure that all things enumerated by you were had by you and Mr. Sawyer while in Centre street?

A. I am quite sure that all the things enumerated by me were had by Mr. Sawyer and myself while in Centre street; I have not enumerated all, or nearly all of them, but only such as comes to my recollection while testifying; of these I have enumerated all that seem to me important to mention, which come to my mind.

X Q. 437. From whom was the various apparatus you have mentioned procured?

A. I cannot recollect.

X Q. 438. Cannot you recollect where any of it was procured?

A. Yes; some of it I got from different glass factories over in Brooklyn; some from Mr. Hahn, a glass-blower in William street, on North William street, near Chatham; some of it was bought from Hagerty Bros., in Platt street; some of it was bought from different rubber stores; some of it from different tin and sheet-iron workers; I think one of these was John Borkel, in Elm street; some of it was bought from an apparatus store in Barclay street; I cannot recollect the name; there was a glass-worker in Chambers street that fixed some apparatus for us; I don't know his name; some of it was got from an apparatus store in Greenwich street; I don't know the name or location; a good deal of it we made ourselves, at 43 Centre street; a good deal I took from my own private apparatus at my house; some was made and fitted up by William Sharp, who was in what was then known as Hickory street, Brooklyn; some we borrowed from different people; the dynamos I have spoken of, some electrical apparatus was obtained from Mr. Chester; 1165 some from Mr. Benjamin; I am not quite certain, but think some was borrowed from the School of Mines.

X Q. 439. In the aggregate as near as you now remember, what did this apparatus cost?

A. I cannot recollect, but think probably from $2,500 to $4,000.

X Q. 440. Who provided the money?

A. I and my friends provided it.

X Q. 441. Did your friends intrust their money to you, and did you pay for the apparatus, or did you pay for some and they for others?

A. I cannot recollect whether the money all passed through my hands or not; my impression is that it did not.

X Q. 442. Is it then your impression that some of your friends purchased apparatus directly, which apparatus was used by you in Centre street?

A. No, sir; but that they furnished money to Mr. Sawyer, who purchased apparatus with it.

X Q. 443. Were any books, accounts or vouchers ever kept of the expenditure of this money?

A. I have already stated that there were not; but memorandum accounts were kept by Mr. Sawyer, handed to me from time to time, and I think that said memorandums were all handed to Mr. Broadnax in '79. I also had a little book there, that had an account of expenditures, of which I have before spoken of in this case.

X Q. 444. Was any of this $2,500 or $4,000 expended for apparatus, paid by check, and if so, by whose?

A. I don't know that any of it was; I never paid any by check, except checks to the order of Mr. Wm. E. Sawyer, which he usually immediately endorsed, and which I therefore either gave him money for, or sent to the bank and got money so that he could have cash to make payments, unless it be in the case of a dynamo machine from Hochausen, about which I have testified.

1166 X Q. 445. You say that the apparatus bought cost from $2,500 to $4,000. How much, about, was expended for experiments while you were in Centre street, including rent, labor and everything and exclusive of payments to Mr. Sawyer for his personal services or use?

A. I think my estimate of apparatus includes experiments; it was all experimental till near the last apparatus and all; but does not include wages for Mr. Sawyer's personal expenditures, and is but a guess. I have no means of verifying it that I know of at present.

X Q. 446. And of these expenditures you know of no letters, vouchers, or memoranda of any kind, which would show in detail for what and when they were made excepting the memoranda and book of which you have testified? Is this correct?

A. I do not, unless among the papers which I gave to Mr. Broadnax, there may have been, as I testified, receipts of tradesmen, and it seems to me that there were such papers, but they may have been all kept by Mr. Sawyer.

X Q. 447. Where did you get the hand metallic air pump or pumps mentioned?

A. Mr. Sawyer borrowed it from somebody.

X Q. 448. Did you have more than one?

A. I am not certain whether he had more than one, or the same one at several times.

X Q. 449. Do you know from whom it was borrowed?

A. I do not recollect from whom it was borrowed.

X Q. 450. Did you purchase any hand metallic air pump or own one when in Centre street?

A. No, sir.

X Q. 451. Did you have one there continually, or did you borrow it at such times as you wanted to use it?

A. We only borrowed it, though I think it remained several days at a time, and only used it until we got the mercury exhaust rigged up.

1167 X Q. 452. From whom did you get the one or more mercurial exhausting apparatus operated on the princip*al* of Geissler's pump mentioned in your last answer?

A. We got the stop-cocks from Mr. Hahn in North William street, and some of the glass tubing; the rest of glass tubing, glass bulbs and tubular bottles I got made in a glass factory in Williamsburgh, and we rigged up the apparatus ourselves. We got 60-odd pounds of mercury through Mr. Haggerty, of Platt street.

X Q. 453. Were accounts kept with any of these people so that their books would show their dealings with you, or were all payments made in cash as the bills were incurred?

A. We kept no accounts with anybody, and paid cash for everything as we bought it.

X Q. 454. What was your working force at Centre street?

A. William E. Sawyer and myself; Mr. Wm. Sawyer, his father, part of the time; Mr. Sharp there part of the time, and part of the time at his shop in Brooklyn. A Mr. Keating and his men, one or two of them part of the time only at his shop in New York. Geo. Sawyer, a boy who ran errands.

X Q. 455. Were Sharp and Keating employed by you in Centre street?

A. Sharp was, but Keating, who had a shop of his own, was not, unless temporarily.

X Q. 456. Where are Sharp and Keating now?

A. Mr. Sharp works for Wallace. Mr. Keating I suppose to be dead. I have searched for him, and been unable to find him for some years past.

X Q. 457. I understand that you left Centre street the latter part of May or the 1st of June. What was the occasion of your leaving?

A. The occasion of our leaving Centre street was that we had got our lamp and other inventions perfected and did not desire 1168 to go further until we secured our patents, and desired to avoid expense, while we did not need a workshop or laboratory.

X Q. 458. Do you mean that your inventions were perfected, and that you were now ready to manufacture them?

A. Yes; many of them.

X Q. 459. Am I correct in understanding that you devoted your energies to securing patents on your inventions, and did not care to do any more work until they had been secured?

A. Yes; that and organization and planning, and did not care to do any other work requiring the use of a laboratory or workshop just then.

X Q. 460. What were your habits in regard to going to the laboratory in Centre street?

A. I was there from early morning until 9 or 9.30, an hour or more at noon, and from 3.30 until dark. Frequently at other times in the day. This was my habit, and about the only exception was, when I was away hunting up things for use in the shop.

X Q. 461. How early in the morning would you get there?

A. I was usually there for about an hour—sometimes more—about 8 o'clock.

X Q. 462. During all this time were you attending to your professional business?

Yes, sir.

X Q. 463. Was not your professional business at this time a large one, and did it not involve the custody and management of large interests?

A. Yes, sir.

X Q. 464. What were Mr. William E. Sawyer's habits?

A. So far as the attendance of the laboratory was concerned he was in the habit of being there all day.

1169 X Q. 465. Was he addicted to intemperance at this time?

A. I never saw him the worse for liquor while we were at Centre street.

X Q. 466. What were Mr. William Sawyer's habits as to attendance at the laboratory?

A. He was there during the usual work hours of mechanics, except when working at some other shop for us.

X Q. 467. Please answer the same question with reference to Messrs. Sharp and Keating?

A. They were working mostly at their own shops.

X Q. 468. Did you neglect your other business to attend to experiments at Centre street, or were you attending to it regularly?

A. I was attending to my other business regularly during my ordinary office hours, except when I went out at noon, which I was not in the habit of doing. My ordinary business hours were from 9 to 3.30.

X Q. 469. Was Sawyer and his father in the habit of getting to the laboratory as early as 8 o'clock in the morning?

A. Yes; they were usually there when I got there, except when the father was going elsewhere.

X Q. 470. To get to the laboratory at 8 you would have to leave your house at 7, would you not? Was it your habit of leaving at that hour?

A. Yes, sir; from 7 to a quarter past; and the time from my house to 43 Centre street, was usually about 50 minutes.

X Q. 471. Do you think you were there every day during the time the laboratory was there?

A. I think I was, but may not have been during the first few days of April, as those days were very busy days at my office; nor during the first few days of May, for a like reason. I have no positive recollection except as to general habit.

1170 X Q. 472. Was Mr. William E. Sawyer there every day?

A. I think he was at the place every day—some part of every day—except during the latter part of the period, when we were there; he was, however, frequently at my office during the time that I was at leisure to give attention to the matters we were at work on.

X Q. 473. Then in point of fact, William E. Sawyer was not there every day, and all day?

A. Well, those words would give a correct impression of his attendance at the place 43 Centre street, his absences being exceptional occurrences made mostly for my convenience.

X Q. 474. Was he dissipated at this period?

A. At this time I had no knowledge of Mr. Sawyer's being an intemperate man or a*b*dicted to drink or other excesses; but from events which subsequently came to my knowledge, I had reason to think and believe afterwards, that he had been and was a dissipated man at this time, but under much self-restraint.

X Q. 475. Was not his father also a dissipated man and addicted to drink at this period?

A. My reply is the same as to the last question.

X Q. 476. In the Sawyer-Man-Edison interference the following question was asked and answer made by Mr. Sawyer: State as near as you can recollect, about how long you and Mr. Man continued your experiments at 43 Centre street.

A. I thould think about two months, all the time we were there.

X Q. 477. Does your recollection agree with Mr. Sawyer's as to this?

A. Yes, substantially; it may, however, — been longer than two months, and my impressions are that it was, but without refreshing my recollection I cannot speak with accuracy.

1171 X Q. 478. In the same interference, the following question was asked Mr. Sawyer, and answer made by him:

"After you got through there did you resume your experiments at any other place? A. We moved from there to No. 2 Howard street, where I don't think we made any experiments on lamps, not having any facilities for such experiments; we then moved in the fall of the year to 94 Walker street; I have got memoranda to show of these things; we moved to 94 Walker street during the 18th and 19th of October, 1878."

X Q. 479. Do you agree with Mr. Sawyer as to his statement in the answer quoted, and is it a fact that you moved to Walker street about the 18th or 19th of October, 1878?

A. I do not; my recollection is different, and I think that the word "October" is a mistake, and should be September; but I speak from recollection, and there are papers which will show the date when we went to Walker street. As to the work done while we were at the corner of Howard and Centre streets, my recollection does not agree with Mr. Sawyer's. We made a lot of experiments at the corner of Howard and Centre streets, and had as assistants Mr. Frank Holbrook and Mr. Edward Myers; we also had Messrs. Arnoux & Hochausen, who were above us, doing a lot of work for us.

X Q. 480. I now call your attention to the following part of your answer to the 17th question submitted to you in the same interference, and given in March, 1881: "I had been speaking thus far of only what took place up to the 1st of June or last of May, 1878. We had no convenience for working from that time up to September, and our experiments were renewed in September and continued on until late in March, 1879." Is it true, as there stated by you, that you had no convenience for working from the last of May, 1878, and that your experiments were only renewed in September?

1172 A. It is true that from the time we left Centre street until we went to work at the corner of Howard and Centre streets we had no shop, and that our experimental work as experiments was discontinued; during this period, however, we were engaged in the discussion of plans, designs, calculations, etc., and in ordering material and in getting apparatus for manufacture, and in getting manufacturing done, though not as actively as after we went to work at the corner of Howard and Centre streets; this period was from the last of May or 1st of June until the last of August or 1st of September; but we were not engaged in experimental work, though upon reflection and refreshing my recollection, our room at Howard and Centre streets was hired perhaps as early as July. Mr. Sawyer went on his summer vacation, and afterwards I went on my vacation, and we did not resume experimental work until my return, about the 1st of September.

X Q. 481. As I understand you, you did no experimental work from the time of leaving 43 Centre street until September 1st, 1878. Is this correct?

A. That is my recollection—that is to say, I do not recollect anything we did during this period.

X Q. 482. Where was it that experimental work was resumed?

A. At No. 2 Howard street.

X Q. 483. How long after September 1st were you at Howard street?

A. My recollection is until the last part of September; I can fix the date exactly, I think.

X Q. 484. How many rooms did you have at Howard street, and what were their sizes?

A. Only one; about 12 x 20, with shop facilities in another room about 25 x 40 or 50, occupied mainly by Arnoux & Hochausen.

X Q. 485. What tools, apparatus, or machinery did you have in this Howard-street room?

1173 A. The same that we had in Centre street, or part of it; part, I think, being left in 43 Centre street until we wanted to use it.

X Q. 486. Between the time of leaving Centre street and going to Walker where were the tools, apparatus and machinery referred to, kept?

A. I think they were stored at 43 Centre street, except dynamo, lamps, switches, and apparatus of delicate character. The dynamo was taken and set up at the corner of Centre and Howard streets, opposite No. 2 Howard street; the other things at my office No. 3 Mercer street.

X Q. 487. With whom were the things stored that were left at 43 Centre street?

A. I think they were left in the room that we occupied; packed up in one corner that was partitioned off for the purpose.

X Q. 488. What power did you have at Howard street?

A. We had only the steam power in the building, which was also used for several buildings in the neighborhood.

X Q. 489. Did you have pulleys and shafting in that room?

A. No, sir; they were all in the room above occupied by Arnoux & Hochausen.

X Q. 490. How did you get the current that you used there?

A. From dynamos in a room of Arnoux & Hochausen, our own and different ones belonging to them, from which wires were led to an office room of Arnoux & Hochausen, and from thence directly to our room underneath. Lamps were set up part of the time in Arnoux & Hochausen's room, but mostly in our room underneath; the regulators, resistances, switches, and measuring instruments, etc., were all in our room; we had no dynamo in our room.

1174 X Q. 491. How were the dynamo machines from which you obtained your current, driven?

A. By pulleys and shafting in the building; we did not put up any pulleys and shafting; we may have changed it around to get the velocity we wanted, and connect it to our counter-shaft with fast and loose pulleys.

X Q. 492. Which of the dynamos that you had at Centre street did you use in Howard street?

A. The one that was bought of Arnoux & Hochausen, and one or more that we borrowed from them.

X Q. 493. Then none but Arnoux & Hochausen machines were used, as I understand it?

A. I don't recollect any but Arnoux & Hochausen machines were used; I suppose that all these machines would be more properly designated Hochausen machines, as they were devised by him; built as I understand by Arnoux & Hochausen.

X Q. 494. With the exception of the machine mentioned in the bill you have produced were these machines the type of machine at that time manufactured by Arnoux & Hochausen?

A. Yes, for electroplating mostly, excepting the one which they wound especially for our use.

X Q. 495. Was the one they wound specially, the one referred to in the exhibit?

A. It was not the one referred to in the exhibit, but another machine, and was by them delivered to us; but Arnoux & Hochausen desired to sell us a machine and to experiment in machines for incandescent lighting, and so wound one or more machines for our use; they had no incandescent lights and we had; it was, therefore, a matter of mutual advantage.

X Q. 496. Which was it, one or more machines that was wound as you have described in your answer?

A. I think one for our special accommodation?

1175 X Q. 497. Was this winding done at their suggestion or according to their ideas, or at your suggestion and according to your ideas?

A. According to the joint ideas of Mr. Sawyer and Mr. Hochausen. I do not think I had anything to do with it except to ask or suggest its being done.

X Q. 498. Am I correct in understanding that this machine was made while you were at Howard street?

A. It was wound while we were there.

X Q. 499. Was it ever used by you, and if so where?

A. It was used by us, while we were at the place, No. 2 Howard street, for a short time; it was then resold by Arnoux & Hochausen, as I understood it, for electroplating business.

X Q. 500. Am I correct in understanding that with the exception of the machine referred to in the exhibit, and the one last mentioned, the only machines used by you in Howard street were the electroplating machines at that time sold by Arnoux & Hochausen?

A. Yes.

Witness states that having obtained from Mr. Broadnax an account made by the witness against the Electro-Dynamic Light Company, which includes the rent paid for the premises at Nos. 2 and 4 Howard street, and shows that the occupation of those premises commenced on or about June 20th, 1878, and that the last payment of rent was on September 27th, 1878. That he also obtained from Mr. Broadnax the lease of 94 Walker street to the said company, which is dated Oct. 15th, 1878; that deponent's recollection of the date of going to Walker street is confirmed by these papers, and by the fact that we moved directly from the Howard-street place to the Walker-street place, and that it was some time after going there before the lease was executed. This same account also confirms my recollection that a large amount of work was done at Howard street, and contains items paid for that work, notably for glass
1176 moulds to Homer Brooks, for glass globes to P. Schneider &
Sons, Archer & Pancoast, for fixtures, Arnoux & Hochausen, for work, other items for material; payments to Mr. Sawyer for expenses incurred by him, etc.

I have also found an entry in my check book, dated April 6th, 1878: "1878, April 6th, Charles "P. Fizer & Co., quicksilver, 81 Maiden lane, "electric light, $27.25;" so that I know *we that* bought quicksilver of P. Fizer & Co., and that I paid for it with my check on April 6th, 1878.

X Q. 501. I understand you to say that you left Howard street the latter part of September or first part of October. Now, what was the nature of the experiments, if any, that were made by you from the 1st of September to the time of leaving Howard street?

A. Experiments in the making of carbons, preparation and treatment of carbons after their manufacture; in making and purifying nitrogen and other gases; experiments in resistances and switches; experiments in dividing the current and in distribution and measurement; experiments in filling the lamps and treating the carbon in process of filling; experiments in exhausting lamps and lamps not exhausted; experiments in safety devices and cut-outs; experiments on globes of different sizes and forms, and generally getting ready to manufacture electric lamps upon a commercial scale and put them in use.

X Q. 502. Was the work done from the 1st of September to the period of your leaving Howard street rather in the nature of getting ready to exploit and produce commercially the inventions which had been perfected, or to make experiments with the view of making inventions?

A. Our object was to get our invention into shape for commercial use, and perfect plans and means of manufacturing, and also we were compelled to continually devise and invent new things.

X Q. 503. Did you consider that you had obtained a lamp which was practical and could be introduced commercially?

1177 A. We did.

X Q. 504. Who composed the force at the Howard-street shops while experiments were going on?

A. I do not think we had any workmen there except Mr. Sawyer's father and Mr. Sharp. We had a large amount of work done outside by the firm of H. L. Judd & Co., Arnoux & Hochausen, by Miller and Newman and by various other people. Mr. George Sawyer was a kind of general utility boy; Mr. William E. Sawyer, Mr. Frank Holbrook, and Mr. E. L. Myers, with some assistance rendered by myself.

X Q. 505. What were the habits of these various people that you have named, as far as attendance at the shop was concerned during the period of September, 1878?

A. Mr. William E. Sawyer was supposed to be at the place all day, also George Sawyer. Holbrook was there, or at a place down in Broadway, near the Battery, for a fortnight, as near as I can recollect, with occasional visits to the School of Mines of half a day or so. Mr. E. L. Myers was there after Mr. Holbrook went away, or in the place down toward the Battery, or at Stevens institute. I do not recollect how much Mr. Sawyer's father was at the place. Sharp was there only a day or two, as I recollect, and did most of his work at his shop near my house in Brooklyn. I was in the habit of going to the place every day, whenever I could find time to do so.

X Q. 506. Was Mr. William E. Sawyer at the place all day, and every day during the month of September?

A. I cannot state at this length of time whether Mr. Sawyer was there every day and all day, or not. I can only say that from the time that he returned from his vacation, and we got to work there in the latter part of August or first part of September, until we went to Walker street, he was very attentive to work, and worked very hard, and I have no recollection of his being absent from his
1178 duties, which were to be there and to be engaged in the work of the company.

X Q. 507. What were Holbrook's habits as to attendance there? also, Mr. Myers' and your own?

A. Holbrook's habits as to attendance depended whether his work was there or elsewhere. He came about 9 a. m.; was engaged upon chemical work and experiments for the company. For lack of apparatus and convenience, he sometimes went to work at the laboratory of the School of Mines, of which he was a graduate, and sometimes went down to the place near the Battery. He was industrious, and usually worked until dark. Myers' employment was similar to that of Holbrook's, with the addition of doing some electrical work and measurements. He was in the habit of getting in about 9.30 a. m. and leaving at 4.30. He worked at Howard street, at the place down Broadway, or at the Stevens institute, of which he was a graduate. I was at the place sometimes in the morning, on my way to my office, for a few moments; sometimes at noon, sometimes at night, sometimes morning, noon and night, after business hours. My attendance there was very irregular, and sometimes, instead of going there, I sent for Mr. Sawyer to come and see me.

X Q. 508. What was the apparatus to which you refer which made it necessary for Mr. Holbrook to go to the School of Mines?

A. Chemical apparatus, such as pumps, tubing, glass holders, retorts, stop-cocks.

X Q. 509. What kind of pumps do you mean?

A. Air pumps.

X Q. 510. Did you not have apparatus of the character mentioned at the Howard-street shop?

A. Yes, I think so; but both Holbrook and Myers thought that the apparatus at the colleges were better and more convenient than we had, and thought they could do better work there, espe-
1179 cially such work as they might desire for subsequent experi-
mental tests. Our lamps were made to be put up and taken apart, sealed and unsealed. We were in the habit of filling them and of running them lighted, both lamps filled with nitrogen gas of ordinary atmospheric pressure, and also after filling with gas and exhausting to a different degree of exhaustion, and also when exhausted not having been filled. We tested them while running, while lighted, and being run; by throwing a picture of the lighted carbon on a screen and watching the effect of the atmosphere of the lamp on the carbon, and after the lamp had been run for awhile, we tested the atmosphere of the lamp chemically, to ascertain what change had taken place in the atmosphere of the lamp or carbon burner or both; and it was with reference to those delicate tests that these gentlemen went to their various colleges.

X Q. 511. What was the rent of the room in Howard street?

A. Ten dollars per month.

X Q. 512. What was the reason for leaving the Howard-street shop?

A. Want of room and facilities for doing work.

X Q. 513. Please state the size of the laboratory at Walker street and Elm, and who composed the working force there.

A. One loft about 20 by 50 or 60, the same working force as Howard street, except that Mr. Holbrook only worked, if at all, for a few days there. The elder Mr. Sawyer, E. L. Myers and Mr. Sharp were there all the time. Machinists and workmen and instrument-makers were hired from time to time, and Mr. Lawrence Myers was there about a month.

X Q. 514. What was your habits as to attendance there?

A. I was more attentive during the month of October than at

Howard street, spent a good deal of time there, and did some
1180 work, chemical and testing myself. Afterwards Mr. Lawrence Myers came to relieve me of the necessity of being at the shop so much.

X Q. 515. What tools, machinery and apparatus did you have at the Walker-street laboratory?

A. We had a very complete set of machinist's and instrument-maker's tools, a partial set of carpenter's tools, a miscellaneous lot of bench tools of all kinds for doing all sorts of things—working in wood, metals, stone and carbon. A pretty complete chemical laboratory, with pumps, retorts, furnaces, piping, tubing, stop-cocks, pinch-cocks, and other chemical apparatus; two dynamos, two engine lathes, lathe tools and gearing, steam engine, pulleys, shafting and belting, electrical instruments, photometers, electrical testing and measuring apparatus, lamps, switches, resistances, electroplating baths and apparatus, electric batteries, lenzes, etc., etc.

X Q. 516. I understand that the Walker-street laboratory was given up in March, '79, and that the experiments of Sawyer and Man at that period ceased? Am I correct?

A. Yes, sir.

X Q. 517. What was the nature of the experiments conducted at Walker street, speaking generally?

A. They were for the purpose of perfecting and exhibiting a system of incandescent lighting with all its necessary accessories, and getting it ready to introduce in practical operation.

X Q. 518. What were the dynamo machines used by you in Walker street?

A. One that we bought while in Centre street; mentioned in Defendant's Exhibit No. 1, dynamo bill; one or two machines which we borrowed of Arnoux & Hochausen for trial, of their largest size of lighting machines, and one large machine which we bought of them in September, which was specially wound for us.

X Q. 519. The one or two lighting machines which you
1181 speak of having borrowed for trial, were they actually used by you, and if so, for what period and how long a period?

A. They were used by us while we were there; my impression is from about the middle of October, but for how long I cannot recollect. It seems to me, however, that one of them was there in March, 1879, at about the time that we left.

X Q. 520. What do you mean by saying these machines were on trial?

A. I mean just what I say, that they were on trial for the purpose of incandescent lighting, and to see what their efficiency were for that purpose. You will remember that at this period dynamo machines were not made ordinarily for incandescent lighting.

X Q. 521. Were these machines after being tried regarded by you as efficient for incandescent lighting?

A. None of them except the one that was specially wound for us; the one ordered in September, that was a good machine; the others would light a few lamps, but their electro-motive force was too high and the quantity too low.

X Q. 522. Is it then the fact that the lighting machines to which you have referred after being tried by you, were found not to be adapted to your lamps, and other machines were used?

A. We could use them, but they were not specially adapted to our lamps—not so well adapted as the machine made in September, and the one mentioned in the Exhibit "Dynamo Bill."

X Q. 523. Who ordered the machine of Arnoux & Hochausen in September?

A. I did; as president of the Electro Dynamic Light Company.

X Q. 524. You speak of having an engine. Whose make was it, and when was it bought?

A. It was known as a Hampton steam engine; was bought
1182 from a firm in Liberty or Dey street about the time we went
to Walker street. It was a six-horse-power engine and was run by Wm. Sawyer, Mr. Sharp and George Sawyer also, who got a licence while we were there.

X Q. 525. After the formation of the Electro-Dynamic Light Company on July 11th, 1878, was such experiments as were conducted and such apparatus as were purchased at the expense of that company?

A. Yes, sir; I think so for the most part.

X Q. 526. Did that company keep books of account?

A. Yes, sir.

X Q. 527. Where are the various books of account, minute book, and records of that company, and in whose possession?

A. I don't know; they were in the possession of Mr. Amos Broadnax, counsel.

X Q. 528. Have you any connection with that company at the present time?

A. I am a stockholder and director.

X Q. 529. Do you know who is president, secretary, and treasurer of that company?

A. Mr. Thomas Wallace is president, Jacob Hayes is treasurer, Lawrence Myers is secretary, I think, but I don't know.

X Q. 530. Will you produce the books of account containing the minutes of the board of trustees of that company, or endeavor to cause their production?

A. They are not in my possession, nor under my control, and I don't know where they are, and am not able to produce them.

X Q. 531. Could you not ascertain where they are?

A. I don't know whether I could, or could not.

X Q. 532. Will you endeavor to ascertain in whose possession the books are, and give the results of your efforts?

A. Not unless I am instructed by counsel or the court that
1183 I am under obligations to go and hunt these things up and
try to find where they are, or try to get possession of them, when I have no right to such possession.

X Q. 533. Are not your relations to that company and its successors, its counsel, and the counsel of its successors, its officers and various directors, such that you could, without any difficulty ascertain the whereabouts of such books?

A. Not, except as a personal favor to myself, which I do not wish to ask for, and not then, even as a personal favor, without consent of complainant or its counsel.

Counsel for defendants state- that he desires the fullest investigations made into the inventions and experiments of Sawyer & Man, and for that purpose desires to inspect the books referred to, and therefore requests complainant's counsel to produce, at the earliest possible time, all the account books, minute books, vouchers, bills, letters and other papers, relating to such experiments and inventions during the existence of the company referred to, and kept by, or in possession, or under the control of the Electro-Dynamic Light Co.

Counsel for complainant responds that thus far the so-called cross-examination has been a mere fishing excursion on the part of defendant's counsel, in the hope of finding something that will aid defendant in making a case; that none of the questions and answers given to and made by the witness, have any pertinency, relevancy or competency upon any of the issues in this case, nor upon anything brought out by the examination-in-chief, and that he does not mean to produce any books or papers which have no pertinency or relevancy upon the issues of this case, merely to gratify the curiosity of the defendant, or its counsel, and shall not produce any books or papers unless ordered to do so by the court, which in his judgment are not material to some of the issues raised by the pleadings in this case; that he has as earnest a desire for the fullest investigation of all the facts pertaining to the issues of the case as defendant's counsel, but objects to putting in the record a
1184 mass of irrelevant matter, which can have no other effect than to confuse, perplex and mislead the court.

Defendant's counsel requests counsel for complainant to state in whose possession the books of account and the minute books of the directors or trustees of the Electro Dynamic Light Company are.

Complainant's counsel declines to gratify defendant's counsel's curiosity, but adds that if defendant's counsel can show that any of the books of the Electro Dynamic Light Co., and over which complainant's counsel has any control, possesses any evidence material to defendant upon any issue in this controversy, he will do all that he can to cause their production, or to produce them himself.

Defendant's counsel replies that he cannot tell whether the books contain any such evidence until he has had an opportunity to examine them, and he desires to examine them to ascertain such fact.

Defendant's counsel offers in evidence an account produced by witness, and also a lease from Elizabeth C. Jay to the Electro Dynamic Light Co., and it is agreed that copies may be substituted for the original: the same are marked "Defendant's Exhibit Accounts and Jay Lease."

X Q. 534. I now hold in my hand which purports to be a copy of an agreement made between yourself and William E. Sawyer, dated

March 19, 1878. Please look at the paper to which I refer, and state whether the Electro Dynamic Light Co. was such a joint stock company as was contemplated in the agreement referred to.

A. The Electro Dynamic Light Co. was formed pursuant to an agreement and understanding between Mr. Sawyer and myself, up to the time of its organization.

X Q. 535. On March 19th, 1878, had any joint inventions been made by Sawyer and Man?

1185 A. Yes, sir; but up to that time I don't think that either Mr. Sawyer or myself had considered for a moment whether these inventions were joint or several.

X Q. 536. Did you not at that time, March 19th, 1878, consider such inventions, as had been made in subjects in which Mr. Sawyer had been conducting experiments, either alone or assisted by you, as the sole invention or inventions of Mr. Sawyer?

A. I do not think I gave it any consideration whatever, one way or the other.

X Q. 537. In view of the contract made on the date referred to, should you not say that it was your opinion at that time, that such inventions as had been made were the sole inventions of Mr. Sawyer, and such was his opinion?

A. If I look at nothing but that bare paper, dated March 19th, 1878, I might come to such conclusion, but in view of the facts as they existed and were known by both Mr. Sawyer and myself, I am confident that the authorship of invention was not one intended to be dealt with specially by that instrument. I am confirmed in this view of the subject-matter from a subsequent statement by Mr. Sawyer, in my presence, to Mr. Broadnax, at the time when the application for the patent in issue in another case, in October, 1878, was made, and in which interview both Mr. Sawyer and myself stated, as nearly as we possibly could, the facts about the invention, what each of us did, and took his advice as to whether the applications should be in Mr. Sawyer's name, in my name, or in our joint names, which advice we followed in making applications for our patents.

X Q. 538. Was this conversation with Mr. Sawyer, the first discussion whether your inventions had been joint, or were the separate inventions of Mr. Sawyer?

A. No.

X Q. 539. In view of the agreement made between you May 11th, 1878, which refers to the agreement of March 19th, please state whether it was not your opinion, at the time of the agreement
1186 of May 11th, and Mr. Sawyer's also, that the question of joint inventorship referred only to inventions made after March 19th, and in regard to those made before that period, they were the sole invention of Mr. Sawyer.

A. No, sir; the agreement of March 19th is referred to in the agreement of May 11th, only for particulars, and in the second clause of that agreement a reference is made to a prior agreement, and the plans proposed by Mr. Sawyer, and that second clause is the one stating the fact of my participation in the inventions. In explanation I wish to further say, it was not until after March 19th that it was demonstrated that the plans proposed by Mr. Sawyer therein referred to were futile.

X Q. 540. What were the plans of Mr. Sawyer, which you say were shown to be futile?

A. At this length of time I do not know that I can specify. I can only say that about the last days of March, 1878, Mr. Sawyer having failed to get anything ready to exhibit to my friends and myself, although I had aided him by suggestions, money and advice up to that time, was in despair about producing a light that would be satisfactory, and wanted more time to do it, and besought me not to leave him, as I was intending to do, and said if I would stick with him and help him that the thing could be worked out; and at that time it was considered that the plans he had proposed originally had failed.

X Q. 541. Cannot you give me any idea whatever as to those plans?

A. There was a lot of things, and I do not remember what they were; different forms of lamp; one, I remember, that the oxygen might be burned out of the air sufficient with phosphorus to leave a practical atmosphere of nitrogen for an incandescent lamp, and that a simple glass-stopper, like a bottle-stopper, would be sufficient sealing for the lamp. Another was burning out the oxygen in the lamp, and absorption of the carbonic acid by water. Another was that hydrocarbon gas would be a suitable atmosphere for an incandescent lamp. Another was that no special peculiarity of switch would be required. Possibly other things would occur to me, but these were some of them. 1187

X Q. 542. Is it, then, true, that in the latter part of March, 1878, Sawyer had failed to get anything satisfactory, and was in despair about getting up a light, and that you intended to leave him, and give the matter up?

A. It is true that up to that time I was not satisfied, although I saw at the same time great promise in many things we had done; and that I expressed to Mr. Sawyer my views on the subject, and that he expressed himself to me as in despair of accomplishing anything if I should leave him, and besought me to stay with him and help him, and, contrary to my better judgment, I did, and have been sorry for it that I did.

X Q. 543. Is it, then, true, that up to that time you had not accomplished anything?

A. No; it is not true that we had not accomplished anything. We had accomplished much, but we had not struck upon what I considered a practical system of incandescent lighting, and the things which Mr. Sawyer had proposed, had, it seemed to me, proved worthless, and what we had done that was of value up to that time, it seemed to me, was the result of my own suggestions and work with Mr. Sawyer, and I told him so.

X Q. 544. What was the cause of your dissatisfaction at this time?

A. Failure in accomplishment on the part of Mr. Sawyer.

X Q. 545. Failure in accomplishment of what?

A. In the making of a practical first-rate incandescent lamp with its accessories for an incandescent lighting system, and in what seemed to me a want of proper diligence and skill in the prosecution of the attempt. I can best illustrate it by saying that it 1188 seemed to me that when I was personally present and aiding and pushing the thing, things did not seem to progress, and seemed to me to remain at a standstill.

X Q. 546. Did you anticipate when you first made your arrangement with Mr. Sawyer that as early as the latter part of March, or within a month from the time experiments were begun, a "practical, first-rate incandescent electric lamp with its accessories for an incandescent lighting system," would be obtained?

A. I had anticipated that it would be done before the last of March.

X Q. 547. Were you impressed with the fact that on the part of Mr. Sawyer there was a want of proper diligence and skill in the attempt to obtain such a lamp and its accessories as far as he was concerned?

A. I have already testified that such was my feeling in regard to the matter, whether it was a fact or not might be a question of dispute.

X Q. 548. Was it your impression at the time referred to that Sawyer was not attending to his work diligently?

A. I have, I think answered that question as fully as I can.

X Q. 549. In what respect did you consider Sawyer lacking in skill?

A. Particularly in a knowledge of chemistry, and its manipulations, and in mechanical adaptations, and proportions, and in neglecting to note and profit by failures in experiments.

X Q. 550. You say Sawyer was lacking in what seemed to you a want of proper diligence in the prosecution of the attempt. How was this manifested? By absence from the laboratory or from inattention to work when there?

A. I do not know that I felt any dissatisfaction as to Sawyer's attendance at the laboratory, nor that he was not busy enough.

1189 X Q. 551. What do you mean by your answer when you say, "when I was not personally present, and aiding and pushing the thing, things did not seem to progress, and it seemed to me to remain at a standstill." I also call your attention to the other portion of the answer in which you say you were dissatisfied with Sawyer because of a want of proper diligence in prosecuting the attempt.

A. I mean just what I say exactly: I cannot better illustrate it than by reference to the common expression, "a man is very busy and does nothing," not that I mean to say that Mr. Sawyer did nothing or accomplish nothing, but that his accomplishments were not satisfactory to me, and it seemed to me to be due to a lack of proper and diligent, persistent, and well-directed attempt.

X Q. 552. Now, just what do you mean; was Sawyer diligent and industrious his work or was he not?

A. He seemed to me to be always busy; I cannot better express it.

X Q. 553. Were you satisfied or dissatisfied with the result of his labors?

A. I was not satisfied.

X Q. 554. What caused you to continue to assist him and why did you alter your conclusion to give the matter up?

A. I think as near as I can recollect, that I was influenced by Mr. Sawyer's urgent request, and his confident statement that if I would remain with him and assist him we could work the matter up to a practical and successful conclusion.

X Q. 555. When did differences first arise between yourself and Mr. Sawyer, and when were his habits of intoxication and dissipation first discovered or ascertained by you?

A. As near as I can recollect, the fall of 1878, while we were at the corner of Walker and Elm streets.

1190 X Q. 556. When did Sawyer first begin to neglect his work?

A. I now think that his habits interfered with his work all the time, but the first cause of complaint on my part of his conduct arose from his absence and nearly entire inattention to the work of the company while I was gone on my vacation in the summer of 1878.

X Q. 557. After the first complaint was not Mr. Sawyer's inattention to business and dissipation almost continuous from that period?

A. No, sir.

X Q. 558. I understand that Sawyer quarreled with the Electro Dynamic Light Co., and was the cause of a great deal of trouble to you and the various organizations with which he was connected, and became so dissipated as to utterly neglect his business. Now, please state when it was Sawyer's dissipation became known to you, how it became known, and what effect it had upon his attendance at your different laboratories, and upon his work while there.

A. Without consenting to your understanding, as stated in the question, exactly, I proceed to answer: My first knowledge of his dissipated habits and character, as near as I can recollect, was derived from information conveyed to me, I think, in October, 1878, of his conduct while I was absent on my vacation. I was told he had been on a spree, or a succession of sprees, during all this time. From this time forward I noticed from time to time in the morning, when I saw him at the shop, that he had been drinking. His dissipation was not such at any time while we were at 94 Walker street as to interfere with his ordinary attendance at the factory. I don't now recollect that I attributed any absence from the laboratory to dissipation, but perhaps I did at the time. Up to, I should now say, the 1st of November, 1878, I should think the effect upon his work while at the laboratory was confined to the effect of drinking 1191 before coming there, and not while at that place. While there I do not think he was drinking, certainly not to excess. From this time forward, that is, from about the first of November, the habit of drinking increased upon him, and interfered with his work so that I was compelled to give more time to the shop or laboratory than I could well spare from my other business, and finally, I think in December, Mr. Lawrence Myers went to the shop and staid there continuously day after day in order to relieve me and exercise a restraining influence upon Mr. Sawyer; it resulted at last, in the month of March, 1879, in the workshop of the company being closed up and the work being transferred to the shops of Wallace & Sons, at Ansonia, Conn., where Mr. Sawyer was to give his time and attention, for, I think, a period of four months. His conduct while there was such, both from habits of drinking and other dissipation, that Mr. Wallace, who had become president of the Electro Dynamic Light Co., made complaint of the same to the board, and refused to go on with him, and it was decided that this work should go on under the charge of Mr. E. L. Myers, who had been in our employ, and who was the only one except Mr. Sawyer and myself who understood all the details of our work and plans. Mr. Myers was taken sick and died, and after awhile the patents of the company were assigned to the Eastern Electric Manufacturing Co. This company had Mr. Sawyer in its employment, and had great trouble with him by reason of his intemperance and dissolute habits, and its patents were assigned to the plaintiff in this action, with whom Mr. Sawyer was never associated.

X Q. 560. Is it not the fact that Sawyer's habits and dissipation, after November, 1878, were of such a character as to seriously interfere with his work?

A. Yes.

X Q. 561. From your knowledge of Mr. Sawyer, in a case where it was his interest to make a false statement, is it your opinion that he would do so?

1192 A. I think it would depend upon his surroundings and circumstances at the time the statement was made and his condition at the time.

X Q. 562. From your knowledge of Mr. Sawyer, where it was, or he considered it to be, for his interest to make statements which were false, or to create the belief in others that things which were not facts existed, is it your opinion that he would do so?

A. I answer as before.

X Q. 563. Please explain your answer?

A. I mean that he would sometimes make, under certain conditions and circumstances, either false or true statements which were against his own interests, and he might be influenced in telling the truth or falsehood by passion, revenge, hatred, gratification of appetite, a desire to have his own way, or by conscience, remorse or desire to make amends.

X Q. 564. Would he make false statements in his own interests, or what he thought to be his own interests?

A. I do not think he was a reliable, truthful man. I do not, however, think that self-interest alone would be sufficient inducement for him to tell a falsehood.

X Q. 565. Do you think that Sawyer, if driven by necessity, could obtain money by making untruthful statements, or by deceiving the people from whom he expected to get it, would do so?

A. During the latter part of his life, driven sometimes by necessities brought upon himself, and sometimes by a desire to obtain means to gratify his appetites and passions, I believe him capable of doing so.

X Q. 566. Do you think he was capable of causing the formation of a company and the investment of money and the payment of money to himself to exploit inventions that he knew to be valueless, and would represent that he possessed patents which he knew to belong to others?

1193 A. Not from self-interest alone, but from hatred, malice, revenge or spite, to have his own way and accomplish his own or ulterior purpose—yes.

X Q. 567. Is it not the fact, whatever the motive may have been, that Sawyer did cause the formation of a company representing that he possessed inventions which he knew that he did not?

A. I believe it to be true. I do not know now that, from my own knowledge, I am able to assert it as a positive fact. I have tried to forget as much as possible these things against Mr. Sawyer. I believe that a refreshment of my recollection would compel me to assert it as a fact, but I don't want to do so.

X Q. 568. Did you ever know of Sawyer's blackmailing one or more of the companies with which he and you were connected, and obtaining money from them by threats, and compelling the payment of money to himself by false representations or threats?

A. I believe he did.

X Q. 569. Was not Sawyer a man of utterly bad character, capable of dishonest or dishonorable acts?

A. No; not until at least the latter part of his lifetime was he utterly bad. He died in 1882, and, indeed, I don't think he was utterly bad ever; he loved his little children, even then. He was capable of, and did, in the few last days of his life, send for a friend whom he had injured, and when that friend refused to go to see him, sent word that he did not want money, but wanted his forgiveness. Nevertheless, he was very bad, and did not hesitate afterwards to malign this very friend. No; he was not utterly bad.

X Q. 570. Do you mean that he was not utterly bad until the latter part of his life, or that you did not know that he was?

A. I knew he was very much worse during the latter part of his life, and that I did not know of his being a bad man in 1878, except for his inebriate habits.

1194 X Q. 571. Have you ever known of his committing perjury?

A. I don't think I can say, of my own knowledge independently, that he committed perjury.

X Q. 572. Do you think he was capable of doing so?

A. I have already answed that question in my answer, or answers, as to his truthfulness. I will answer in the same way, adding that, if the circumstances were such as to induce him to do it, I think he might have done so.

X Q. 573. Are you familiar with what was his general reputation for truth and veracity among his business associates in the various companies that have been mentioned?

A. I do not know that I would be a competent witness upon that point. My knowledge of his reputation was somewhat limited; however, I know something of it.

X Q. 574. From your knowledge of his general reputation for truth and veracity, would you have believed him under oath?

A. From my knowledge of his reputation, speaking from that alone, without any reference to my personal knowledge of the man, I should say that it would be necessary to know his circumstances, surroundings and the influences at work upon him at the time of his declaration under oath before I could say that I would believe or disbelieve him.

X Q. 575. Prior to your association with Mr. Sawyer did you consider yourself an electrician?

A. Only theoretically; I was not a practical electrician. My main knowledge derived only from reading and observation. It had been a favorite study of mine for some years before that time. I had considered the subject of electric lighting in connection with other matters of electrial interest only—not as a specialty.

1195 X Q. 576. Did you read or were you familiar with such patents on the subject of electric lighting, either by the arc or by incandescence as had been taken out prior to your connection with Mr. Sawyer?

A. I do not as patents. I had read and was familiar with the labors and investigations of others relating to this subject, so far as the same as published had come to my attention in the scientific journals and reports.

X Q. 577. Had they come to your attention to a sufficient degree to familiarize you with the labors and investigations of others in this art?

A. I think so, to a very considerable extent.

X Q. 578. At the time of your meeting with Mr. Sawyer, was he familiar, in your judgment, with the labors and investigations of others in this department?

A. He seemed to me to be quite familiar with the history of the subject.

X Q. 579. Referring now to the dynamo machines, which you used in your experiments, I understand your recollection to be as follows: That for the first two or three days at Centre street there was an Arnoux & Hochausen light machine in the basement of the building; that after that was removed, and until about March 25th, you borrowed some plating machines from Arnoux & Hochausen; on or about March 25th a specially wound machine was delivered; that after you went to Howard street and from there to Walker and Elm streets another specially wound machine was obtained; that from then on you used the specially wound machines, and occasionally one of Arnoux & Hochausen plating machines. Is this correct?

A. The exact details will better appear in my testimony as given.

X Q. 580. Describe in detail the construction of the machine which was specially wound for you in Centre street and delivered to you March 25th.

A. I cannot do so without the machine being present.

X Q. 581. Do you not remember them sufficiently well to describe it?

1196 A. No, not in detail.

X Q. 582. Describe it as well as you can?

A. It was an ordinary type of Siemen's H armature dynamo, about two and a half or three feet long, and the same height, say two and a half feet.

X Q. 583. Please state the construction of the field magnets of this machine?

A. I could not do it.

X Q. 584. Were they permanent or electro-magnets?

A. Electro-magnets.

X Q. 585. How were the magnets energized in your experiments with this machine?

A. Ordinarily by the current evolved by the machine, but in some experiments by a separate machine.

X Q. 586. Please describe completely the connections made where the magnets were energized by another machine, and where they were energized by the machine itself?

A. I cannot recollect the details of these connections more than any other electrical connections.

X Q. 587. If this machine were now before you would you be able to make the proper connections to energize the field by the machine itself, or in the other case by a separate machine?

A. I think so; if the machine was so constructed as to permit it.

X Q. 588. Please state what you would do to make the connections suggested, and illustrate the same by a sketch?

A. I do not know how you could expect me to construct a machine of which I have told you I have no recollections of its details. I decline to do it.

X Q. 589. Please describe the "ordinary Seaman's H armature machine"?

A. I have never built a dynamo. I have never made any invention of a dynamo; my knowledge in regard to dynamos is wholly theoretical, derived from books and descriptions; in giving a description of Seaman's H armature machine, I am liable to omit details and perhaps essential parts. If you desire to have me make a description I will do so as well as I am able. 1197

X Q. 590. Describe the ordinary Seaman's H armature machine.

A. Suppose an iron frame in the form of the letter H, pivoted on a shaft parallel to two sides of the letter and midway between them, the cross-piece of the H extended so as to give it more of the form of an ordinary reel for winding up yarn or fishing line by hand. Let this iron frame be wound lengthwise between the sides of the

H with insulated copper wire until it assumes the form of a cylinder or nearly such, the two ends of the wire being brought out and insulated to near the ends of the axis where they are in communication with insulated semi-cylinder plates of metal, embracing and nearly surrounding the axis, called a commutator. Resting upon these and insulated, two brushes or spring plates touching opposite portions of the commutator plates last described; a pulley connected to the axis of the armature, by which it may be driven; supports in which the axis revolves; field magnets, or magnets whose opposite poles substantially embraces the armature. These are the essential features of construction; the field magnets may be permanent magnets or electro-magnets, and in the latter case may be actuated by the current of the machine, a portion of the current in a shunt circuit, or by a current derived from a battery or other machine.

X Q. 591. Are machines of this type always provided with commutators such as you have described?

A. I don't know that I have described any particular kind of commutator except such as is generally used; if no commutator were used the currents would be to and fro, or alternate.

1198 X Q. 592. Please state the length and shape of the magnets of the specially wound machine to which we refer—that delivered in March, 1878.

A. I do not recollect them well enough to describe them with accuracy; I only recollect they were broad lengthwise of the machine and their poles projected upward.

X Q. 593. Please state the weight of the machine.

A. I don't know; two men could lift it.

X Q. 594. What was the size of the wire of the field and armature?

A. I don't recollect.

X Q. 595. How many turns of wire were there on the armature?

A. I say I cannot recollect the details; I never knew.

X Q. 596. What was the resistance of the armature and of the field?

A. I don't know.

X Q. 597. State approximately or as near as you can.

A. I have no recollection.

X Q. 598. In the experiments with this machine where the magnets were energized by the currents of the machine, was the magnet connected in series with the armature or in multiple arc with it?

A. I don't recollect whether the whole currents were sent around the field magnet or whether they were connected in a shunt circuit.

X Q. 599. Do you know what the difference between these two methods of connection would be, with reference to the electrical apparatus or lamps operated by the machine?

A. I don't think anybody could tell without a thorough knowledge of the machine in a given case, and without a knowledge of the number of appliances, their resistances and relation to the circuit, and without knowing whether the re-entering point of 1199 the shunt was before or after the appliances to which you refer in the general circuit.

X Q. 600. Answer me with reference to the machine in question and to the experiments of Sawyer and Man.

A. I do not recollect how it was connected, and therefore cannot tell you how it operated one way or the other.

X Q. 601. What was the electro-motive force of this machine?

A. I don't recollect; I guess some twenty-five or thirty volts; it may have been much more or it may have been less.

X Q. 602. And you don't now recollect it?

A. I don't know.

X Q. 603. Do you mean to say that you cannot state what the electro-motive force of the machine was, that was specially made for you, and used by you throughout your experiments?

A. I do mean to say that I cannot recollect what it was.

X Q. 604. Will you swear that it was over five volts?

A. I think that it was very much more than that; but I do swear at the same time, I don't know anything about it.

X Q. 605. What was the E. M. F. of the machine that you borrowed from Arnoux & Hochausen in Centre and Howard streets?

A. I don't know.

X Q. 606. About what?

A. I don't know.

X Q. 607. Can you not give any idea?

A. I have no recollection.

X Q. 608. More than one volt?

A. You have exhausted my recollection in regard to this matter, so far as giving details of electrical measurements is con- 1200 cerned; the machines we used were perhaps not all of them measured, and I don't recollect them with sufficient accuracy to give the details of their electrical measurement in any case; it would, however, from the work they accomplished, as a general rule, be absurd to estimate the electro-motive force of any of them so low as one volt, as it seems to me.

X Q. 609. Was it more than two volts?

A. I have nothing to add to the explanation I have just made.

X Q. 610. Was it more than three volts?

A. I think the machines we used would probably be estimated from thirty to two hundred volts; you drive me to make a guess in regard to it; it is all that I can say and I don't know that I am right.

X Q. 611. The machines you used have been specially pointed out in the testimony; what was the E. M. F. of the electroplating machines borrowed by you from Arnoux & Hochausen, and which you say were a type of machines made by them and sold in the open market; do you mean to say it was between thirty and two hundred volts?

A. If they had been pointed out it has been an error on my part, for I have intended to be understood as not recollecting specifically the different machines that we used; we did use plating machines, and those principally at the corner of Howard and Centre street, and part of the time at 43 Centre street; whether we used any other than plating machines at the corner of Howard and Centre streets I do not recollect, except our own first machine we used at 43 Centre street, and at 94 Walker street lighting machines built by Arnoux & Hochausen; the E. M. F. of the plating machines was not high as compared with the lighting machines nor as compared with our own machines built by Arnoux & Hochausen, nor as compared with the machine whose field magnets were energized by another machine.

X Q. 612. Question repeated.

A. I don't know.

1201 X Q. 613. Do you wish then to be understood as being able to give no idea whatsoever as to the E. M. F. of the machines which were loaned you and used by you in experiments? I refer to machines which you stated were plating machines made by Arnoux & Hochausen, and sold for that purpose in the open market.

A. Your question implies inaccurately that I can give no idea, or have given no idea whatever in regard to the subject-matter. I therefore decline further to answer it.

X Q. 614. Please state what was the E. M. F. of the plating machines made by Arnoux & Hochausen and sold for that purpose in the open market, and which were borrowed by you and used in your experiments.

A. The E. M. F. of different machines which we borrowed and used including the different plating machines was widely different one from the other, and we coupled them to produce different E. M. F. as we used them, but I have no recollection whatever what the E. M. F. was as a matter of recollection.

X Q. 615. I restricted my last question, and restrict this to such electroplating machines as you borrowed of Arnoux & Hochausen. I wish to know what the E. M. F. of those machines—not other machines—but those machines, was. Please state.

A. The electro-motive force of these machines greatly varied one from the other. I mean the electroplating machines that we borrowed and used. I don't know the E. M. F. of any of them. I don't know the highest E. M. F. obtained from any of them, nor the E. M. F. that could be obtained from any combination of them; nor the lowest E. M. F. of any one of them; nor the range by which the E. M. F. varied from the highest to lowest.

X Q. 616. Did you ever hear of an electroplating machine of over 15 volts?

A. I don't remember to have ever heard the E. M. F. of any plating machine spoken of.

1202 X Q. 617. Does not your investigation into this favorite study of electricity enable you to state what the E. M. F. of plating machines usually is?

A. I do not remember to have ever looked into the subject; doubtless Mr. Edison, from his experience with his electric meter, could give you the information you seek.

X Q. 618. Then, as I understand you, you have no idea whether the E. M. F. of these electroplating machines was as low as half a volt or as high as 10,000 volts?

A. I have no question as to your understanding, and deny all responsibility for the same.

X Q. 619. Have you any idea as to the E. M. F. of the plating machines sold by Arnoux & Hochausen while you were at 43 Centre street?

A. I don't know what the E. M. F. of those machines, or any of them was.

X Q. 620. Do you know whether it was above or below 15 volts?

A. I think, as a rule, it was much above; I don't know.

X Q. 621. How much, then, do you think it was?

A. I have already said that I guessed their E. M. F. was 25 or 30 volts.

X Q. 622. Confining ourselves to the electroplating machines which you borrowed while at 43 Centre street, of Arnoux & Hochausen, what is your best recollection of the number of such machines that were borrowed while you were there?

A. I don't recollect how many they were of them. There were several; I should think in all five or six different machines—possibly more.

X Q. 623. Were they of the same size and character?

A. Their type was similar but some of them were very much larger than others.

1203 X Q. 624. How did they vary as far as their electric effects were concerned, if at all?

A. Some of them were very much more efficient for lighting purposes, and would light up a much larger number of our lamps than others, and some of them would alone send a current through carbon for the first time, when it was being heated in hydrocarbon gas, sufficient to bring the carbon up to incandescence, and some of them would not—that is to say, both their electro-motive force and quantity greatly vary.

X Q. 625. Please state, as nearly as you can, within what limits this variation in electro-motive force and quantity was?

A. I cannot give it in terms of electrical measurement.

X Q. 626. Have you no idea of it?

Q. I have no recollection of it sufficient to express it in terms of accuracy or electrical measurement.

X Q. 627. Can you not give me any idea?

A. I prefer not to guess at the matter.

X Q. 628. What I desire to know is, whether it is true that while you were at No. 43 Centre street you borrowed from Arnoux & Hochausen five or six different plating machines; second, whether these different machines differed in construction and electrical effect, or whether some of them, or all of them, were alike.

A. What I said, and intended to be understood, is that while at 43 Centre street we borrowed and used several machines of Arnoux & Hochauson of the general type and character of machines in appearance, which they built and sold for electroplating; that I es-

timated their number at five or six—it may be more or less. It may be that not all of the machines were intended by them for electroplating; they may have intended some of them for electric lighting, in which they were also engaged, but I took them to be, if I
recollect right, their plating machines. The general con-
1204 struction of the machines, except one that was in the base-
ment, and which they used for electric lighting, and which
they let us have the use of for a day or two, or so, was similar. I think there were three sizes of them; those of the same size were more nearly alike in electrical effect probably, but no two of the machines were alike in effect.

X Q. 629. I understand you to say that with the exception of the light machine in the basement, the five or six machines which you understood to be plating machines, and which you borrowed of Arnoux & Hochausen, were alike in construction, but were of three different sizes. Now, were these machines which were of the same size wound in the same way, with the same wire, and designed to be of the same effect electrically?

A. Excuse me from testifying to the accuracy or inaccuracy of your understanding. To your question alone I reply. I do not know how the machines were wound, nor with what wire. I only know that they differed one from the other in electrical effect.

X Q. 630. Were those machines which were of the same size of such difference in electrical effect as to have been designedly so, or was the difference merely such as would exist between machines of the same size and character and intended to produce the same results?

A. I think the difference in electrical effect of machines of the same size, was due to design and experiments on the part of Mr. Hochausen, but I am not certain of this, and it may have been due to selection among different machines intended in construction to be the same.

X Q. 631. In machines of the same size, what was the difference in E. M. F.?

A. Some of these machines of the same size differed widely in E. M. F. I cannot give the difference in volts.

X Q. 632. As much as 100 volts?
1205 A. I should think not, but as I have said, I don't know.
If you wish me to guess I will do so, but it will be a guess.

X Q. 633. As much as 50 volts?

A. I don't know.

X Q. 634. As much as 10 volts?

A. I think so; I don't know.

X Q. 635. As much as 15?

A. I think so; I don't know.

X Q. 636. As much as 25?

A. I think so; I don't know.

X Q. 637. As much as 40?

A. I guess so; I don't know. The average E. M. F. I have guessed at or estimated as 25 or 30 volts. It will not surprise me to know that some of these machines had not 5 volts of E. M. F., and that another machine of the same size and general appearance might actually have had in the neighborhood of 200 volts E. M. F.

X Q. 638. Do you mean that of these machines which you took for plating machines, and which were borrowed from Arnoux & Hochausen, while you were at 43 Centre street, which were of the same size, may have varied in E. M. F. from 5 to 200 volts, and that you would not be surprised at such being the case?

A. I mean exactly this: that I never knew or heard of but one or two of these machines being measured. That I noticed in our experiments from time to time, a wide difference in the E. M. F. of these machines, and that if any competent electrician should have measured two machines of the same size and told me then or tell me now that one measured but 5 volts and the other measured 200 volts, I would not doubt, and would have no means that I recollect of now to doubt the accuracy of his statement, and the same would be true if he should report to me that one measured 3 volts and the other 30.

X Q. 639. What was the difference in E. M. F. of those machines which were measured?

1206 A. I do not recollect.

X Q. 640. Can you give me any idea?

A. No; and I don't know that two were measured, but I think they were.

X Q. 641. What machine, or which machines were measured for electro-motive force?

A. To the best of my recollection the machine we bought of Arnoux & Hochausen and the machine we borrowed of them, and which seemed nearest like it in electrical effect.

X Q. 642. Do you know upon what the E. M. F. of a dynamo depends?

A. I think I know some of the causes. I have never made a study of dynamos particularly.

X Q. 643. What are they?

A. Velocity of motion in the armature; size of the resistance in the wires of the armature; and density of magnetism in the field of the field magnets, through which the wires of the armature move.

X Q. 644. Please explain what the size and resistance of the wires of the armature have to do with the E. M. F. of the machine?

A. I do not propose to go into a theoretical discussion of electrical subjects.

X Q. 645. Do you decline to answer my question, or are you incapable of doing so?

A. I decline to answer it.

X Q. 646. Are you quite certain that you know the conditions which enter into the E. M. F. of a machine?

A. I do not think that I am called upon to discuss this subject-matter with you or to express an opinion as to my own abilities.

X Q. 647. Question repeated. (Witness is silent.)

The witness has declined to answer, and is instructed by counsel not to undertake to testify as an expert on matters pertaining 1207 to dynamos unless he feels himself competent as an expert and unless the court compels him, and counsel submits to the court, whether, in view of the facts that the witness has testified, that he has not made any dynamos, or experimented with them, and knows nothing of them only as a matter of theory, he must answer the question.

The witness himself further objects, that he has not submitted himself to an examination-in-chief on the part of the defendant, and that if defendant desired to test the electrical knowledge of the witness, or to obtain expert testimony from him, he must first obtain the consent of the witness to testify and pay him therefor.

X Q. 648. Please state what you mean by density in magnetism in the field of the field magnets in your answer.

A. The number of lines of force in the field of those magnets for a given space determines the density of the magnetism in that field of force, and the number of these lines is increased as the magnetism of the field magnets is increased up to the point of saturation.

X Q. 649. These machines which were borrowed of Arnoux & Hochausen, at 43 Centre street, had they any name or designation by which they were known in the business, and if so please state what it was?

A. I don't know of any.

X Q. 650. What was the weight of those borrowed machines; how did you get them into the room in Centre street, and who placed them there?

A. I never knew their weight; they were hoisted up in a hoistway to the floor on which our shop was. I think they were got into the room by old Mr. Sawyer, George and the men at work in the different shops there, and placed under the direction of Mr. Wm. E. Sawyer.

X Q. 651. The machine which was bought of Arnoux & Hochausen, while in Centre street, and which has been described as the specially wound machine, please state why it was specially 1208 wound; how it was specially wound, and what the effect of this special winding was.

A. As I have stated I do not recollect any of the details of this special winding. I only know that this machine was a very much more effective one than the others.

X Q. 652. Do you mean that you gave no instructions as to how you wanted the machine made, but merely stated that you wanted a machine to produce certain results, leaving them to ascertain how such results were to be brought about?

A. No, I don't think that that is quite right. I think it was about like this: We had tried several of Arnoux & Hochausen's machines, one of which was intended for arc lighting. We discussed with Mr. Hochausen the matter of building a machine which would be more effective for our purpose of incandescent lighting than any of those we had used. At the time I knew nothing about dynamos, except what little I had read, and the small experience I had obtained from the use of those that we had had so far. I don't know that any of us knew much about it. Mr. Hochausen had had the most experience and knew most, and I think they agreed to wind the machine over again if it did not prove satisfactory.

X Q. 653. What were the properties of a machine that you considered at that time as effective for incandescent lighting?

A. The one that would heat up the most lamps to the highest degree with the power.

X Q. 654. Was that the definite information that you conveyed to Mr. Hochausen?

A. At that time just as definite as that.

X Q. 655. Did you want high or low E. M. F.?

A. We thought we wanted a greater quantity of current in pro-
portion to its intensity than his arc-light machines gave, and
1209 a greater intensity than the other machines gave, that is,
less E. M. F. than the arc-lighting machines and more than
the plating machines.

X Q. 656. What amount of E. M. F. did you want to get by this specially wound machine?

A. We did not know ourselves.

X Q. 657. Did you know approximately?

A. No, only somewhere between the E. M. F. of the arc-lighting machine and that of the plating machines, as we judged from experiments.

X Q. 658. Did you know what the E. M. F. of the lighting machines that were in the basement for a day or two and of the plating machines were?

A. No, only in effects, not in electrical units.

X Q. 659. Please state what the effects were which enabled you to judge of the E. M. F. of this light machine, and of the plating machines.

A. The one would light up several lamps of a high resistance, and would send a current through fine carbon before it had been treated and its resistance reduced; the little plating machine would heat up several lamps of low resistance with large carbons in them, after they had been treated, about as well as the large lighting machine, but would not send a current through carbon that had not been treated of high resistance without forcing to start it, by making and breaking the connections rapidly and suddenly.

X Q. 660. Was the specially wound machine of greater E. M. F. than the plating machines?

A. At first, yes; and it also gave a larger current under the resistance with which we used it.

X Q. 661. What do you mean by "at first" in your last answer?

A. Just what I say. It was rewound several times.

X Q. 662. How many different times was the machine wound, and by whom was it wound?

A. By Arnoux & Hochausen, I think twice after the first winding, perhaps three times.

1210 X Q. 663. What was it that was rewound?

A. I think the armature alone at one time—perhaps the armature alone twice; once I think the whole machine was rewound.

X Q. 664. State, as nearly as you now recollect, when these several rewindings were done?

A. The first, I think, was soon after we first received it, and while we were at 43 Centre street. I think it was again wound while at Centre street. The final winding was while we were at 94 Walker street.

X Q. 665. Please state what the nature of the first rewinding was, and what effect it had upon the machines?

A. I did not see the work done, and, therefore, can only state generally what I understood was to be done, and what I assumed from the results was done. The armature was rewound with finer wire and differently connected up, for the purpose of giving the machine greater E. M. F.

X Q. 666. What was the difference between the connections as rewound and its connections prior to that time?

A. I can only answer as before from my understanding of what was to be done, and from the results obtained. I understood that the machine was to be coupled up more in series than before. I neither did this work myself, nor saw it done, nor supervised it. All that I had to do was to talk about it and advise about it beforehand. Judging from the effect, I assume it was done.

X Q. 668. Do you mean that now the armature was in series with the magnets, whereas, before, it had been in multiple arc with them, or that such was your understanding?

A. No. I had reference to the armature alone. Perhaps my expression "more in series" does not convey a correct impression. The armature first being wound with coarser wire in several separate coils connected to the commu*nic*ator; by the use of a
1211 finer wire, a larger number of coils was produced, occupying
the same space, and having a greater length than the coils of coarse wire; they were connected up perhaps one coil to another in series, or two or more coils were united before connection to the commutator.

X Q. 669. How much was the E. M. F. of the machine increased by this operation?

A. I don't know.

X Q. 670. Can you state approximately?

A. No; I can only state results; it was largely increased.

X Q. 671. About how long after the machine was first delivered was this rewinding done.

A. I cannot remember, but my impression is not very long. My attention being called to this matter, my impression is that some change was made in the winding of the field magnets soon after the first change in the winding of the armature of this machine, or it may have been before the change in the winding of the armature. I think the field magnets were first connected up in series with the armature, and that they received a compound winding in connection after we got the machine.

X Q. 672. What was the nature of the second rewinding, when was it done, and what was its effect?

A. I think the second rewinding was rendered necessary by burning out some of the coils of the armature of the machine. I do not remember that any discussion was had in regard to it, and as I did not give it personal attention I do not think I could give any other description of it. I do not remember that it affected particularly the working of the machine; if anything, it increased the quantity, but left the E. M. F. about the same.

X Q. 673. What was the nature of the third rewinding, when was it done, and what was its effect?

A. I think the third rewinding was done after we went to 94 Walker street. I only recollect about it, that it was our object at that time to get a machine of greater quantity current. I did not see it done, but assume that a larger wire was used in winding the armature in separate coils as before, more connected up in multiple arc to the commutator for the purpose of giving quantity than was the previous winding. I do not remember whether the field magnets were rewound here or not; nor whether they were connected up differently from what they had been. We got a machine with a current of larger quantity and less E. M. F. 1212

X Q. 674. Do you remember how much the E. M. F. was reduced, or approximately?

A. I do not, to give it in terms of electrical units, but as a fact I think it was not very much reduced, while the quantity, I think, was largely increased.

X Q. 675. Please describe the machine which you had specially made for you while at 94 Walker street.

A. I do not think I could describe it except in a general manner. I should think that it would weigh possibly 1,000 or 1,200 pounds, and from that up to a ton. It had a series of field magnets, I should think, set around a circumference, within which revolve the armature. It was of the type of machine built by Arnoux & Hochausen for arc electric lighting, but either its winding or connections were such as to give current of less E. M. F. and larger quantity than their ordinary arc electric light machines. It stood about 2½ feet high; was, I think, something over 2 feet in diameter, and 2 to 2½ feet in length. I am speaking of this machine without having seen it, or one like it, for some seven years.

X Q. 676. Can you remember the size of the wires of the magnets or armature, the nature of the windings and connections, and the E. M. F. of the machine? If so, please state them.

A. I cannot; I can only remember what we did with it.

1213 X Q. 677. I have gone over in detail the various dynamo machines which were used by you in your experiments, and I understand that you are unable to describe these machines in detail, to state in detail the size of the wires with which the magnets or armatures were wound, or to give in detail in electric units the electro-motive force or quantity of the machines. Am I correct in so understanding?

A. It is true that I cannot describe with accuracy the machines which we used, nor give in detail in regard to them the particulars of which you speak, whether all of the machines which we used have been gone over by you or not.

X Q. 678. What has become of the machine that was bought while you were in Howard street?

A. I think that machine was taken to Ansonia, Conn., by Thos. Wallace.

X Q. 679. I understand that that machine belonged to the Electro Dynamic Light Company. Can you inform me where that machine now is, and under whose control?

A. I do not know, but assume that Mr. Thos. Wallace has it.

X Q. 681. The machine ordered in Centre street I understand to be in your possession at your place in Georgia?

A. It is in my possession at Garnett's, near Dahlonega.

X Q. 682. Do you remember at what velocities the armatures of these machines were driven?

A. The smaller machine was run from 1,600 to 2,000 revolutions per minute; the larger machine from 12 to 1,600, according to the best of my recollection.

X Q. 683. In one of your answers you speak of the arc-light machine which was in the basement for a day or two as one that "would light up several lamps of high resistance, and would send a current through fine carbon before it had been treated, and its resistance reduced." Is this an inference of your own, or do you mean
1214 to be understood that it did do, by actual work, that which you say it could do?

A. I mean to say that it did it, while we were using it there, the work I mentioned. I think that I used the expression "within a day or two," that may be correct, or it may have been a longer period, as I have several times endeavored to express myself since using the expression.

New York, *July* 20, 1887.

Met pursuant to arrangement of counsel.

Present, counsel as before, and the cross-examination of Mr. Man was continued as follows:

X Q. 684. Referring to your 7th answer on your examination-in-chief, what did you, and do you, consider to be the invention or improvement covered by the first claim of the patent in suit?

Objected to as incompetent, on the ground that the patent is the best evidence, and the only evidence by which the invention, covered by it, can be ascertained.

A. I cannot state it more accurately than is stated in the claim, which is as follows:

"An incandescent conductor for an electric lamp of carbonized fibrous or textile material, and of an arch or horseshoe shape, substantially as hereinbefore set forth."

X Q. 685. Do you understand the word "substantially as hereinbefore set forth" to define, in any way, the invention?

Objected to as incompetent and immaterial.

A. I don't know what their effect is.

X Q. 686. If these words had been left out would you regard the invention the same as you do now?

Same objection.

1215 A. I suppose the invention would be sufficiently described for claiming with these words omitted. Whether they add or detract anything is a matter of opinion. I don't profess to know.

X Q. 687. Do you regard the invention of that claim to be an incandescent conductor for an electric lamp of carbonized fibrous or textile material and of an arch or horseshoe shape?

Same objection, and further that the question is a mere repetition of the claim.

A. I regard that claim as covering such an invention.

X Q. 688. Do you regard it as covering any other, or further, invention?

Objected to as incompetent and immaterial.

A. So far as the words of the claim having reference to the specification of the patent add to, or amplify the claim, or are necessary to its understanding, yes.

X Q. 689. What invention, different or other than as stated in my 687th question do you regard the invention of the claim as covering?

Same objection.

A. The specification in speaking of the advantages of manufacturing the carbon from vegetable, fibrous or textile material, speaks of the convenience afforded for cutting and making the conductor in the desired form and size, the purity and equality of the carbon obtained, its susceptibility to tempering both as to hardness and resistance, its toughness and durability. They also speak of the advantages derived from the particular form of the conductor mentioned in this claim, and it seems to me, though I may be wrong, that these descriptions do amplify the claim as set forth to a something beyond what you state in your question. Just how much or how far this goes, I am unable to define, and I may not be right in my supposition. I will explain by saying that a mere conductor of unsuitable size, though of the shape and material mentioned, might be entirely unsuited to the purposes of electric lighting as ordinarily practised with incandescent lamps. It might be as big as your leg or as long as a ship's cable and utterly unfit for the purposes intended, though of the material and shape mentioned in the claim. So that it seems to me that the claim should be taken with the specification in a reasonable man- 1216 ner, and I think the court is the proper party to judge of what it covers and what the invention is, that is, I have reference to its limits.

X Q. 690. I do not request from you a construction of the claim of the patent to which you are referring, but inasmuch as you were asked on your direct examination to read the claim "and state when the invention or improvement covered by that claim was made," to which you replied—"In the month of March or April, 1878"—I desire to know what you understood to be the invention or improvement when answering the question. Please tell me.

Same objection.

A. The invention or improvements stated in the claim which I then read. I can't state it better. Any further answer would be to construe the claim.

X Q. 691. Is this your position; that whatever the court may hold to be the invention covered by that claim, was made by you and Mr. Sawyer in the month of March or April, 1878, but that you are now unable to say what that invention was?

Same objections, and as improper in that it assumes that the court would construe the claim to mean something not stated by the claim, and that it is not competent for the witness to testify that he has any other understanding of the invention than that described by the language of the claim as a part of the specification.

A. I do not stultify myself in that way.

X Q. 692. When you made your answer to question 7 what was the invention or improvement you then stated to have been made in the month of March or April, 1878?

1217 Objected to as incompetent and immaterial.

A. I have already answered that and the words of the claim answer it.

X Q. 693. The trouble is this: The question referred to did not define or state any invention, but asked when the invention covered by the first claim was made. Now what the invention may be is a question of construction for the court, but I take it that the counsel must have assumed that you had some definite understanding as to what the invention was that was covered by that claim and I infer that you must have understood what or considered the invention or improvement covered by that claim to be, when you say it was made in the month of March or April, 1878. When I ask what you understood to be the invention you read me the claim of the patent in suit. Now it may be hereafter said by the court that the invention covered by that claim is one of several things. Can you not, therefore, tell me what, when answering the seventh question you understood the invention or improvement to be, which was made in the month of March or April, 1878?

Objected to.

1st Upon the ground that the question don't fairly state what the question of the counsel was, inasmuch as counsel did state by putting the patent itself in the hands of the witness, what the invention was, referred to by his question, and

2d. That the question is improper in that it calls upon the witness for a construction of the claim which in its terms is a statement of the invention.

3d. If the court construes the invention to be anything different from that stated by the claim it would be impossible for the witness to know when such invention was made, and

4th. Upon the ground that it is immaterial what the witness thought that the invention was, and improper for him to testify, that he thought it was anything different from that stated by the patent, since every one who may be interested in or who 1218 deals with the patent must be governed by the language of the specification and claim, and that the witness, who is one of the inventors, cannot be permitted to say that the invention was anything else than that stated in the patent.

A. When the 7th Q. was put to me I was already familiar with and then recently read over the whole patent, specification and claims. I had myself drawn or aided in drawing the claim in question putting it in the best language I could to state succinctly the invention or a part of it, which the patent was intended to cover as a whole. Immediately preceding the claim 1 in the patent are the words "we claim as our invention," then follows claim 1 which I understood and now understand to be a clear, concise and succinct statement of an invention or of the thing found out by us. I understood the word "cover" in the question to mean "stated" in the claim; in such sense I answered it as I did. In answering I intended and meant nothing whatever that is not stated in the patent, specification and claim, and I meant all that was stated in the specification of the patent and in this claim so far as it is applicable to the things stated in the specification. In answering your previous question I must be understood as answering with this limitation and not as assuming that the court would decide that anything not in the patent was covered by it, but that it might in its discretion limit the invention stated in the claim by words contained elsewhere in the patent and that it would have to refer to those words in the construction of the claim.

X Q. 694. Have you any different understanding now of what the invention covered by the first claim is, than when you answered question seven.

A. No.

X Q. 695. Do you regard the language of the claim as clearly stating what the invention is?

Objected to as incompetent and immaterial.

1219 A. Taken in connection with the whole patent, yes.

X Q. 696. By "taken in connection with the whole patent," do you mean that the invention of the first claim is explained by the specifications and drawings?

Same objections.

A. I think what it meant is rendered clearer therein.

X Q. 697. Do you recognize it as possible that any difference of opinion might exist as to what the invention covered by the first claim is?

Same objections.

A. Human language cannot be framed to remove all possible question that may arise in regard to its meaning in the future; in that sense I recognize it as possible that questions may be raised about this claim; I do not recognize it as a probability; or perhaps I had better say as a difficult question for the court to determine.

X Q. 698. Do you regard it as possible that after a careful reading of the entire patent a difference of opinion could exist as to what the invention covered by this first claim is?

Same objections.

A. I do not concern myself in regard to it.

X Q. 699. That may be, but I would like you to answer my last question.

Same objections.

A. I don't know whether it would or not; if the opinion were an unprejudiced one I think not.

Adjourned till Thursday the 21st inst., at 1 p. m.

1220 THURSDAY, *July* 21, 1887.

Met. Present: Counsel as before.

Cross-examination of Mr. MAN continued:

X Q. 700. Do you regard cutting the material to size before carbonization as a feature or part of the invention of the first claim?

Same objections, and as calling upon the inventor to vary or construe the claim and specification of the patent.

A. I am one of the inventors. In the preparation of the specification and claims of this patent, in making the claims including the first claim, I considered them as analagous to the syllabus of a case or proposition, or theorem in geometry, and endeavored in concise language therein to state the invention or inventions we had made. I have parted with all my interest in the patent, and I do not feel myself at liberty to give construction, alter or vary the statement of the invention contained in the patent, to enlarge or diminish it, or to give construction to it. In answering the question No. 7 of the examination-in-chief, I understood the question as meaning to ask me when the invention stated in claim 1 was made. I then considered, and now consider that that claim states an invention. Whether it does or not, I am not called upon to decide, but understand that to be a question for the court. My answer, then, to question 7 is to be construed, and I wish it to be so, that if claim 1 states any invention, that invention was made at the time specified in my answer. I decline to give construction to the claim or state my views in regard to what it covers, but I will answer any questions in regard to what we did which are pertinent and proper.

X Q. 701. I am trying to get at what your understanding of the invention of the first claim was when you answered question
1221 7. Please state, therefore, whether you then considered cutting the material to size before carbonization as a feature of the invention of that claim.

Objected to as incompetent and immaterial and as calling upon the witness to construe the claim and specification of the patent.

A. I considered the invention to be just what it is stated in the patent.

Answer objected to as irresponsive.

X Q. 702. Question repeated.

Same objections.

A. I can only state that the patent refers to the cutting of the material to size before carbonization, that we did so cut the material to size before carbonization at the time mentioned in my answer, in the spring of 1878; that we used the carbons so prepared, and others manufactured from material reduced to size before carbonization in one or more directions, and that if the claim should be held by the court to cover the cutting to size before carbonization, my answer would include it.

Answer objected to as irresponsive.

X Q. 703. Question repeated.

Objected to as having been already answered very fully by the witness, and complainant's counsel instructs the witness that the meaning of the specification and claim of the patent must be ascertained by the instrument itself, and in view of the answers already given, complainant's counsel instructs the witness not to answer further to the question, and submits to the court whether the question is a proper one, and whether the witness must answer further.

(Question reread to witness, and under instruction of counsel witness declines to answer.)

Counsel for defendant here give notice that they will at the proper time move to strike out the entire deposition of the witness, for his refusal to answer the question, and will remove for
1222 such further relief as may be proper. Counsel for defendant, without waiving, but insisting upon his right under the above notice, continues the examination *de bene esse*.

X Q. 704. When answering question 23 of your examination-in-chief, what did you consider the invention or improvement covered by the 2d claim of the patent to be?

Objected to as incompetent and immaterial and as calling for a construction of the patent.

A. The invention stated by the 2d claim of the patent, upon a fair and reasonable construction of its words, and with reference to the other matter contained in the patent, not by forced construction, nor in a manner in which it might be said that the millen-ium had come, because the lion sometimes lies down with the lamb inside of him, but by taking the words in their ordinary signification.

Answer objected to as irresponsive.

X Q. 705. Question repeated.

Same objections.

A. The invention just as stated by the claim.

X Q. 706. Question repeated.

Same objections.

A. The combination substantially (as hereinbefore set forth, to wit, in the specification of the patent) of an electric circuit and an incandescent conductor of carbonized fibrous material included in and forming part of said circuit, and a transparent, hermetically sealed chamber in which the conductor is enclosed.

X Q. 707. Did you regard, at the time of making the answer referred to, that the shape of the conductor was a feature of the invention of this claim?

Defendant's counsel request that the counsel for complainant, if he has any objection to the question to make, that he will do so out of the hearing of the witness, as counsel desire witness to answer the question without any suggestion as to how he shall 1223 answer it conveyed in the form of an objection. This request does not apply to a simple request to the witness to decline to answer the question.

Counsel for complainant nevertheless, objects to the question in the presence of the witness *is* clearly improper, in that it calls upon the witness to state what he thinks the claim means in language other than that of the specification and claims, which counsel for complainant insists *that* the witness shall not do, being one of the inventors, unless he is instructed to do so by the court, and instructs the witness accordingly.

A. Inasmuch as the specification of the patent refers to the shapes and shaping of the carbons, and the material of which they were made before carbonization, and we did so make the carbons in shape, and the material before carbonization, and used material already shaped and selected, and to size, at least in one direction before carbonization, at the time I have stated in answer to the question you refer to, to wit, in the spring of 1878; if the court should hold that the 2d claim of the patent included the shape of carbon, my answer would also include in its consideration the shape of the carbon, as I took into consideration and had in mind in making that answer the words of the claim and the specification.

Answer objected to as irresponsive.

X Q. 708. Question repeated.

Same objections.

A. No further than I have stated.

Answer objected to as irresponsive.

X Q. 709. Question repeated.

Same objections.

A. I have no further answer to make.

Same objection to answer.

X Q. 710. Question repeated.

Same objections.

1224 Counsel for defendant desires to state upon the record that he has repeatedly requested counsel for complainant not to indulge in conversation with the witness in regard to questions and the answers to be made thereto, off the record, and now repeats the request on the record, that any remarks or suggestions that counsel for complainant has to make be made upon the record, and that they be read to the witness by the examiner, and counsel requests the examiner from this point on, to state on the record all that occurs at the hearing.

In response, complainant's counsel instructs the witness not to testify that he understands the claims to mean anything beyond or different from what is stated in the language of the claims, or that he regards anything as a part, or the invention described in the claims that is not stated in the description of the invention given by the claims, and calls the witness' attention to the fact that the claim in question does not call for any special form of incandescing conductor, but submits to the court whether the witness must answer the question and testify as to his understanding of the claim.

Counsel for defendant gives notice that, owing to the instruction just given by counsel to the witness, he will move to strike out the entire deposition at the proper time.

Witness says to complainant's counsel: "Do you mean by that to instruct me not to answer?"

Counsel says: "I mean by that to instruct you not to testify that you regarded the invention of the claim in question to be different from that described by the claim."

A. I have not so testified nor intended to do so, but inasmuch as an incandescing conductor must have a shape, I do not see how, without confining myself to any shape, I could regard in any way a combination, such, for instance, as is claimed in this claim without a conductor having some shape. I have not testified, 1225 nor do I intend to do so, nor to express the opinion that the court would hold that this claim had reference to any particular shape, or that I had in mind any particular shape when I answered the direct question referred to, but only that I had in mind the whole subject-matter of the patent.

Answer objected to as irresponsive and argumentative.

X Q. 711. Question repeated.

Same objections and instructions.

A. I don't understand the question. The claim itself, without reference to any of the rest of the patent, says nothing about shape, but is a combination claim of different things, in which shape is not included. I have already stated what I took into consideration, to wit: the exact words of the claim. Shape must be a feature of any incandescing conductor. The combination of the claim includes "an incandescing conductor of carbonized, fibrous material." How can it be considered without taking into consideration shape of some kind, or the shaping of it, which includes shape, I cannot see. So far I must have taken it into consideration and regarded it as a part of the claim. If you desire to know whether I took any particular shape of conductor into consideration or regarded it as part of the claim, I answer, I don't see how I could.

Answer objected to as irresponsive and argumentative.

X Q. 712. You would have saved much time if you had stated originally that you did not understand my question. Please tell me whether, at the time of answering question 23, you considered that the invention or improvement covered by the second claim of the patent, covered any specific form, or every form, of incandescing conductor made of fibrous material and placed in combination with other elements of the claim.

1226 Objected to as immaterial and incompetent, and as asking the witness now, whether at the time he answered the question-in-chief, referred to by counsel, whether he understood the claim to embrace something in addition to what is described by the claim.

A. I do not see how I could have done so when the claim makes no reference to form, and follows one in which form is referred to. I do not think I did, further than I have heretofore explained.

Answer objected to as irresponsive and argumentative.

X Q. 713. I am not concerned in what you "could" have done, or what you "think" your understanding was; please tell me —, in answering question 23, you considered the invention of the second claim to embrace, or cover, any specific form of conductor, or every form?

Objected to as incompetent, immaterial and irrelevant.

A. In answering your question I have already stated that I did not take into consideration in my answer to that question, form in any particular specific, or every form, further than I have stated, that every conductor must have form, as I think, and when I say, "I think," it is the conclusion that my mind is logically led to from the facts and circumstances, and for some slight consideration for my own intelligence.

Answer objected to as irresponsive and argumentative.

Question repeated and defendant's counsel requests the witness not to argue, but to answer his question.

Same objections and also that the witness has already answered the question very fully.

A. You have exhausted my recollection upon the subject; I have answered as fully as I can.

X Q. 714. Can you not state in terms whether, when answering
question 23, you did not or did consider the in*in*vention of
1227 the second claim of the patent in suit as covering every form
of conductor made of fibrous material, and placed in the combination stated, or only some specific form?

Same objections and as already fully answered.

A. I have already stated, and I repeat that in answering that question, I have no recollection of taking any specific form into consideration but only form generally. From the facts and circumstances, I think, and am confident that I treated the claim as stating only general form and not specific. By "general form" I mean any form applicable and suitable to an incandescent conductor for an electric light.

X Q. 715. Did this require on your part a construction of the claim?

Same objections and as not having any meaning.

A. I do not think it did, further than as any ordinary language must be construed to be understood.

X Q. 716. When answering question 23, did you consider that the cutting the conductor of that claim to size, prior to carbonization, was a feature of the invention, or improvement covered by that claim?

Objected to as incompetent and immaterial.

A. I don't think I considered it one way or the other.

X Q. 717. Have you no recollection as to whether you did or did not consider this question?

Same objections.

A. I have no recollection of having considered it.

X Q. 718. Then, do you mean that, as far as your recollection goes, you did not consider this subject?

Same objections.

A. I mean what I say.

X Q. 719. I understand you to say that you have no recollection of having considered it. Is my understanding correct?

Same objections.

A. It is.

1228 X Q. 720. It would seem to me to result from its not occurring to you whether the conductor of the claim must be cut to size prior to carbonization, that you must have considered that the invention of the claim covered any conductor of fibrous material, placed in the combination of the claim whether cut to size prior to carbonization or not. Do you wish to be so understood?

Same objections.

A. I have no objection to your having any opinion you may desire in the matter. I do not endorse your opinion or the contrary, and I am not concerned as to whether you are right or wrong in your conclusions as to what I had in mind, and do not wish to express an opinion.

Answer objected to as irresponsive.

X Q. 721. You seem to forget that this is a judicial examination, and that you are a witness testifying before a court of justice. You may be indifferent as to whether I do or do not understand what you mean by your answers; the court, however, is entitled to have clearly upon the record what you mean, and my effort, as an officer of the court, is to understand your testimony, so that I may not misquote you or mislead the court by any statement of mine in regard to your meaning hereafter. You have testified in this case that you were an attorney and counsellor at law, I will therefore not discuss with you the propriety of your last answer, and I have made this statement preparatory to my question to recall to your mind where you are. I repeat my question.

Same objections, and further objection that the question and a number of the immediately preceding questions are merely an attempt to obtain indirectly from the witness a construction of the patent. As to the lecture of defendant's counsel to the witness, complainant's counsel submits that it is a mere piece of impertinence. Neither the court nor counsel can have any difficulty in understanding the testimony of the witness nor the position of the witness as such. Counsel again instructs the witness 1229 not to testify to anything that can be considered as a construction of the claim or the patent.

A. I have not forgotten my position as a witness nor my duty to the profession of which I am a member, and I do not need a lecture upon that subject. If you quote my language, as I give it, you will not misconstrue my testimony to the court, and I have no fear but that the court will fully understand me and my testimony, but if you undertake to group together, according to your own fashion, and to give your own construction of my testimony for your own purposes, I shall hereafter, as in the past, tell you, in substance, that I am testifying and not you, and that I prefer to give that shade of expression and meaning to my words and plainly indicate it, which I prefer, and not to adopt or concern myself with your interpretation: I have answered your question and I am ready to answer any further questions. I repeat again, that whether your conclusion is right or wrong does not concern me. I have stated the facts.

Answer objected to as irresponsive.

X Q. 722. Question 720 repeated?

A. I do not wish to be so understood nor to be understood to the contrary effect. I wish to be understood as I said, that I do not recollect.

X Q. 723. You say that when answering question twenty-three you have no recollection of having considered whether cutting the conductor of *of* that claim to size prior to carbonization was a feature of the invention or improvement covered by that claim. Now, did you consider that the invention of that claim covered any incandescent conductor of fibrous material placed in the combination of that claim, whether cut to size prior to carbonization or not?

Same objections.

1230 A. The question asked me in question twenty-three was a question of time of invention. The invention of cutting the carbon to shape before carbonization, if it may be called such, and the matters mentioned in the combinations of claim two, were both discovered in the spring of 1878, and put in use by Mr. Sawyer and myself at that time. I did not understand myself as called upon by question twenty-three to give legal construction to that claim, but only to state when the invention stated in that claim was made. It was a matter of indifference, therefore, to me, in answering that question, whether it included carbon cut to shape or not, or involved carbon cut to shape or not. I could, therefore, and did answer the question by giving the time of the invention stated in claim two, without considering the separate parts of the invention, and without considering all that might be included in the claim by legal construction, or whether it was included in the claim by legal construction, and I made no attempt to give the legal construction to the claim further than to take the things there stated as facts. It was not necessary for me to consider in answering question twenty-three, whether the "invention" of that claim covered any incandescent conductor of "fibrous material placed in the combination of that claim, whether cut to size prior to carbonization or not," and I have no recollection of giving it consideration.

All that part of the answer of the witness prior to "it was not necessary," is objected to as irresponsive, argumentative and as many conclusions of fact, improper as evidence, the facts on which the conclusions are based not having been given, and the witness not having been interrogated in relation thereto.

X Q. 724. I understand from the latter part of your answer that when answering question twenty-three you do not recollect having considered the question whether the invention of the second 1231 claim covered any incandescent conductor of fibrous material, whether cut to size prior to carbonization or not. Do I correctly understand you?

Same objections.

A. I have no doubt that you correctly understand me, but my answer must be taken as a whole, including the reason I gave of concurrent invention doing away with the necessity of any such consideration.

All that part of the witness' answer following "but my answer" is objected to as being irresponsive and argumentative.

Witness here says that he wishes to have the first sentence of his answer read as follows:

"I have no doubt that you correctly understand me and the whole of my answer, but my answer must be taken as a whole, etc."

X Q. 725. Do you wish the court to understand your answer according to my statement in question 724?

A. Yes, with the explanation that I have given.

Adjourned till Friday, the 22d inst.; at 1 p. m.

FRIDAY, *July* 22, 1887.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. Man was continued as follows:

X Q. 726. When answering question 24, what did you understand the invention or improvement covered by the third claim of the patent to be?

Objected to as incompetent and immaterial, as the patent itself is the best and only evidence to prove what the invention of the claim is.

A. The invention stated in the 3d claim to wit, "the incandescent conductor for an electric lamp formed of carbonized paper, substantially as described," that is, as described in the specification preceding the claims in the patent.

1232 X Q. 727. What meaning did you attach to the words "substantially as described" when answering the question referred to?

Same objections.

Counsel for complainant withdraws his instruction given to the witness yesterday leaving the witness free to testify as he chooses, as to his understanding of the specification and claims of the patent in suit, but insists upon his objection as to the competency and materiality of such testimony.

Counsel for defendant inquires whether the withdrawal of the instruction to witness not to answer the questions submitted as to his understanding of the claims, applies to the instructions given at the last two sittings.

Counsel answers "yes."

Counsel for defendant waives for the present an answer to the question last submitted to the witness, as in view of the withdrawal of counsel from his previous position he desires to interrogate the witness further concerning his understanding of the invention of the 1st and 2d claims of the patent in suit at the time of testifying, on his direct examination.

Counsel for complainant desires it distinctly understood that he does not withdraw any of the objections, but only the instruction to the witness.

X Q. 728. I now repeat in substance cross-question 701 as follows: "Please state whether you considered at the time of answering question 7, cutting the material to size before carbonization as a feature of the invention of 1st claim?"

Question objected to on the ground that it is incompetent and immaterial in that it calls upon the witness for a construction of the claim of the patent to which the witness is not competent to testify, being one of the inventors to whom the patent was 1233 granted, and also as not proper cross-examination, and notice of motion is given that at the proper time counsel will move to strike out the question and answer.

A. The question 7 is a question simply, as I understand it, of time, to wit, the time when an invention stated in the claim, if any were stated, was made. In answering that question I read the claim and noticed its words. Inasmuch as it contained the words "as hereinbefore set forth," viz., as set forth in the specification of the patent, and the specification of the patent make reference to cutting the conductor to shape before carbonization, and the conductor was so cut to shape before carbonization by us and put to use at the time mentioned in my answer, to wit, in the spring of 1878, I think and believe that I had that fact in mind at the time of making answer to the question; I do not think that I considered at the time the abstract question, which I believe to be one of construction for the court, whether or not the cutting of the conductor to size and shape, or the shaping of it before carbonization, was covered by the claim; I have no recollection of considering any such question, and do not believe that I did.

Answer objected to as irresponsive and argumentative in stating conclusions of fact and not any facts concerning which the witness has been interrogated.

X Q. 729. Do you mean to be understood by your last answer that when answering question 7 you did not consider the question whether cutting the carbon to size prior to carbonization was, or was not, part of the invention of that claim?

Same objection and notice.

A. I mean simply that I do not recollect whether or not in my own mind at the time I decided or believed that it was covered by the claim or not. I do recollect that the fact of doing the thing, to wit, the cutting to shape before carbonization, was present to my mind in answering the question.

1234 Last sentence of the answer objected to as irresponsive.

X Q. 730. Before, and at or about the time of giving your examination-in-chief, had you advised or consulted with complainant's counsel in regard to the general subject of your testimony?

A. I had talked over the whole subject-matter of the patent with the counsel for complainant for the purpose of refreshing my recollection of facts, and informing him of what I did recollect.

X Q. 731. Was your examination furnished you for examination and correction by consent of counsel, prior to the beginning of the cross-examination?

A. The examination was conducted by question and answer, and subsequently was submitted to me after being written out, for examination and correction. I assumed that it was so done by stipulation of counsel.

X Q. 732. It strikes me as very peculiar that you cannot recollect whether, in answering question 7, in which you state that an invention was made at a certain time, the question not defining the invention or asking for any facts, but referring only to the invention as covered by the first claim of the patent, that you cannot now recollect whether you considered the invention to include or not to include this feature of cutting the material to size prior to carbonization. Is your failure to now recollect whether this question was or was not considered by you due to a defective memory?

Objected to on the ground that it does not fairly state the facts referred to, inasmuch as question 7 referred to a certain specific invention that is succinctly described by the claim itself, the claim of the patent, and that the inquiry of the question was limited to the invention described by the claim, and that there was nothing in the question to suggest to the witness' mind anything whatever about cutting the carbons to size before carbonization. 1235

A. In explanation of anything that may seem to you peculiar in the matter, I have already stated that the fact was present to my mind of cutting the carbon to shape before carbonization; that the time of the occurrence of that fact was concurrent with the other matters stated in the claim; that I did not and do not understand the question asked of me as calling for a construction of the claims; that the answer would be the same, whether I construed the claim to include the cutting of the carbon to shape before carbonization or not; that, therefore, I do not believe that I took into consideration the question whether or not it was included; and under those circumstances I cannot consider my failure to recollect whether I thought it was included or not included as due to a defective memory, as it was a matter of no consequence to my mind.

Same objection to answer as before.

X Q. 733. You were asked by question 7 when you made the invention covered by the first claim of the patent in suit, could you have answered that question without having some understanding in your own mind as to what that invention was?

A. No.

X Q. 734. Now, did you, when answering that question, have an understanding in your mind as to what the invention was?

A. I did.

X Q. 735. A clear understanding?

A. I believe so, as to the most of it.

X Q. 735*a*. If the first claim of the patent read: "An incandescing conductor for an electric lamp, of carbonized fibrous or textile material, and of an arch or horseshoe shape, cut to size prior to carbonization," would you regard the invention of the claim 1236 as the same as if the claim read "an incandescing conductor for an electric lamp of carbonized, fibrous or textile material and of an arch or horseshoe shape," assuming that in the latter case there was no mention in the specification of cutting the material to size before carbonization?

Objected to as incompetent and immaterial, and as calling upon the witness for his opinion on hypothetical claims not found in the patent and as unfair to the witness.

A. The claims would not be the same, and one would describe an invention not mentioned in the other.

X Q. 736. Should you, in the case supposed, regard the inventions as different?

Same objections.

A. Only in the respect that one includes an invention not mentioned in the other. In that respect, yes.

X Q. 737. You say when answering question 7, you did have an understanding as to what the invention of the first claim of the patent in suit was. Please state what you then understood it to be, and in this connection I request that you do not read the language of the claim as an answer, but state in your own language what you then considered the invention to be?

Objected to as incompetent and immaterial, and notice of motion is given to strike it out at the proper time.

A. I understood the invention to be the finding of an incandescing conductor for an electric lamp of carbonized, fibrous or textile material of an arch or horseshoe form, and therefore, as including as one kind of such conductor, one cut to shape before carbonization. Whether limited to or covering only one, cut to shape before carbonization, I do not think I determined in my own mind, not considering it necessary to do so.

X Q. 738. Is this what you mean: That you then considered the invention to be an incandescing conductor of fibrous or tex- 1237 tile material, and of the arch or horseshoe shape, and that you then considered and now consider that such being the invention, it would include such a conductor cut to size prior to carbonization as well as one not cut to size?

Same objection and notice.

A. Yes, I meant that and more.

X Q. 739. What do you mean by "more?"

Same objection and notice.

A. I mean that the invention might include the cutting to shape before carbonization, or that it might not include the cutting to shape before carbonization.

Answer objected to as argumentative, and as not stating any fact or recollection of the witness.

(Witness continues.) I had this in mind in answering question 7, to wit: The fact of the cutting to shape before carbonization, but not the determining whether such cutting to shape was included in the invention of the claim. I was answering as to time, and it made no difference in my answer whether the cutting to shape before carbonization was a part of the invention stated in the claim or not. If it was part of the invention stated in the claim, which I did not determine, my answer would be as given, in the spring of 1878. If it was not part of the invention stated in the claim, my answer would be the same.

Supplemental answer of the witness objected to as irresponsive and argumentative, and as stating conclusions of fact and not anything as to which he has been interrogated.

X Q. 740. Do you recognize that if the cutting the carbon to size before carbonization is an element of the 1st claim, the invention is different than if that element is not included?

Same objections and notice.

A. I recognize that the claim includes the conductor cut to shape before carbonization. I recognize also that there would be difference of invention if the claim were limited by cutting the
1238 conductor to shape before carbonization, or if the cutting to shape before carbonization were an additional element of invention stated or implied in the claim a difference from what the invention would be if the claim were not limited by the cutting to shape before carbonization, or if the cutting to shape before carbonization were not an element of additional invention stated or implied in the claim.

X Q. 741. Do you recognize this as true, that if the invention of the claim does not include as an element, this cutting to size, the claim is broader than if the element referred to is an element of the claim, the broader construction would comprehend the case of a conductor cut to size, whereas, if the cutting to size should be regarded as a necessary element of the claim, the claim would be narrowed and require for its infringement the infringing conductor to be so cut to size?

Same objection and notice.

A. I understand that if the claim were limited to a conductor; cut to size before carbonization, either by the terms of the claim or by construction, it would be narrower than if not so limited, and that there could be no infringement outside the limit of the claim.

Adjourned till Saturday, the 23d, 1887.

SATURDAY, *July 23d*, 1887.

Met, pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. MAN was continued as follows:

X Q. 742. You have stated that you assisted in the preparation of this claim, which invention did you intend to claim to cover, the broad invention of an incandescing conductor of fibrous material and of the arch or horseshoe shape, or the narrower invention of an incandescing conductor of carbonized, fibrous or textile material, and cut to shape prior to carbonization. 1239

Same objections and notice.

A. I intended that it should cover the broad invention including the fact that it was cut to shape or not cut to shape as the case might be. I did not know or contemplate whether the claim or invention would be subsequently limited to the narrower invention by construction or by the facts of the state of the art, or would not.

X Q. 743. If a block or irregular mass of textile or carbonized material should be taken and carbonized, and an arched or horseshoe-shaped conductor should be cut from such mass after carbonization, would such a conductor, according to what you intended the claim should cover, be within the invention of the claim?

Same objection and notice.

A. It clearly would be within the invention of the claim, if the mass which should be carbonized should be of selected, prepared and homogen-ous material of proper purity and suitably carbonized, such as described in this patent, but whether any conductor cut after carbonization from an indiscriminate mass of such material not homogen-ous, or pure, nor selected, would be covered by the claim in question, upon construction by the court, or under the facts in regard to the state of the art at the time when the invention was made, I do not know, nor do I recollect any question in my mind in regard to the matter at the time of the preparation of the claim.

X Q. 744. Do you mean to be understood from your last answer that a conductor of the kind specified in my question, would be within the invention you intended to cover by the first claim?

A. I mean that in my judgment it might be, if of the material described in the specification, and carbonized as therein referred to.

1240 X Q. 745. You say it might be; might such a conductor not be?

Same objection and notice.

A. That question is one that I cannot determine. The range of the future is illimitable. It seems to me probable, or at least possible, that it might not be, but I am unable to determine the question definitely.

Adjourned till Monday, the 25th inst., at 11 a m.

NEW YORK, *July* 25, 1887.

Met. Present, counsel as before, and the cross-examination of Mr. MAN was continued:

X Q. 746. At the time of filing the application for the patent in suit, did you consider the cutting the material to size prior to carbonization as necessary to the production of a suitable incandescent conductor for an electric lamp made of carbonized, fibrous or textile material?

Same objections and notice.

A. I considered it highly advantageous that the conductor should be either cut to size and shape before carbonization or made from materials already in shape, or that could be put in shape without cutting, in order to obtain the best conductor. I do not think that I considered it absolutely indispensable, though it was the method practiced by us, except in a few cases. In some cases we did select material already in shape and of the desired size, or which could be put in shape by a simple bending, and made a large number of conductors of such material, carefully selected, which were of as good quality as those that were cut to shape, and we also cut to shape after carbonization some conductors which were good; so that I cannot say that I considered it absolutely necessary that the conductors should be cut to shape before carbonization. I considered it highly advantageous.

1241 All that portion of the witness' answer which relates to what was done by them, objected to as irresponsive.

X Q. 747. Did you consider it necessary that the material should be either cut to shape prior carbonization or that the material to be carbonized should be of the same dimensions as the conductor to be made from it, or that the material should be carbonized in a sheet and the conductor cut from it?

Same objection and notice.

A. I did not consider it absolutely necessary that the material should be cut to shape before carbonization, or that it should already be of the size proper to make the required conductor after carbonization, or that it should be carbonized in a sheet of the proper thickness in order that it might be cut out of the sheet of carbon as formed, but I considered that this was the best and most practical way, but not an absolute necessity if the material were of the proper kind and properly selected before carbonization.

X Q. 748. If the material were of the proper kind and properly selected, could you obtain an incandescent conductor having the valuable properties of the fibrous conductor you assert to have been invented and used by Sawyer and Man?

Same objection and notice.

A. Yes; if it was of the proper size, such a conductor with proper selection of material, and of a mass of material rendered homogeneous beforehand and carbonized in mass with the utmost care and particularity, from a mass not too large, could be made, and was made by us having many of the properties enumerated in the specifications of the patent, but only with the utmost painstaking and care and by the highest skill of manipulation, and working with immensely a greater number of failures than successes; and we did not consider it a practical way of doing it.

1242 X Q. 749. Do you assert that an incandescent conductor of fibrous or textile material, and having the properties which you claim the fibrous conductor to have been invented by Sawyer & Man possessed, was ever made by you where the material had neither been cut to size prior to carbonization nor where the material when carbonized was substantially the size of the conductor, nor where the material was carbonized in a sheet of substantially the thickness of one of the dimensions of the conductor, and the conductor cut from this carbonized sheet?

Objected to as incompetent and immaterial, and notice of motion to strike out question and answer.

A. Yes. I think and believe that we made a conductor out of carbon of such material, selected and homogenized before carbonization, and cut to shape after carbonization, having most, if not all, of the properties mentioned in the specifications of this patent, but it was not a practical way of doing it, was very expensive and uncertain.

X Q. 750. Please state in what way the incandescent conductor to which you refer in your last answer as not being made by one of the methods described in my question 749, was made?

Same objection, same notice.

A. We used selected and compressed papier-mache, thick sheets of paper cemented or glued together, carbonized them in the usual manner in a furnace excluded from the atmosphere by powdered carbon. We took the masses in this manner, cemented them to laps or glass, worked them down to near the thickness required, cut them out in the other direction—in the direction parallel with the plate, with knives and gravers and files and emery—released them from the lap or glass, dried them, cemented them the other side up to the glass or lap, finished the surface that had been next to the glass or lap, released them from the glass or lap, when they were ready to be placed in the lamps. We also cemented masses of carbon, not of the shape or size of conductor required, after
1243 smoothing it off on one side to the flat end of a tool, put the tool with the carbon so cemented to it in lathe; turned out the inner portion of the carbon down to the tool, and the outside of the carbon to make a proper ring in the direction toward the centre, of a thickness corresponding to the conductor we wanted. Released

the carbon ring thus made from the tool, recemented it to the end of the tool the other side out; finished the outside; released the ring thus formed of carbon from the tool, placed it in the clamps of the lamp, and broke or cut away that part of the ring at the lower edge between the clamps, leaving the portion of the ring extending above the clamps, as the incandescent conductor of the lamp.

X Q. 751. Did you consider any of the methods referred to in your last answer practical?

Same objection, same notice.

A. They could be done; they were not practical in any commercial sense. I do not know whether they could be rendered so or not.

X Q. 752. Did any of the conductors——

Witness adds to his answer: "In speaking of the practicability, I refer to the making, and not the quality of the carbon; they were good carbons."

made by the method described in your 750th answer possess the properties you allege to be possessed by fibrous conductor, you claim to have been used and invented by Sawyer and Man?

Same objection, same notice.

A. Yes.

X Q. 752*a*. Were they as good conductors, or did you consider them as good conductors as those made the other way?

A. I do not remember to have compared them as to which was the best.

1244 X Q. 753. What was the object of either cutting the carbon to size prior to carbonization, or having the material to be carbonized of substantially the size of the conductor, or of carbonizing the materials in sheets of the thickness of one of the dimensions of the conductor?

A. First. The greater facility of shaping and sizing before carbonization over the facility of shaping and sizing after carbonization.

Second. The greater uniformity and facility of carbonization without fracture.

Third. Greater facility of tempering and consolidation in carbonizing.

Fourth. The advantage of nicer selection of material to be carbonized.

Fifth. Ability to obtain homogeneous material in the same conductor; and,

Sixth. The carbon made from material cut to size before carbonization is more uniform after carbonization, and smoother than it can be made after carbonization, more equal throughout in its electrical resistance or conductibility.

Adjourned to July 26th, 1887.

NEW YORK, *July 26th*, 1887.

Met. Present, counsel as before, and cross-examination of Mr. MAN proceeded:

X Q. 754. Are the second and third advantages pointed out in your 751st answer, due to the superior carbonization to be obtained by carbonizing a small mass of material over what would be obtained by carbonizing a larger mass?

Same objection and notice.

A. The second advantage which I have mentioned—avoidance of fracture and uniformity of carbonization without fracture—1245 has reference to the difference of strain in the material carbonized by the shrinkage which takes place in all carbonization. This liability to fracture is lessened by lessening the mass to be carbonized, so that the carbonization takes place more uniformly throughout it and the shrinkage goes on uniformly with the carbonization, avoiding fracture, while in the mass not cut to shape the carbonization does not proceed equally throughout the mass; the shrinkage is unequal in different parts of the mass, and the liability to fracture is increased. The third has reference to better carbonization, and more practical, of a mass already in shape over an amorphous mass shrinkage, consolidation, hardness, tempering, the same difference in kind which takes place practically in uniformly tempering a large mass of steel, as compared with the tempering of a small mass, or one formed to the shape desired before tempering.

X Q. 755. Which of the incandescent conductors made by Sawyer & Man did you consider the best adapted for the incandescent conductor of your electric lamp?

Same objection and notice.

A. Those formed to shape and size before carbonization, or those which were, before carbonization, already of the shape and size desired, according to my present opinion.

X Q. 756. Has your opinion changed any since the application for the patent in suit was filed?

Same objections and notice.

A. As I said yesterday, in answer to your question, I do not recollect having compared in my mind at the time the absolute quality of the few carbons, comparatively, which we cut out of the mass after carbonization with the quality of the many shaped before carbonization, or selected to size before carbonization, as the practical carbon for an electric lamp. I thought then, and still think, that the one formed to shape, or selected of the size and shape desired before carbonization, was the best by reason of the very ex-1246 treme difficulty of getting a good carbon by cutting to shape after carbonization.

X Q. 757. Did you regard the incandescent conductor made from carbonized fibrous material as superior to a conductor made from non-fibrous material?

Same objections and notice.

A. For many purposes, yes, and, on the whole, yes.

X Q. 758. Did you consider that you were the first persons to use carbonized fibrous material as the incandescent conductor for an electric lamp?

Same objections and notice.

A. We considered and believed that we were the first to make and use a good, practical incandescent conductor of an electric lamp of carbonized, fibrous or textile material, and we did not know, nor believe, then, nor do I know, nor believe, now, that any one, prior to us, had made or used a good, practical conductor for an incandescent lamp made from textile or fibrous material prior to the time when we made it, and I certainly did not know that any one prior to us had attempted to use, as the conductor of an incandescent electric lamp, carbonized, fibrous or textile material prior to our doing so, nor do I know it now.

X Q. 759. Did you know at the time of the application for the patent in suit that charcoal had been used as the incandescent conductor for an electric lamp, or that there were patents in which it was stated that the incandescent conductor of these lamps was made of charcoal?

Same objections and notice.

A. I knew of no such patents, and I do not think that I knew or had heard of the use of charcoal for this purpose, or that charcoal had been so used, except that I had heard at the time of, or prior to the application for this patent that Mr. Edison had tried to 1247 make such a conductor, late in the fall of 1879, from carbonized paper, and I knew of our own use prior to then.

X Q. 760. Do you now know that there were patents or publications prior to the 1st of March, 1878, in which incandescent electric lamps were described the conductors of which lamps were made of charcoal?

Same objection and notice.

A. I have heard such statements made; I do not know it as a fact.

X Q. 761. Did you, at the time of the application for the patent in suit, consider the arch or V-shaped carbon as original with Sawyer and Man, irrespective of the character of the carbon or the material?

Same objections and notice.

A. I did.

X Q. 762. What materials did Sawyer and Man try or use as the incandescent conductor for an electric lamp?

Same objection and notice.

A. Carbon, only of different kinds. I have very fully described, as I think, the different carbons we used. Carbons cut out of gas-retort carbons, carbons cut out of carbonized, fibrous and textile material, natural and artificial, carbons produced from such materials shaped and sized before carbonization and carbons made from such materials selected to shape and size before carbonization. French carbons prepared and sold in the market of what is usually known as mineral carbon, carbons made by ourselves from such material, usually called mineral carbons, carbons made by ourselves from various vegetable and animal substances not fibrous or textile; carbons made from lamp-black and bone-black with admixture of animal and vegetable substances, and not so mixed, carbons made by deposit by the use of an electrical current and a hydrocarbon gas or liquid. All the carbons I have enumerated treated after the manner of our patents for that purpose in a hydrocarbon 1248 gas or liquid, and the same not so treated. I do not now call to mind others, though perhaps there may have been others.

X Q. 763. Then, as I understand you, you tried and used the following classes of carbons for the incandescent conductors of your lamps: Non-fibrous, treated and untreated; fibrous, treated and untreated; and carbon obtained by electric action.

Same objection and notice.

A. Yes.

X Q. 764. And I understand of these classes you consider the fibrous carbon the best?

Same objection and notice.

A. I certainly considered the carbon obtained from fibrous or textile material the best. I considered that it was improved by treatment as a conductor for an incandescent electric lamp for general purposes.

X Q. 765. The patent in suit contains the following statement: "The advantages resulting from the manufacture of the carbon from vegetable, fibrous or textile material instead of mineral and a gas carbon are many." And then proceeds to point out such advantages. At the time the application for the patent in suit was filed was it, and has it always been your opinion, as stated in your last answer, that carbon from fibrous material was superior as an incandescent conductor to mineral or gas-retort carbon?

Same objection and notice.

A. At the time of the application for the patent such was my opinion according to my recollection. My first idea that it was superior was in the spring of 1878, when we first tried it. I do not think from my recollection now that my mind was fully made up in regard to the matter, except that it might be superior, and probably was, until on more extended trials of it, commencing the last of August or first of September, 1878, and continuing up to 1249 March, 1879. My mind was fully made up in regard to its superior quality early in October, 1878, perhaps in September. My mind was made up as to its excellence, whether superior or not, in the spring of 1878.

X Q. 766. Since the application for the patent in suit was filed have you changed your opinion?

Same objection and notice.

A. I do not think I have.

Adjourned till Wednesday, the 27th inst., at 10½ a. m.

New York, *July 27th*, 1887.

Met. Present, counsel as before and cross-examination of Mr. Man continued as follows:

X Q. 767. What did you consider the advantages of the arch or V-shaped conductor to be?

Same objections and notice.

A. First. The avoidance of shadows, except in the one direction, by placing both the attachments at the end of the conductors in the same plane so that the conductor would be entirely outside of that plane, and so that the shadow of the holders or support of the conductor would be cast in only one direction.

Second. By this form, doing away with the necessity of mechanical arrangements or appliances to compensate for or prevent the injurious effects of expansion or contraction of the conductor when heated up and cooled. In other words that the form permits the carbon conductor to expand and contract under the varying temperatures to which it is subjected, when the electric current is turned on or off, without the necessity of altering the position of its fixed terminals.

1250 X Q. 768. Aside from the advantage due to avoidance of shadows and the necessity of providing devices to compensate for the expansion and contraction of the conductor, are there any other advantages?

Same objection and notice.

A. Facility of manufacture perhaps. There may be other advantages. They do not occur to me now.

X Q. 769. What were the methods in practice before the spring of 1878, familiar to those skilled in the arts appertaining to the making of carbons for electric lighting, and what were the ordinary methods then in vogue of forming the material to be carbonized to the desired shape and size? I call your attention in this connection to that part of the specification of the patent in suit between lines 85 and 100.

Same objections and notice.

A. I do not remember to have seen, read or heard of any particular method prior to the spring of 1878, further than the ordinary method of carbonization, getting anything into shape and size and the ordinary method of carbonization, consisting of excluding the air from the substance to be carbonized and heating it up.

X Q. 770. The specification at the point noted, states:

"No special description of making the illuminating carbon conductors described in this specification, and making the subject-matter of this improvement is thought necessary, as any of the ordinary methods of forming the material to be carbonized to the desired shape and size, and carbonizing it while confined in retorts in powdered carbon substantially, according to the method in practice before the date of this improvement, may be adopted in the practice thereof by any one skilled in the art appertaining to the making of carbons for electric lighting."

Was it old in the arts at the alleged time of this invention to manufacture carbons by first forming the material into the
1251 shape and size which it was desired the carbon should be, and then to carbonize the material so formed, to shape or size?

Same objections and notice.

A. The making of anything to shape or size was not new at the time of our invention. The method of making anything almost to shape and size was well known and in ordinary use. The carbonizing of different substances had been long practiced previous to our invention. The methods of carbonization of different substances as an act of carbonization alone consisting of excluding air and applying heat were also, of course, well known. By this I do not mean that new methods and better appliances for the purpose might not have been the subject-matter of invention in the spring of 1878, but prior to that time I had never heard, read or seen the making of a carbon conductor for an incandescent electric light, a delicate, fragile and difficult article to produce, by first cutting the material to be carbonized on forming or selecting it to the appropriate size and shape, and then carbonizing it afterwards in shape and of the size appropriate to produce the article required. I think a carbon conductor of an incandescent lamp so produced, was new and a new article of manufacture in the spring of 1878, and I think, further, that Mr. Sawyer and myself were the first to realize and discover that by this method of procedure the incandescent conductor of an electric lamp could thus be practically produced, and so far as I know, in this manner only, be practically on a large scale, and that by following this method of procedure the conductor would possess, or could be made to possess, the properties essential to an incandescent conductor, as I believe, viz., purity and equality of the carbon, susceptibility to tempering, both as to hardness and resistance, and toughness and durability. I do not know whether other things had, prior to this time, been cut to shape or size and afterwards carbonized or not. I do not think that the incandescing con-
1252 ductor of an electric lamp had been so produced, and believe from all that I have read and heard of upon the subject that it had not, and I further feel confident that no one, prior to this time, had realized that by this method of procedure such a conductor would be produced, possessing the essential properties and requisites of the incandescing conductor of any electric lamp which I have enumerated.

Answer objected to as irresponsive and argumentative, and containing many conclusions of fact in regard to which witness has not been interrogated.

X Q. 771. Please state whether at the alleged time of the invention of the patent in suit, it was old in the arts where an article of carbon (I do not refer to the incandescent conductor of an electric lamp, but to any article of carbon) was desired to have a certain size and shape, to cut or form the material of which the carbon article was to be made to the desired form and size of such article, and carbonize it after being so cut or formed to size and shape.

Same objection and notice.

A. I do not remember now any article made from carbon that was at the time usually, or ever, so cut to shape or form before carbonization, but I do not know as a fact whether at that time it was old or new to do so.

X Q. 772. The specification of the patent as a reason for no special description of making the illuminating conductor of the patent, states that any of the ordinary methods of forming the material to be carbonized to the desired shape and size, and carbonizing it while confined in retorts and powdered carbon, substantially in accordance with the method in practice before the date of the improvement, may be adopted by any one skilled in the arts appertaining to the making of carbons for electric lighting or other purposes, you say that you considered the forming of an incandescent conductor to size and shape before carbonization as new with you, and that you do not know whether it was new or old to
1253 form articles of carbon to shape and size before carbonization
or not. Will you, therefore, explain what you meant by the statement in the patent, that any of the ordinary methods of forming the material to the desired size and shape should be followed, and what you meant by the further statement that these methods should be, substantially, according to the method and practice before the date of the improvement?

Same objection and notice.

A. I have already in my answer to question 770 endeavored to make such explanation. I will now repeat in substance my interpretation of the statement of the specification, to wit, that no special description of the making of the illuminating carbon conductors, consisting, first, in cutting to shape, and second, in carbonizing, was thought necessary, because cutting a thing to shape or forming it to shape and size, anything, was a common thing in the arts and any one skilled in the arts appertaining to the making of carbon for electric lighting, could make use of the means and methods (knowing the size and shape of the thing he was required to produce and its purpose) for making anything into shape and size.

Second, that no special description of carbonization was deemed necessary, as any one skilled in the art of making carbons for electric lighting, or for other use in the arts, could do the carbonizing in methods, substantially, according to the methods in practice for carbonization, before the date of our improvement, being skilled in the art, he would know how to do carbonizing. In other words, the two things required in the manufacture of carbon conductors for electric lamps, cutting to shape and carbonization, were both well-known operations, and could be practiced by any one skilled in such work.

X Q. 773. At the time of the alleged invention, was there, in fact, any art in existence appertaining to the making of carbons for electric lighting?

Same objections and notice.

1254 A. There was, for arc lighting; I knew of none for incandescent lighting further than the ordinary arts not specially applicable for making carbons for incandescent lighting, more than to other things. There was not at the time, so far as I knew, or have since learned, any manufacture going on except our own of carbons for incandescent electric lighting.

X Q. 774. Was there any art in existence appertaining to the making of carbons for electric lighting at this time, in which fibrous material that had been carbonized was used?

Same objection and notice.

A. I knew of none.

X Q. 775. Or in which the material was formed to size and then carbonized?

Same objections and notice.

A. I knew of none, or at least none occurs to me now, as known and practiced at the time.

X Q. 776. Was there at this time in existence any art in which carbon obtained from fibrous material was used?

Same objection and notice.

A. I think there was, but none in which the textile or fibrous structure was preserved in the carbon as put to use.

X Q. 777. What was the art to which you refer?

Same objection and notice.

A. Before this time, pencils or rods for arc lighting had been made by carbonizing such materials, grinding them up and forming them subsequently into the pencils.

X Q. 778. Any other art?

Same objection and notice.

A. Yes; carbon obtained from fibrous and textile material was used in many and perhaps most of the arts, directly or indirectly. It was used for filters, it was used for disinfection, it was used as a medicine, it was used by the blacksmiths. I could not go on to enumerate the very many uses to which carbon made from
1255 such material was put. If, however, your question refers simply to carbon made of such material in which the fibrous

or textile structure was preserved intentionally, or was an element of its usefulness, I do not recollect any.

X Q. 779. Was there, at this time, in existence any art in which carbonized fibrous or textile material was used where the material was carbonized while confined in retorts and surrounded with powdered carbon?

Same objection and notice.

A. Yes, I think there was.

X Q. 780. What art?

Same objection and notice.

A. The art of making carbons of charcoal for crayons and for rubbing down and polishing metals, especially the plates used in engravings.

X Q. 781. Any other?

Same objections and notice.

A. There may have been others, I don't recollect them.

X Q. 782. Were these crayons cut to size and shape before carbonization?

Same objection and notice.

A. No, not to my knowledge, I never heard of it.

X Q. 783. Is this a subject with which you are familiar or on which you are ignorant?

Same objections and notice.

A. A subject with which I was familiar prior to 1878.

X Q. 784. Do you know whether it was old in the arts prior to the alleged date of this invention, in making artists' and other crayons from fibrous material to the *material to the* desired shape and size and to carbonize it after being so shaped and cut?

Same objections and notice.

A. I do not know whether it was done or not. I only know
1256 I was never aware of any such thing. I had large occasion
to make use of such crayons and procured them in large
quantities that were not so produced.

X Q. 785. I understand that you were not aware that prior to the alleged date of this invention various articles had been made from carbonized fibrous material, in which the material had been cut to shape and size prior to carbonization and then carbonized.

Same objection and notice.

A. All I can say is, I do not now recollect any such article.

X Q. 786. But you do know it was old to carbonize fibrous or textile material while confined in retorts and surrounded with powdered carbon?

Same objections and notice.

A. Yes, I think it was.

X Q. 787. Were there at the alleged time of this invention, so far as your knowledge goes, any ordinary methods that were familiar to any art of first forming material to be carbonized to the desired shape and size and then carbonizing it while confined in retorts in powdered carbon?

Same objection and notice.

A. There were ordinary methods of forming material to shape and size and ordinary methods of carbonization; that there were any arts in which it was required to first form the material to shape and size and subsequently to carbonize the same, in which the two processes combined were essential or necessary to the product, I do not know; none occur to me now.

X Q. 788. When you say there were ordinary methods of forming material to shape and size, do you mean that there were a number of arts in which it was common to take fibrous material and cut it or form it into a desired shape and size such as the trade of the carpenter.

Same objections and notice.

1257 A. Yes, the trade of the carpenter, the Yankee whittler, and almost every trade and occupation.

X Q. 789. Now, there being, so far as your knowledge goes, no methods in practice before the date of this invention, of first cutting the material to size and shape and then carbonizing it, what was meant by saying that of these "ordinary method-, the method to be adopted must be substantially according to the method in practice before the date of this improvement."

Same objections and notice.

A. I do not understand that there is any statement in the patent that any method of cutting to shape or of carbonizing, or of first cutting to shape and then carbonizing, must be adopted (and the word "must" is not used) but only a reason given that it was deemed unnecessary to describe the manufacture of the carbon incandescent conductor of an electric lamp, for the reason that the steps of manufacture were known at the time of the invention; by this I do not mean to say that the order of procedure, first cutting to shape and size and subsequently carbonizing, is not pointed out and deemed an advantage; the words of the specification are:

"No especial description of making the illuminating conductor, etc., is thought necessary, as (or because) any of the ordinary methods of forming the material to the desired shape and size, and carbonizing it substantially according to methods in practice before the date of the invention might be adopted in the practice thereof, (to wit, in the making) by one skilled in the art," etc.

X Q. 790. You have said that you regarded yourselves as the first to make an incandescent conductor of carbonized fibrous material, that being so, were there at the time of this invention any ordinary methods known of forming the fibrous material to the desired shape and size?

Same objection and notice.

1258 A. I have said that I deemed we were the first to make a practical incandescent conductor for an electric lamp of carbonized fibrous or textile material, and I mean to say that there were ordinary methods applicable to this and a great many other things for cutting such material to shape and size before carbonization, not differing in character from the process of cutting the material to shape and size from which an incandescent conductor was to be produced.

X Q. 791. That may all be, but what I want to know is, whether there were at the time of this invention any ordinary methods then known of forming to shape and size for the special or particular purpose of an incandescent conductor of fibrous or textile material?

Same objection and notice.

A. There were well-known methods by which it could be done, and which would occur to any one of ordinary intelligence who should have occasion to do it; I do not mean to say or to be understood that it had actually been done, more than I would mean to say that there was a practice of cutting or a method of cutting or shaping some unknown thing just now found out, which was capable of being cut or formed to shape in the ordinary method of cutting or forming to shape anything else, almost, nor do I interpret the patent as saying any such ridiculous thing.

X Q. 792. Then you did not intend this as meaning anything more than that in forming the material to size and shape, a person following the patent should do it in such a way as seemed to him best.

Same objection and notice.

A. I have not indicated any such thing; I have said in substance, and repeat that my interpretation of that part of the specification to which you refer is, to point out the order of doing things and to state that it was unnecessary to describe cutting or forming to shape to such persons, to wit, those skilled in the art of making conductors for incandescent electric lamps, at the time when the application for the patent was filed, because at the time of the invention such a person by pursuing the order pointed out and using the means then known for forming and cutting to shape and the means then known for carbonization, could make such conductors. 1259

Answer objected to as irresponsive and argumentative.

X Q. 793. Question repeated.

Same objection and notice, and further on the ground that it is indefinite and misleading.

A. I now understand the question as asking me in regard to the step in the process of manufacturing or making a carbon for an incandescent lamp, implied in the words, "cutting to form or shape." I distinctly state, as the specification does, that I deemed it unnecessary to describe so simple a process, and I wish to be understood as saying that I believe any intelligent, skillful person would have no difficulty in the cutting or making to shape, no more nor no less.

X Q. 794. Do you regard that portion of the specification as a statement that a process consisting of two steps was to be followed—first, cutting the material to the desired shape, and, second, carbonizing it after being so cut?

Same objection and notice as last but one.

A. I regard it as a statement that it was unnecessary further to describe the making of the carbon, than is done in the specifications, and that it was a statement indicating that if the order therein pointed out, first, cutting to shape and then carbonizing, was followed, it would be all that was necessary in the hands of a skillful person.

Answer objected to as irresponsive.

X Q. 795. Question repeated.

Same objection and notice.

1260 A. The question being repeated I endeavor to answer responsively. I regard it as a statement pointing out the steps, which, if followed would result successfully.

X Q. 796. Do you regard those steps as being two; first, cutting the material to the desired size or shape; second, carbonizing it after being so cut?

Same objection and notice.

A. I do.

X Q. 797. Now, so far as the first step is concerned, do you regard this portion of the specification as meaning that the person following the patent is to cut the material to size and shape in such manner as he should think best?

Same objection and notice.

A. Yes, according to well-known methods of cutting or forming things to shape.

X Q. 798. But there were no well-known methods at the time of this invention of forming an incandescent conductor to shape?

Same objection and notice.

A. Yes, but only in the sense that there were no such conductors being made except by Sawyer & Man, and not in the sense in which there were well-known means by which it could be done.

X Q. 799. Then, when the specification says that any of the ordinary methods of forming the material to the desired shape and size may be employed, you did not intend it to mean that at the time of the invention there were ordinary methods known of making this specific article, but only intended it as meaning that, in forming the material to size, the person so doing should exercise his best judgment as to the way of doing it?

Same objections and notice.

A. No, we did not intend it to mean that there were ordinary methods of forming the material of an incandescent conductor to shape and size as a specific thing, at the date of the invention,
1261 but we meant that any of the ordinary methods of forming material to shape and size to be carbonized, or otherwise, substantially according to the methods in practice for forming and shaping any material before the date of the invention, might be adopted.

Adjourned till Thursday, the 28th inst., at 10.30 a. m.

THURSDAY, *July 28th*, 1887.

Met. Present—Counsel as before, and the cross-examination of Mr. MAN was continued as follows:

X Q. 800. "Methods in practice" in the ninety-fifth line of the specification according to your understanding of this clause, do not mean methods in practice before the date of the improvement of making illuminating conductors by cutting the material to size and then carbonizing it, but only mean methods in practice of cutting anything to a desired shape without reference to the fact that it is to be carbonized, and methods in practice for carbonizing things that could be carbonized?

Same objection and notice.

A. That is my interpretation of the meaning of the specification, and I do not think the specification contains an assertion, or is intended to do so, that there were methods in practice at the time of making the improvement, of cutting the material for an incandescent conductor to shape and size, and then carbonizing it.

X Q. 801. The suggestion being made that the material should be cut to size and then carbonized, did you consider that it would require invention to properly cut or shape the material and properly carbonize it?

Same objection and notice, and on the ground that the witness was not produced as an expert on the question inquired about.

1262 A. The act of so cutting, and the act of carbonizing alone, it does not seem to me could be the subject-matter of invention, but the adaptation of size and shape to the purpose would involve invention, as it seems to me, and the properties imparted to the conductor by carbonization, after sizing and shaping, would, it seems to me, be the subject-matter of invention, and the conductor produced with the particular qualities of such a made conductor, it seems to me would be the subject-matter of an invention, and properly patentable.

X Q. 802. As when the suggestion was made that the material should be cut to size and then carbonized, it would not, in your opinion, require invention to properly cut and carbonize the conductor, what art or class of artizans at the time of the invention, possessed the requisite skill and information to properly perform these two steps?

Same objections and notice as to last question but one.

A. Understanding your question to refer to the mere acts of cutting and carbonization, all arts involving delicate cutting and shaping and handling, such as the use of scissors, knives, punches and dies, fine small planes, guarded knives of the character of spoke-shaves, the use of fine emery papers for cutting. And for carbonizing, I think the manufacturers of crayons and manufacturers of bone black, the workers in chemicals and experimental laboratories. Probably there were other arts for both, but these now occur to me.

X Q. 803. Was there any one art or class of artizans possessed of the requisite skill to properly perform both steps at the time of the invention, if so, please state?

A. I remember none in which both steps were necessarily practiced at the time of the invention, but I think the intelligent conductors of chemical laboratories were capable of performing both.

1263 X Q. 804. In the year 1885 do you know whether arts had grown up and existed in which there were what might properly be described as ordinary methods forming to the desired shape and size of the incandescent conductor, fibrous material, and in which there were what might properly be described as ordinary methods of carbonizing such material?

Same objection and notice.

A. Yes, I think there were.

X Q. 805. Were there in 1885, methods in practice familiar to the art of incandescent lighting, of cutting fibrous material to size and shape and carbonizing it after so cut?

Same objection and notice.

A. Yes, I think so.

X Q. 806. Referring to the second claim of the patent in suit, did you regard "a transparent, hermetically sealed chamber" in which the conductor was to be inclosed, as original or new with Sawyer and Man?

Same objection and notice.

A. Only, I think, in the combination stated in the claim.

X Q. 807. Referring to the fourth claim of the patent did you consider "an illuminating chamber made wholly of glass, hermetically sealed and out of which all carbon-consuming gas has been exhausted or driven," as original or new with Sawyer and Man?

Same objection and notice.

A. In the combination stated in the claim, yes, in and of itself I don't know or remember.

X Q. 808. Did you consider as original and new with Sawyer and Man, the following element of the fourth claim, "an electric circuit conductor passing through the glass wall of said chamber, and hermetically sealed therein as described"?

Same objection and notice.

A. Yes, I believe I thought so at the time of the application for the patent.

1264 X Q. 809. Do you regard the patent as issued, as containing any different or other invention, or claiming any different or other invention than the application as originally filed?

Same objection and notice, and as calling for expert opinion.

A. In the sense that it claims less than the application as originally filed, claimed, yes; in any other sense I consider that all that is claimed in this patent and more, was in the specification and claims of application as first filed.

X Q. 810. At the time the application for the patent in suit was filed, did you consider that an arc of carbon, whether made from fibrous material for from gas-retort carbon as a conductor for an electric lamp, was the invention of Sawyer and Man, and as such patentable?

Same objection and notice, as to last question but one.

A. Yes, I knew that we invented it, believed that we were the first to invent it, that it was therefore patentable to us, and intended to claim it.

X Q. 811. Did you consider that you were the first to use mineral carbon of any form as the incandescent conductor?

Same objection and notice.

A. No.

X Q. 812. Then as to the first two claims of the application as originally filed, all that you considered as new was the arc or arc shape?

Same objection and notice.

A. That is all we intended to claim and as confined to carbon.

X Q. 813. Do you regard or did you at the time it was filed, regard the original application as in any way stating a preference of the carbon made from fibrous or textile material, over one made 1265 from metallic carbon, or as pointing out any advantages possessed by the one over the other?

Same objection and notice.

A. Yes.

X Q. 814. Please point out what, in your judgment in the original specification, indicates such a preference of the one over the other, or what advantage one is stated to possess over the other?

Same objection and notice.

A. Claim third is a claim for a combination, including a fibrous or textile material. Claim fourth is for the incandescent arc of carbonized fibrous or textile material. The specifications state the object to be, to secure a cheap and effective apparatus (the word "apparatus" evidently referring to the word "conductor" going immediately before it). Immediately following this statement in the specifications are the words, "The subject-matter claimed is hereafter specifically designated." I think no other construction can be put upon them than what I have put on them.

X Q. 815. Do you think, and did you think at the time it was filed, that the original specification indicated a preference of a conductor of fibrous carbon over one of metallic carbon?

Same objection and notice.

A. Yes.

X Q. 816. Now point out what, in the specification, you regard as indicating such a preference?

Same objection and notice.

A. Claim 3d and 4th, in connection with the words of the specification commencing on the first page with the words "our invention" and ending with the words "specifically designated," together with the whole scope of the specification and the statement of the kind of carbons we had used.

1266 X Q. 817. What is there between the words "our invention" and the words "specifically designated," which taken by itself, in your judgment, indicates such a preference?

Same objection and notice.

A. The statement that "the invention especially relates to the incandescent conductor," and that "its object is to secure a cheap and effective apparatus" (the word "apparatus" evidently referring to and used as synonymous with "conductor"), and the statement that "the subject-matter claimed is hereinafter specifically designated." That designation I take as referring to the claims, and it evidently is so. The third and fourth claims, therefore, are referred to between the words you named, and are to be taken as part of the meaning between those words.

X Q. 818. And the first and second claims also referred to, and are to be also taken as part of, the meaning of these words?

Same objection and notice.

A. They are, but they have no reference to the preference in regard to which you ask me.

X Q. 819. What do you regard in the statement, "we have tried carbonized paper covered with powdered plumbago, wood carbon or charcoal and ordinary gas carbon," as indicating a preference of carbon of fibrous origin over metallic carbon?

Same objection and notice.

A. Taken alone, without reference to anything else in the specifications or the claims, I do not know that they express a preference; but, taken in connection with the whole specification and claims, especially with the fact that textile and fibrous carbon is specifically claimed, while gas-retort or mineral carbon is not, they seem, to my mind, as aiding in indicating our preference as to carbon.

1267 X Q. 820. Now, point out what, in the original specification you regard as stating the advantages of carbon of fibrous origin to be.

Same objection and notice.

A. The only thing that I see in the specifications is the reference on page 1 stating the object of the invention to be to secure a cheap and effective conductor, with the reference made on the same page to the thing specifically claimed in the words, "The subject-matter claimed is hereinafter specifically described." These two things, to the mind of a person accustomed to make conductors for incandescent lamps would point out the advantage of cheapness of construction of a conductor of textile or fibrous material over conductors made of mineral or gas-retort carbon.

X Q. 821. You think, then, that the original specification points out, because it states "its object is to secure a cheap and effective apparatus" (by apparatus you understand a conductor to be meant), that persons skilled in making conductors for incandescent lamps would know that the fibrous carbon conductor is made more cheaply than the metallic carbon conductors?

Same objections and notice.

A. Yes, taken in connection with the third and fourth claims.

X Q. 822. Were there, at the alleged time of this invention, persons skilled in the making of conductors for incandescent lamps?

Same objection and notice.

A. At the time of the invention, I knew of none but ourselves, Sawyer and Man. At the time of the application there were such persons.

X Q. 823. Do you regard the original application as pointing out any advantage possessed by the conductor of fibrous carbon over the one of gas-retort carbon other than cheapness of making?

Same objection and notice.

1268 A. The words "pointing out" are perhaps too strong, and I should prefer to use the work "indicating." I think the advantage of "effectiveness" is indicated in connection with cheapness of construction, by specifically claiming the carbon made from fibrous or textile material, and indicating thereby a preference for that kind of material.

X Q. 824. Question repeated.

Same objection and notice.

A. Yes, I think the advantage of effectiveness is pointed out.

X Q. 825. Please state what you consider as pointing out the advantage of effectiveness.

Same objection and notice.

A. I think effectiveness for the carbon made of fibrous or textile material is pointed out by the fact that it is specifically claimed, and by the fact that the object of the invention is stated to be "to secure a cheap and effective apparatus," by which I understand to be meant conductor.

X Q. 826. Do you regard the original specification as stating in what this effectiveness consists?

Same objection and notice.

A. I do not know that it does.

X Q. 827. Had the patent been granted upon the day and in the form in which the application was originally filed, do you seriously mean to say that in your opinion this patent, so and then issued, would have indicated a preference for fibrous carbon over non-fibrous carbon, and would have indicated that the inventors considered the one superior to the other.

Same objection and notice.

A. Yes. Otherwise they would not have specifically claimed it.

X Q. 828. Do you on your oath now state that at the time you filed this application you considered a fibrous, superior to a non-fibrous carbon?

Same objection and notice.

1269 A. No. Not in exactly those terms. My mind was made up, as I have stated before, in the fall of 1878, from all that I knew in regard to the matter, that a carbon from fibrous or textile materials was better for the incandescent conductor of an incandescent lamp, than carbon made from gas-retort carbon, or from any other materials that we had used. I considered it the most valuable kind of carbon for the purpose. I was not at the time so fully advised as to decide whether the fibrous carbon was better than any other that had been, or should be made, that was not fibrous.

X Q. 829. I do not understand your answer. I want you to tell me now on your oath whether, at the time when this application was filed, you did or did not consider a carbon of fibrous origin superior to one of non-fibrous origin?

Same objection and notice.

A. I have already answered the question fully. I considered carbon made from fibrous or textile material most available, and better in that respect and in its qualities than any other carbon I knew of.

X Q. 830. Question repeated. And counsel states that he wishes a categorical answer, and requests counsel for complainant to instruct the witness to so answer his question.

Same objection. Counsel for complainant replies that the witness has already specifically and definitely answered counsel's question, and in view of that fact he declines to give the witness any instruction such as called for.

Counsel for defendant requests counsel for complainant to state whether he regards the witness as having answered question 829, yes or no.

Counsel replies that he undestands the answer of the witness to be in the affirmative as far as his then experience had enabled him to decide.

A. Yes, so far as I then knew. I have no recollection further, as I have stated before as my answer.

X Q. 831. Have you changed or altered your opinion since?

1270 Same objection and notice.

A. My opinion of that time has been brought in question to my mind several times since. It is now with me, with the further knowledge I have obtained, an undecided question whether carbon made from fibrous or textile material, or carbon made from material not textile or fibrous is the best, with a preference for that made from fibrous or textile material.

X Q. 832. I want to know whether since the application was filed, you have altered your opinion; I wish you to answer me yes or no.

Same objection and notice.

A. I have stated the facts in regard to my present opinion, and the fact in regard to my opinion at the time of the application for the patent, and the fact that at present I was unable to form a definite opinion, and I am unable therefore to answer directly yes or no.

X Q. 833. When, if at all, did you alter your opinion which you had at the time the application was filed that fibrous was superior to non-fibrous material?

Same objection and notice as last but one before.

A. I have not stated that I altered it.

X Q. 834. Have you since the application was filed altered your then opinion that fibrous was superior to non-fibrous material?

Same objection and notice.

Counsel for defendant asks counsel for complainant to instruct the witness to answer the question categorically.

Counsel for complainant understands from the witness' last answer that the question may not be properly susceptible of a categorical answer, but he instructs the witness to give a categorical answer if he can do so without misleading the court.

A. The trouble is that the counsel for defendant insists 1271 upon stating the opinion given by the witness differently from the statement of the witness as to his opinion at the time the application for the patent was made. My statement was that my opinion was at the time, that carbon made from fibrous or textile material was better than any other that I knew of. The question states that I had the opinion that carbon made from fibrous or textile material was better than carbon not made from fibrous or textile material, as I understand the question, my opinion being that it was better so far as I knew, but not an absolute opinion that it was positively better.

X Q. 835. Well, have you or have you not altered that opinion since?

Counsel for defendant requests a categorical answer. Objection and notice same as last.

A. I think I have, in the respect only, that I am not so confident that my opinion is right as I was at the time of the application for this patent.

X Q. 836. I do not understand your answer; do you know whether you have altered your opinion or not since the application was filed?

Same objection and notice, and on the further ground that the witness has very fully and specifically testified on this matter, and that the object of the question appears to be merely to anney and harass the witness.

A. My opinion is the same in kind now as then, less strong now than it was then, it is an alteration in opinion only as regards strength of opinion; so far as I know my opinion is altered.

X Q. 837. Do you mean that you have not altered your opinion, but that your opinion is not as strong now as then?

Same objection and notice as to question next before the last.

A. I mean that my opinion is not altered in kind, but is in strength.

1272 X Q. 838. I understand that you are of the same opinion but it is less strong?

Same objection and notice.

A. That very nearly expresses my opinion if you insist upon it; it is not a perfectly accurate statement.

X Q. 839. Have you ever testified under oath since this application was filed, that you preferred and always did prefer a carbon of non-fibrous origin to any other carbon used by Sawyer & Man?

Same objection and notice.

A. I do not remember to have ever done so.

X Q. 840. Do you think it possible that you could have done so and forgotten it?

Same objection and notice.

A. It does not seem to me so intentionally; my recollection of past events may have been different at some time from what it is now, and I may have given such recollection different from my present recollection, but I do not think it.

X Q. 841. I call your attention to the following answer and question given by you on April 15th, 1879, in the interference between Sawyer and Man, Kieth and Maxim. Q. "After the carbon has been heated as you describe, how does it compare in color and density with the same carbon and its utility as an electrode in electric lighting." A. "The original strip of carbon is deprived of its impurities which — driven off. The poles are filled with a dense deposit of pure carbon and its outside coated with the same; it appears more uniform and its outside has a bright silvery lustre, instead of being black; it is much stronger and less liable to fracture and almost indestruct*a*ble by combustion, uniting with very great difficulty, if at all, with any other substance under the influence of heat or electricity, and, therefore, a much better substance for the electrodes of incandescent parts of electric lights and the deposited carbon when separated from ths original pencil is a better article still for these purposes."

1273 —. Do you remember giving this testimony?

Same objection and notice.

A. Yes, I think that is correct.

X Q. 842. Is it true?

Same objection and notice.

A. Yes, in the sense and in the connection in which it was used there then.

X Q. 843. Did you then consider carbon deposited by electric action and cut so as to make an incandescent conductor, as a better article for the electrodes or incandescent parts of electric lights, than a slip of carbon upon which carbon had been deposited according to the Sawyer and Man process?

Same objection and notice.

A. Yes, intrinsically.

X Q. 844. How do you reconcile this testimony given in April, 1879, with your testimony in this suit?

Same objection and notice.

A. They are both perfectly reconcilable, and in the one case the question in my mind, and to which I made answer, was one in regard to the intrinsic character of carbon, in the other it is a question solely of the practicability and usefulness of an incandescent conductor and of its character; you have endeavored to force me to say that I considered carbon made from fibrous or textile material, aside from its practicability and facility for making and usefulness in incandescent electric lighting, superior to all other carbons; I have endeavored to keep out that exact statement and to state my own views in regard to it. A fair construction of my language, and the whole of my testimony, will not exclude the idea, nor have I intended to do so, that carbon deposited by electric action aside from the practicability of manufacture and only considering its intrinsic character, is the ideal carbon for the incandescent conductor of an electric lamp, and you will remember my statement while giving this testimony that I considered the carbon conductor made 1274 from fibrous or textile material to be improved by treatment after the manner referred to in my testimony to which you have called my attention. The difficulty is solely that you leave out of view the context of my statements and if in your bulldozing and insisting upon categorical answers, you have obtained anything from me that would imply that my statement in the testimony you have referred to is not true, I withdraw it, because it was my opinion then, and it is my opinion now, that the incandescent conductor of an electric lamp formed from carbonized fibrous or textile material and treated after the manner of our patents, all things considered, is the best conductor I know of, though in regard to the textile or fibrous carbon being the best substratum conductor, my opinion at the present time is not so strong as it was at the time of the application for this patent. By substratum, I mean, the form, shape, and size of the conductor for an incandescent lamp, having in mind its subsequent treatment after the patented processes of Sawyer & Man, and having in mind the facilities for obtaining such a conductor in proper size and shape, its cheapness of construction, its good qualities and availability. It is for such purposes the best carbon I know of, in my opinion. If, however, the same carbon could be cheaply obtained, put in size and shape reduced to size and required no more skill in making than the fibrous carbon, it is my opinion now, and it was then, that the deposit carbon would be the ideal best carbon for the incandescent conductor of an electric lamp.

X Q. 845. Aside from the difficulty of making, do you now, and have you always considered, that as between two conductors of the same shape and size, one being of carbonized fibrous or textile material and the other being of carbon obtained by electric action pure and simple, that the carbon obtained by electric action would be the superior?

Same objection and notice.

A. I do now consider that the carbon obtained by electric 1275 action is the purer, and therefore, the better carbon intrinsically. I do not remember all my phases of opinion in the past, but I do not remember to have had a different opinion after the discovery by us of the deposit carbons.

X Q. 846. This discovery you claim to have been made, do you not, in March, 1878?

Same objection and notice.

A. About that time.

X Q. 847. Then, is this and has it always been your opinion, that of two conductors of the same shape and size, one of carbonized fibrous material and the other of carbon obtained by electric action, pure and simple, that the latter would be the better, and the former the easier to make?

Same objection and notice.

A. I think that would be true, limiting the one to intrinsic character and the other to the facility of formation and that both would be good conductors. I repeat that I cannot remember all my phases of opinion in the past but I do not recollect having any other opinion.

X Q. 848. Did you in the year 1879, or have you at any time since, considered that it was impractical to make incandescent conductors for electric lamps from carbon obtained from electric action, pure and simple?

Same objection and notice.

A. Not, I think, in the sense that it could not be done. My views of the practicability of manufacturing such conductors have varied from time to time, considering as a practicability the relative cheapness of manufacturing competing incandescent conductors.

Adjourned till Friday, the 29th inst., at 10½ a. m.

1276 FRIDAY, *July* 29, 1887.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. MAN proceeded as follows:

X Q. 849. If you desired to make two incandescent conductors of the same size and shape, would it be more difficult to make from a piece of carbon obtained by electric action, pure and simple, such a conductor, than it would be to make it from a block of gas-retort carbon?

Same objection and notice.

A. On the contrary it would be easier to make it from the electric deposit carbon.

X Q. 850. Did Sawyer and Man regard it as impractical to make the incandescent conductors of their lamps from gas-retort carbon?

Same objection and notice.

A. No, I think they could be made from, and we did make them from gas-retort carbon. I am not speaking of the qualities of the conductors when made, but of the making of them.

X Q. 851. If you considered it practical to make conductors from gas-retort carbon, and if, as you say, of two conductors of the same size and shape it would be less difficult to make a conductor from electro-deposit carbon, pure and simple, explain why you considered it impractical to make conductors from carbon obtained by electric action?

Same objection and notice.

A. I have not intended to be so understood, but only to speak of the difficulties of doing it, and the nice work required, and the spoiling of many in manufacture, and as compared with another carbon of most excellent character for the conductor of an electric lamp and which was easily and cheaply made.

1277 X Q. 852. Let me ask you again: Of two conductors of the same size and shape, leaving out of consideration the difficulty or cost of manufacture, am I correct in understanding that you considered a conductor composed of carbon obtained by electric action, pure and simple, as superior to one of carbonized fibrous material?

Same objection and notice.

A. As to the material of which the conductor in each case was made, considering it after carbonization and not before, I mean as carbon, we considered electro-deposit carbon, the purest carbon, and, therefore, the best as carbon. Pure carbon and unadulterated was considered the ideal substance for the conductor of an electric lamp, because carbon, of all substances which are conductors of electricity to any considerable extent, such as to be called conductor, is the only substance that will endure the heat and strain due to the current of electricity used in an incandescent electric lamp. The admixture of any other substance would detract, as I thought then and think now, from this quality of enduring the heat and strain. In this sense we considered the deposit carbon the ideal substance for the conductor of an electric lamp. In obtaining such a pure carbon by electro-deposit it was necessarily made dense and solid throughout the mass of the conductor. Now, in the use of such a conductor, dense and solid throughout its mass, and, perhaps, and probably cystalline in structure, there were difficulties. These difficulties were mainly want of flexibility, as I call it (I don't know as I correctly describe it), and a consequent danger of a liability to breaking, fracture, bursting, flying to pieces of the conductor when heated up. The conductor formed from it alone was a difficult and expensive conductor to make. When fully going and standing in the lamp undisturbed and unjarred in any way, and after the dangers of fracture, bursting and heating up, etc., were passed, it was the best conductor that we knew of, and would stand more heat, and endure longer at an extremely high incandescence, than any
1278 conductor which I knew. Now, in this sense, we considered it the best conductor for an incandescent electric lamp; but electric lamps had to endure jar, shaking, etc., in transportation and use, and the conductors had to be heated up. We found it more advantageous, or thought so, to use a means of gradually heating up with such conductors. The conductor made of carbonized fibrous material retained the structure of the material after it had been carbonized. That structure being open and porous before carbonization, and in its fibres of very small mass and extremely tenuous, considering the fibres separately. In carbonization there was great facility for the escape of impurities and of all substances other than carbon, and for the driving off of such impurities and other substances in carbonization at a high heat, thus producing an extremely pure carbon by reason of the structure of the material from which it is produced. Again, there was great facility of selecting before carbonization, pure and homogeneous material from which there would not need to be driven out so great a number of impuri-

ties as in case such selection could not be made. The material before carbonization was flexible and tough, and therefore capable of being cut to size and shape with facility and without danger of fracture before carbonization. Its mass, by such cutting, was reduced substantially to the mass of the conductor required as a whole, and it therefore furnished facilities for better and more equal carbonization than large masses, and at the same time furnished facilities from its small mass for the escape in the act of carbonization, or the driving out of the substances other than carbon. From its structure it was not very liable to fracture in carbonization, retaining after carbonization the fibrous or textile structure possessed before carbonization, it retained, in large measure, the qualities due to fibrous or textile structure, to wit, flexibility, toughness. It was, therefore, not so liable to fracture by a jar or accident, nor so liable
to breakage, fracture and bursting to pieces in heating up as
1279 the deposit carbon. I have said that it was cheaply
manufactured. Taking, therefore, all the qualities I have enumerated, and the others mentioned in the patent, convenience of making of the required size and form, susceptibility to tempering, both as to hardness and resistance, toughness and durability, it possessed a practical durability, and I considered, although in my experience it would not endure so high incandescence nor so powerful a current of electricity as deposit carbon, under the circumstances I have stated, would endure. I considered that it was the best practical conductor for an incandescent electric lamp that I knew of, taken as a whole.

Answer objected to as irresponsive and argumentative, and as containing many facts concerning which the witness was not interrogated and as stating many conclusions of fact, the facts upon which such conclusions were based not having been asked of the witness and as immaterial.

X Q. 853. Question repeated.

Same objection and notice.

A. Yes, in some respects, but not as a whole as I endeavored to explain in my last answer.

X Q. 854. Leaving out of consideration the cost or ease of manufacture, which did you consider as best on the whole?

Same objection and notice.

A. The conductor made from textile or fibrous material.

X Q. 855. Please tell me which of your two answers is true, and which you desire to be believed by the court, your answer to question 847, or your answer to my last question?

Same objection and notice.

A. Both my answers are true, and I do not wish to be relieved by the court from either.

X Q. 856. Since the hearing of yesterday, have you con-
1280 versed with counsel for complainant in regard to your ex-
amination?

Same objection and notice.

A. I have.

X Q. 857. Did you and he discuss the testimony given by you in the Sawyer & Man, Keith & Maxim interference, or at all consider it; and did you and he at all discuss or consider what your testimony should be if interrogated further as to your preference for carbon of fibrous material or carbon obtained by electric action?

Same objection and notice.

A. We did not at all discuss my testimony given in that interference, nor at all consider it further than this, that I remarked to the counsel that I considered my testimony in that interference entirely consistent with my testimony in this case, in which the counsel agreed with me. We did not at all discuss what my testimony should be in regard to any matter further than this; that the counsel said to me that he thought the word substratum used by me might be liable to misconstruction or convey some false idea, to which I replied that in the connection in which it was used, and with the explanation given, I did not think it could be, to which he said that he would think of it, and we would ask the counsel for defendant to strike out the word substratum, and the words defining its meaning, and it would then leave the sense clear; we read over and examined the matter to make sure to both of us that such would be the fact, and I agreed to ask to have the emendation made. This was the whole substance of our discussion.

X Q. 858. How do you reconcile your answer to cross-question 847 with your answer to cross-question 854?

Same objection and notice.

A. I do not think that an explanation is necessary, or that the answers to these two questions are conflicting; but if explanation
were necessary it will be found in my answer to cross-ques-
1281 tion 852, in which I explained, or endeavored to, the respect
in which I considered the pure deposit carbon conductor superior, but on the whole preferred as a conductor that made from carbonized fibrous or textile material with the reasons for each. I answer, therefore, that if explanation is necessary, I explained by my answer to cross-question 852.

X Q. 859. How does it happen that in answer to a question where you are asked to make no explanation you claim now to have explained what appears to be a discrepancy between your testimony at the last sitting and your answer to a question in effect the same as that asked you at the last sitting?

Same objection and notice.

A. It happens in this wise. You asked me a question, No. 852, which I could not truthfully, fully and completely answer, as it seemed to me, without making the statement I did in respons*ive* to that question, and that statement repeated would be a full and complete explanation, as it happens, of any inconsistency between my two answers, though I deny that there is any actual inconsistency therein; if there is any want of clearness of my intention and meaning in the two answers it will be removed by reading that explanation.

X Q. 860. I repeat now and desire you to answer this question: Do you now, and have you always considered that of two conductors of the same shape and size, one of carbonized fibrous material and the other of carbon obtained by electric action, pure and simple, that the latter would be better, and the former easier to make?

Same objection and notice.

A. Yes, with the explanation I have given in respect to the things in which the latter, the deposit carbon, would be the better, the fibre carbon being the better on the whole, excluding the advantages of cutting, from consideration, and that the former, that is, the fibrous conductor, would be the easier to make.

1282 X Q. 861. Do you consider your answer intelligible?

Same objection and notice.

A. I do.

X Q. 862. Excluding from consideration the cost or difficulty of making, which of the two conductors do you consider the best?

Same objection and notice.

The witness desires to state that his last answer is not what he intended to say in respect to his thoughts or opinions in the past, and has only reference to the present; that he desires to say in this connection that he cannot remember, and will not attempt to state, whether he has "always" thought so, but he does not recollect having any different opinion.

A. I have answered that question over and over again. I repeat it. I prefer, on the whole the conductor made from carbonized fibrous material, and on the whole think it the best. In the respect which I have stated in particular the deposit carbon is, in my opinion, the best.

X Q. 863. Leaving out of consideration the cost or ease of manufacture, please tell me of two carbons of the same size and shape, one made from carbon obtained by electric action, pure and simple, and the other from carbonized fibrous material, which do you consider the best?

Same objection and notice, and further counsel for complainant objects to the question on the ground that the witness has fully and fairly answered the question more than once, and while he does not wish to obstruct the free course of this cross-examination, he most emphatically protests against the obvious effort of counsel to compel the witness to make answers which he has expressed his unwillingness to do, and because this cross-examination appears to be prolonged beyond all reason, merely to waste time and to postpone the judicial determination of the cause.

1283 Witness requests counsel for defendant to permit him to see the answer to the question yesterday No. —. It occurs to witness that he may have answered with reference to "former" when he meant "latter." The question had reference to which I considered the better—the conductor I made from the deposit carbon or the conductor made from fibre carbon in which I used the word "intrinsically" having reference to, as I understood, deposit carbon.

Complainant's counsel explains, on behalf of witness, that the witness off the record courteously requested defendant's counsel, as between gentlemen, to permit him to read the answer referred to, to see if his recollection of it was correct, and defendant's counsel refused to do so.

Defendant's counsel requests the writer to state on the record whether the statement of counsel as to what occurred is correct, and if not, that the writer state in the record what he considers was correct.

The writer says that in the confusion that has recently attended this stage of the examination and *and* the pressure on him to keep up the record, his recollection may be erroneous, but that his understanding was that the request of the witness was declined by counsel.

Witness states, that I have seen the answer and my recollection of it is confirmed.

Defendant's counsel withdraws for the moment the last question and asks the witness the following:

X Q. 864. What do you mean to be understood from your statement on the record, "it occurs to the witness that he may have answered former when he meant latter"?

Same objection and notice as to last but two.

A. I referred to question 847, without knowing its number, 1284 in which the words "latter" and "former" are used; not having it before me, I did not have it distinct and did not know but that I had confounded the one with the other.

Adjourned till Monday, August the 1st, 1887.

MONDAY, *August* 1, 1887.

Met. Present—counsel as before, and the cross-examination of Mr. MAN continued, as follows:

X Q. 865. Do you wish to be understood as having confounded the one with the other?

Same objection and notice.

A. No, I have not.

X Q. 866. Counsel repeats cross-question 863.

Same objection and notice.

A. For practical use as the incandescent conductor of an electric lamp, the one made from carbonized, fibrous or textile material.

X Q. 867. Has this been your opinion since the spring of 1878?

Same objection and notice.

A. I cannot undertake to remember all the phases of opinion I may have had since the spring of 1878, but I — no recollection of having had any other opinion.

X Q. 868. At the time of testifying in the Sawyer and Man, Keith, Maxim interference in 1879, was your recollection of the experiments of Sawyer and Man as clear as it is now?

Same objection and notice on the ground further that the subject-matter in the interference between Sawyer and Man on one side, and Maxim and Keith on the other, was wholly different from the subject-matter in the patent in suit; anything that the witness may have sworn to in that case is utterly immaterial in this.

A. It is fair to assume, I think, that it was.

1285 X Q. 869. Do you remember what the invention of Sawyer and Man was in interference and concerning which you were testifying?

A. Not with particularity, only generally.

X Q. 870. Was it not the application which resulted in letters patent No. 211,262 and 229,335, the application for the former being filed in October, 1878, and of the latter November 29, 1878?

Same objection and notice.

A. I think it had no reference to patent 211,262, dated January 7th, 1879, but had reference to the application filed by Sawyer and Man November 29th, 1878, resulting in letters patent No. 229,335, dated June 29th, 1880, in which the claim in the patent was carbon consolidated and purified by electrically treating it in combination with a carbonaceous substance for the production of electric burners.

X Q. 871. If in 1879 you considered your treated carbon better than untreated carbon, and if you considered a pencil cut from the deposited carbon as a better substance than either for the incandescent parts of electric lights, as testified by you in that interference, how do you reconcile that testimony with your present statement that you have always preferred carbon from fibrous material?

Same objection and notice.

A. Your question states what I have not said, that "I have always preferred carbon from fibrous material." You undertake, without making the distinction as to what I did say, to make me attempt to reconcile something that I have not said with something I have said. I have said that as carbon, pure and simple, the deposit carbon is a purer and better article of carbon than the carbon made from fibrous or textile material, and I have stated the advantages of such a carbon and its disadvantages, and I have further said

that for reasons given by me I preferred and deemed it best
1286 on the whole, the incandescent conductor on an electric lamp made from fibrous or textile material.

X Q. 872. Which do you now consider the better substance for the incandescent parts of electric lights, deposited carbon, pure and simple, or carbonized fibrous material?

Same objection and notice.

A. In the carbons of arc lamps, I now prefer the deposit carbon; for the incandescent portion of an incandescent lamp, I now prefer carbons made from fibrous or textile material. I mean after both are manufactured.

X Q. 873. Do you now, and, so far as your recollection goes, have you always considered that for the incandescent parts of incandescent electric lights you considered carbonized fibrous material as a better substance for such incandescent parts than carbon obtained by electric action, pure and simple?

Same objection and notice.

A. I consider that, for the incandescent parts of incandescent electric lights, carbonized fibrous or textile material is a better substance, all things considered, than carbon obtained by electric action, pure and simple. I do not pretend to remember all my different phases of opinion in regard to such conductors since we first got practically good conductors in the spring of 1878 from carbonized fibrous or textile material, but I have no recollection of having had any other preference in the matter than that I have now.

X Q. 874. What, then, did you mean by your answer 10, in the Keith interference, which I have quoted?

Same objection and notice.

A. Just what I said (to the writer). Copy my words. They are (speaking of the deposit carbon, I say) "the original slip of carbon is deprived of its impurities, which are driven off. The pores are filled with a dense deposit of fine carbon and its outside coated with the same. It appears more uniform, and its outside has a brighter, silvery lustre, instead of being black. It is much stronger,
1287 and less liable to fracture, and almost indestructible by combustion, uniting with very great difficulty, if at all, with any other substance under the influence of heat or electricity, and therefore a much better substance for the electrodes, or incandescent parts of electric lights, and the deposited carbon, when separated from the original pencil, is a better article still for these purposes." I was describing the good qualities of electro-deposited carbon as such, to wit, as carbon, and the question required me to answer in regard to these particulars, and I did so, not, however, confining it to incandescent electric lighting, and I was not comparing a conductor made of such deposit pure and simple for an incandescent lamp with a conductor of carbonized fibrous or textile material, nor with an electrode or electrodes made respectively of the two materials pure and simple.

X Q. 875. This answer says that a treated carbon was "a much better substance for the electrodes, or incandescent parts of an electric light." Were you referring to arc lights or incandescent lights?

Same objection and notice.

A. I cannot remember; but, if I recollect correctly, the interference was declared between Sawyer and Man on the one side, and parties who were claiming to make the electrodes of arc lights in a similar manner on the other side.

X Q. 876. You then go on to say: "And the deposited carbon, when separated from the original pencil, is a better article still for these purposes." By "these purposes," were you referring to the "electrodes, or incandescent parts of electric lights"?

Same objection and notice.

A. I seem to have done so; "electrodes" referring to arc lights, and "incandescent parts" to incandescent lights.

X Q. 877. Did you mean by this answer to say that you 1288 considered a treated carbon as a better substance for the incandescent parts of incandescent electric lights than an untreated carbon, and that the deposited carbon was a better article still for such incandescent parts?

Same objection and notice.

A. I think there is no question that I meant that the incandescing portions of incandescent lights were improved by the treatment. By the latter part of the answer it would seem to me now that I was speaking simply of the quality of the carbon itself, and I was certainly not making any comparison between such conductor of pure deposit carbon only, for an incandescent electric lamp and a conductor made purely from carbonized fibrous or textile material. At that time we were not publishing, so far as I could prevent it, what we had done, and for which we had not applied for patents, and we had not applied for the patent for the incandescent conductor made from fibrous or textile material, and I do not remember to have had in mind, and don't believe that I had in mind, in making that answer, a conductor formed from carbonized fibrous or textile material.

X Q. 888. Now, did you, in fact, at the time this testimony was given, consider that for the incandescent part of incandescent electric lights, the deposited carbon, when separated from the original pencil, was a better article than a treated carbon?

Same objection and notice.

A. I think you take the language too strongly there. I think there should be added to the answer the words "in some respects or for some uses," so that it would read "and the deposited carbon, when separated from the original pencil, is a better article still for these purposes in some respects or for some uses." If you would confine it simply to conductors, and not also to the qualities of deposited carbon, as carbon, which is the sense in which I think it was mainly intended.

Answer objected to as irresponsive.

X Q. 889. Question repeated.

1289 Same objection and notice.

A. In some respects I most certainly did.

X Q. 890. Did you consider it on the whole as a better article?

Same objection and notice.

A. I cannot recollect what I had in mind in making answer to the question, but, according to the best of my judgment, I did not think it a fair in*ter*ference from my answer that I did so in all respects.

X Q. 891. I am not asking you about any answer. I merely wish to know whether you in fact considered at the time of giving the testimony, that for the incandescent parts of incandescent lights, the deposited carbon, pure and simple, was, on the whole, a better article than a treated carbon?

Same objection and notice and not cross-examination; immaterial, incompetent and irrelevant.

A. As to some treated carbons, yes. As to all possible treated carbons I don't think that I so considered or intended to state in my answer.

X Q. 892. Don't you know whether you did or did not consider this a better article than any or all treated carbons?

Same objection and notice and that it is impossible for the witness to state what he had in mind seven or eight years ago when he answered that question, and for the purposes of this case it is not material what he had in his mind or what he thought.

A. I do know that I considered the deposit carbon in and of itself a better article, and I think I knew that I considered then, as I do now, a conductor for the incandescent parts of an electric lamp made from carbonized fibrous or textile material and treated, a better conductor for the incandescent portion of an incandescent lamp that one made purely from deposit carbon, by reason of the greater facilities of making the fibrous conductor and the
1290 properties which it possessed other than mere purity, but I cannot pretend to, nor do not remember, what I had in mind at the time referred to, when I made the answer to the question, as a matter of mere recollection.

X Q. 893. Now aside from the cost or cheapness of manufacture, did you, in fact, consider at this time that for the incandescent part of an electric light a fibrous carbon treated was a better article than the deposited carbon, pure and simple?

Same objection and notice and that the witness has fully answered the question, and he is instructed that he need not answer further unless he chooses.

A. I have already said that I do not recollect to have had the subject in mind at that time or to have considered it at that time.

Counsel for complainant says to the witness, "There, that is an answer to the question," and counsel for defendant insists that what counsel for complainants said to be put down on the record. (Witness says:) "I had said all I was going to."

X Q. 894. By "at this time" in my question I did not refer to the exact date of your testimony, but to the general period of the spring of 1879, I have understood that you have no recollection of your opinions having changed since the conclusion of the Sawyer and Man experiments; with this explanation I repeat my question?

Same objection and notice.

A. You are right in stating that I have no recollection of having changed my opinion that the incandescent conductor of an electric lamp made from carbonized fibrous or textile material was, on the whole, better than one made from deposit carbon, pure and simple, neither have I at present any recollection of having considered the subject-matter, though I may have done so.

1291 X Q. 895. Then it is not true, so far as your recollection goes, that you considered "the deposited carbon, when separated from the original pencil, is a better article for the incandescent parts of incandescent electric lights than a deposited carbon, but what is true is that you considered it better than some deposited carbons, but not as good as others"?

Same objection and notice.

A. I have given no such intimation at all.

Witness here said something about "treated carbons," and counsel for defendant says, "Didn't I say treated carbons? I meant to," when witness insists that the present question and answer shall stand.

X Q. 896. Then it is not true, so far as your recollection goes, that you considered "the deposited carbon when separated from the original pencil as a better article" for "the incandescent parts of an incandescent electric light, than a treated carbon," but what is true is that you considered it better than some treated carbons but not as good as others?

Same objections and notice.

A. I understand the question as referring to my interpretation of my answer in the Keith interference to which you have referred: am I right?

Counsel says, "You are not right."
Then you ask the question without reference to my answer in that case.
Counsel says, "I want to get the fact."

A. I have recollection in regard to it, but it seems improbable to my mind. If I considered it at all that I considered it in any other light than I have heretofore stated it.

X Q. 897. Do you now consider the deposited carbon, pure and simple, as a better article for the incandescent part of an incandescent lamp, than some treated carbons, but not as good as some other treated carbons? I am leaving out of consideration the cost or facility of manufacture.

Same objections and notice.

1292 A. Yes, having reference to the quality of the carbon treated, and character, extent and manner of treatment. Some treated carbons might be good for nothing, by reason of the bad quality of the carbon treated. Some treated carbons might be spoiled for the use intended by either the character or extent of the treatment.

Adjourned subject to notice.

NEW YORK, *Oct. 4th*, 1887—1 p. m.

Met pursuant to arrangement of counsel.

Present: Counsel as before, and the cross-examination of Mr. ALBON MAN was continued as follows:

X Q. 898. Do you recognize the difference between a carbon which is heated by having a carbon deposited upon it for the purpose of making its resistance conform to a given standard, and the case of a carbon upon which a shell of carbon is deposited, the original piece or stick of carbon being a core?

A. I recognize no distinction except in the amount of carbon deposited. The process is the same in both cases, and the effect upon the original stick or piece of carbon the same.

X Q. 899. If a given carbon conductor with a given current have a resistance of, say, a hundred and fifty ohms, caused by the carbon being smaller at one point than its general mass, what amount of treatment would be required to reduce the resistance of the carbon to one hundred and twenty-five ohms, and what effect would such treatment have upon the carbon?

Objected to on the ground that it is immaterial, there being no question in this case as to high or low resistance, or as to treatment of carbon in the manufacture of illuminating conductors.

1293 A. I do not understand what you mean by "treatment." The question does not contain data sufficient to answer specifically. I can answer the question generally. Shall I do so?

X Q. 900. I understand you to have testified that you, in your experiment, used carbons that had not been treated, carbons that had been treated and pencils cut from deposited carbon. By "treated carbons," I refer to such carbons as have deposited upon and in them carbon. Now, where a pencil of carbon had deposited upon it a layer or shell of deposited carbon, how thick was this layer or shell?

Same objection.

A. In our work the shell deposited was sometimes almost inappreciable upon the outside of the carbon. As a whole the main work of deposit being done within the pores of the carbon and at the points of highest resistance in the length of the carbon. In other cases, and in most cases, it was of extreme tenuity, barely visible upon the outside of the carbon; but in cases where we desired to cut it to pieces after treatment, I think the treatment was carried to the extent of depositing from a thirty-second to a sixty-fourth of an inch, or to one one-hundredth of an inch. The thick deposits were only made by us for the purpose of cutting to pieces lengthwise, or removal of the original slip of carbon on which the deposit was made, as I recollect it now.

X Q. 901. Do you remember testifying in an interference between Edward Weston and William E. Sawyer & Albon Man, wherein the invention in issue was "the improvement in the art of manufacturing carbon conductors for incandescent lamps, which consist in building up on a carbon core or base the body of the conductor with carbon obtained and deposited upon the carbon core while surrounded by or saturated with a carbonaceous liquid"?

Same objection.

A. I do.

1294 X Q. 902. I call your attention to the 69th question, and your answer thereto, of your deposition in that interference, as follows:

"R. D. Q. 65. Please state whether all the carbons used by you and your assignees in electric lighting by incandescence so far as you know have been treated according to the process of the invention involved in this interference?

"A. They have (and I think I know in regard to all of them), except so far as mere experiment for testing the quality of carbon went; we tested in lamps experimentally a great many kinds of carbon; but for practical use, made use only of the carbons treated according to this invention."

Is your statement in the testimony I have quoted correct?

Same objection.

A. I think my statement is correct. I think we believed, as I do now, that all the carbons were improved by treatment, and so in our practical work we were in the habit of treating them.

X Q. 903. I call your attention to the following question and answer submitted to and made by you in the Sawyer & Man, Keith & Maxim interference, to which reference has been already made.

"Q. State whether you are one of the parties to the application for a patent by William E. Sawyer & Albon Man for a joint invention of an improvement in carbons for electric lighting, making part of the subject-matter of this interference?

"Same objection.

"A. I am.

"Q. Please to state what that joint invention is?

"A. The production of a dense, homogeneous, pure carbon by electric action and the action of heat, by decomposition and deposit of carbon from hydocarbon gases and fluids. The object being to produce such carbon for subsequent use, principally for electric lighting purposes." 1295

In the deposition from which I have quoted, after describing the apparatus used in depositing the carbon and the manner of depositing the same, you say:

"The result was that the slip or pencil of carbon was heated up to a most intense degree of heat, decomposition of the hydrocarbon gas took place, and pure carbon, very dense, and hard, and homogeneous, was deposited upon the slip or pencil of carbon. After this deposit had gone on until the slip or pencil became of the size we desired we ceased the operation, took out the slip or pencil thus prepared and used it in an electric lamp. * * *

"We cut up the carbons so produced and took out all the original slips, leaving only the prepared carbon precipitated or deposited by the action of heat and electricity."

At the conclusion of your deposition you were asked:

"Q. Since you have commenced to treat carbon as you have described how much of the time have you used it for electrodes, or the incandescent parts of your electric lamps?"

"A. Constantly. Ever since we first began."

It is true that from the beginning of your experiment on treating carbons by deposition, as described in the testimony referred to, up to April 15th, 1879, you constantly used such carbons as the incandescent parts of your electric lamps?

Same objection; and counsel for defendant is requested to state upon the record how the question or answer is material upon any issue in this case, and upon the further ground that the question contains a garbled statement of the testimony quoted from.

Counsel for defendant makes no response to the request.

1296 A. The interference between Keith and Sawyer and Man, as I recollect it, had reference to deposited carbon; my attention in giving my testimony in that case I assume to have been directed to the point at issue and not to matters not at issue, and my answers in that case are to be taken with this in view. I do not recollect of course, at this time the words of my answer; I do recollect that up to the time of this interference we did use treated carbons as the incandescent conductors of an electric lamp, some with the original carbons on which the deposit was made remaining and some of pure-deposit carbon cut from, or separated from the original carbon on which the deposit was made. I also remember that we used carbon for the incandescent portion of the electric lamp on which no deposit was made and to which no treatment was given, and also carbons treated only in the slightest degree, and from that to carbons treated heavily. We were in the habit of generally treating our carbons in some degree. But in this interference the subject-matter, as I recollect, was the deposit carbon, and I do not think my attention was directed to the other things that we had done.

X Q. 904. Mr. Sawyer in that interference, was asked and testified as follows:

"Please to state whether, in the practice of this invention, you build upon the original carbon a consolidated pure carbon which you separate from the original carbons and use as electrodes in electric lighting.

"A. In some cases we do, and in others we allow the original carbon and the shell deposited to remain together.

"Q. Please to state how much of the time you have used this joint invention; since it was first made?

"A. Hardly a week has passed that we have not made a number of these carbons and used them. We never use anything else.

1297 "Q. Have you used, or attempted to use in your electric lamps, carbon pencils of different manufacture, and if yes, please to state what carbons you have used, or attempted to use?

"A. We have not used anything else in our regular lamps but the deposit carbon, but have experimented with several kinds of willow charcoal, with gas-retort carbon and the best French artificial carbons such as Du Bosgas, Grandison and Cane, all infinitely inferior to our invention."

Is it true, as there stated by Mr. Sawyer, that up to April 21st, 1879, the date at which the testimony quoted was given, Sawyer and Man had not used anything else in their regular lamps but the deposit carbon?

Same objection and request repeated. Counsel for defendant is silent.

A. No; and in the alleged testimony you have read Mr. Sawyer does not say so. I understand Mr. Sawyer to say that he used carbons; that is, carbons on which a deposit, more or less, had been made. And he also said that he has used carbons made wholly from the deposit carbon.

X Q. 905. Do you understand from the testimony quoted, him to say that in your regular lamps none but carbon upon which a shell had been deposited and carbon cut from deposited carbon were used by Sawyer and Man?

Same objection and request; no response.

A. Mr. Sawyer, by the testimony quoted, seems to have so stated; nevertheless, I think that his statement should be taken, if at all, as made with reference to the question at issue and that his answer is broader than he intended, and had his attention been called at the time to specific facts and instances, the exceptions would have been made by him in regard to the use of other carbons which actually existed in regular lamps used *used* by us; and I think in answer to the last question quoted that Mr. Sawyer must be 1298 taken as speaking of carbons, not treated, and not of carbons treated, and to have had in mind our general practice of treating our carbons, and the fact of the issue being the ownership of the invention deposit of carbon. I think he did not mean deposit carbon, pure and simple, by reason of his previously quoted answer and because of the fact.

X Q. 906. Now, is it true, that in your regular lamps and for practical use, Sawyer and Man used only carbons made from deposit carbons, pure and simple, or carbons which had been treated by depositing carbon upon them according to the inventions involved in the Sawyer-Man, Keith and Maxim interference, and Weston and Sawyer and Man interference; in the first of said interferences the application of Sawyer and Man, filed November 22, 1878, being involved, and in the latter the Sawyer and Man patent No. 211,262, the application for which was filed, October 15, 1878?

Objection and request repeated; no response.

A. No, it is not true, the difference being in the understanding of the words "regular" and "practical." To the extent that we preferred, and mainly used, treated carbons in our lamps which we exhibited and used for illuminating purposes in our workshops, it is true, because we thought our carbons were improved by treatment according to the process of these patents and applications; but it is not true, if it were intended to say, that we did not use for illuminating purposes in our workshops or exhibit any lamps in which the carbons had not been treated, nor any deposits made in or upon them, because we did use and did exhibit such lamps with untreated carbons; but we did avoid the exhibiting of such lamps when we had those with carbons that had been treated, because we preferred the latter; we thought the treated carbons were better; we were in the habit of running all our lamps for lighting our workshops until they gave out.

X Q. 907. The expressions "regular lamps" and "for 1299 practical use" are not my terms, but were respectively used by Sawyer and yourself in the testimony quoted. According to your present recollection, is it true that, "except so far as mere experiment for testing the quality of carbon went," all the carbon used by you and your assignees (up to Nov. 22, 1882,) an electric lighting by incandescence, so far as you know, have been treated according to the process of the invention involved in this interference—meaning the invention involved in the Weston and Sawyer and Man interference; that "for practical use you made use only of the carbons treated according to that invention"?

Objection and request repeated; no response.

A. In the sense of the matter at issue when that testimony was given, as a general statement and not going into particulars, it would be true, because it was our purpose, finding it advantageous to treat all our carbons, in the sense of the present issue, as to whether we use lamps in which the carbons were not treated, which were practical lamps, if there be such an issue in this case, it would not be true, because we did in running our lamps with carbons before treatment find some that were good. Nevertheless, it was our purpose when putting up the same kind of carbons in our lamps which we designed for practical use, to have them treated before being put into the lamps.

Defendant's counsel requests examiner to note that complainant's counsel here says to witness, "Would you like to refer to any of those lamp globes"?

A. I have recently refreshed my recollection by reference to old lamps and parts or lamps with tickets upon them, stating whether the carbons were treated or not treated, used by Sawyer and Man in the fall of 1878, and the winter following, 1879.

X Q. 908. I am anxious simply to ascertain what the fact 1300 was. Does your answer to R. D. Q. 65 in the Weston-Sawyer and Man interference state what is true?

Objection and request continued; no response.

A. In the sense of that interference I think it is true; so far as the question at issue in that case is concerned, it is true.

X Q. 909. The answers, as I understand you, contain a truthful statement of what the fact really was?

Objection and request continued; no response.

A. It is, but it does not state all the fact, that some of the lamps with carbons not treated were good lamps.

X Q. 910. The fact I am interested in ascertaining is, whether it is true that for practical use you made use only of the carbons treated according to the invention in that interference involved?

Objection and request continued; no response.

A. If you mean by that, that we did not make any lamps which we practically used in which the carbons were not treated, it is not true, because we did light up our shops in whole or part with lamps in which the carbons were not treated, and they were good lamps, but in the sense that the best lamps that we made, and which were our pattern lamps, and to which we desire to conform the lamps which we should make, these being called our practical lamps and in which the carbons were treated, it is true. In other words, we did not mean to stop with the invention at issue in this case, but intended, and almost always did add to our lamps the invention of treatment.

X Q. 911. At the time of the conclusion of the Sawyer and Man experiments in March, 1879, had Sawyer and Man decided upon a lamp, which could be correctly described as their "regular" lamp, and which they designed for practical use?

A. I think they had upon several.

X Q. 912. Do you mean to be understood that they had 1301 not decided upon any one lamp, but that they had several lamps which they considered equally good?

A. They had several lamps which they considered good and practical.

X Q. 913. What I wish to know is whether they had decided upon any one lamp as being the best and the one they intended to introduce for practical use?

A. They had decided upon several different lamps which they thought were best for use in different places and under different circumstances.

X Q. 914. And had not, as I understand you, determined finally upon any one type or character of lamp?

A. They had, in a certain sense, determined upon one type or character of lamp, that is, the incandescent lamp, for most uses and most purposes; but of this incandescent lamp they had decided that one kind was best for use in one place and for one purpose, and other kinds for use in other places and for other purposes.

It is proper to add that in addition to this Mr. Sawyer had of himself made up his mind in regard to some arc lamps in which he alone took part, and in a semi-incandescent lamp, which he called a feeder lamp, in which I think we both took part, but in regard to which I do not think I had come to a favorable conclusion.

X Q. 915. You have said that when you left Centre street you had a practical and successful lamp. Had you then decided upon any one type of lamp as your standard lamp, or did you have several standard lamps of different types and constructions?

A. We had several lamps of different types or constructions, all of which we thought were practical lamps. One we considered then the best kind of lamp which we had made, so far as we knew.

X Q. 916. Was there any one type of lamp which you 1302 considered best, and which you designed to introduce commercially?

A. Yes, and we also intended to introduce commercially all the types which we considered good.

X Q. 917. You had not then, as I understand, determined upon any one type of lamp, but you had several lamps of different types, all of which you intended to introduce?

A. We had decided upon a type of lamp which we thought would be most useful for most purposes, and which we considered the best that we had so far made, and we had decided upon other types of lamps, all incandescent, which we intended to introduce for some purposes and some uses.

X Q. 918. Up to 1882, were any of your lamps used for "practical use"?

A. Yes, a great many of them.

X Q. 919. Did these lamps all have carbons made from deposit carbon, pure and simple, or carbons which had had carbon deposited upon them according to the invention of the patent of Sawyer and Man involved in the Sawyer and Man-Weston interference?

A. No; not all of them, but most of them.

X Q. 920. Then, the broad statement you made in the Sawyer-Man-Weston interference that for practical use the only carbons used were those of the kind mentioned in my question, was not true, was it?

A. Yes; in the sense of that interference it was true. In practice our carbons were treated; but some of the lamps we used for the illumination of our shop were not treated. We did not intend to put out for use by others any lamps in which the carbons were not either deposit carbons or carbons treated by deposition according to our invention, but we used for our own illumination and sometimes exhibited lamps in which the carbons were not treated; in other
words we intended to add to our other inventions in regard
1303 to carbon for electric lamps the invention in regard to treating the carbons before putting them out for use, and I do not remember that any lamps were put out in which the carbons were not treated, or of deposit carbon, pure and simple.

Adjourned till Wednesday, the 5th inst., at 1 p. m.

New York, *Oct. 5th*, 1887.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. Albon Man was continued as follows:

X Q. 921. Where we have been speaking of treated carbons or carbons made of deposit carbon, pure and simple, or carbons with carbon deposited on or in them, do you understand we have been referring to the carbons and the carbons with carbon deposited on or in them referred to and described in the Sawyer-Man patent No. 211,262, the application for which we filed October 15, 1878, and which was involved in an interference with Edward Weston and referred to and described in the Sawyer-Man application, filed November 22, 1878, and involved in an interference with Keith & Maxim?

Last objection and request continued. No response.

A. I assume that your reference- to patents and applications are correct. If so, yes; I mean carbons produced or improved according to our patents for those purposes.

X Q. 922. Did you consider carbons made from willow charcoal, gas-retort carbon, and the best French artificial carbons inferior as incandescent conductors to the deposit carbon or carbons that had carbon deposited on or in them?

Objection and request continued. No response.

A. As to the French carbons and gas-retort carbons, yes;
1304 as to the carbons made from willow, I do not think so; certainly not after treatment. I am not certain, however, in regard to my recollection of my thought at the time of giving tes-

timony in those cases, and I may have thought, while testifying, that the deposit carbon, pure and simple, was better for an incandescent conductor than the willow carbon alone and before treatment.

X Q. 923. Do you know what Mr. Sawyer's opinion was?

Objection and request continued. No response.

A. I do not recollect, if I knew at the time.

Adjourned till Friday, the 7th inst., at 1 p. m.

NEW YORK, *Oct. 7th*, 1887.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. MAN was continued as follows:

X Q. 924. In the testimony from the Sawyer-Man-Keith-Weston interference, Mr. Sawyer testified that Sawyer and Man had experimented with several kinds of willow charcoal, with gas-retort carbon and the best French artificial carbons, but that all were "infinitely inferior to our invention," referring to carbons made from deposit carbons or carbons which had had carbon deposited upon or in them according to the process of your patents. Do you know, of your own knowledge, whether such was Mr. Sawyer's opinion?

Question objected to on the ground of incompetency, immateriality, and irrelevancy, and as not cross-examination, there being no question in this case respecting the comparative merits of different kinds of carbon.

1305 Counsel for the plaintiff, or complainant, requests defendant's counsel to state upon the record how the question is material upon any issue in the case

No response from defendant's counsel.

A. I understood Mr. Sawyer, by the word carbon in the testimony spoken of by you, to mean the illuminating conductor of an incandescent electric light. I think I know of my own knowledge that he considered such conductors made from the carbon he mentioned without treatment to be inferior to such conductors made of the same material and treated after the manner of our patents. I think, also, I know that as the matter of carbon, referring to its quality for the purposes of an incandescent electric lamp, he considered the quality of the deposit carbon, pure and simple, superior to that of any other carbon, but that at the same time, by reason of the difficulty and expense of making certain kinds of conductor from that carbon, and its liability to fracture, he did not consider the conductor made wholly of that kind of carbon the best conductor.

X Q. 925. At the conclusion of the Sawyer-Man's experiment, did you and Mr. Sawyer agree as to what was the lamp and type of lamp you intended to introduce?

Same objection.

A. Yes, we agreed as to all the lamps and types of lamps which we intended to introduce except one, which was what he termed the feeder lamp, which was semi-incandescent and semi-arc lamp; but it is proper to say that in regard to these different types and kinds of lamps, other than a feeder lamp, my views and those of Mr. Sawyer at that time, were not entirely in accordance as to the comparative value of the different lamps which we considered good and intended to introduce.

X Q. 926. Among the patents applied for by Sawyer and Man prior to their separation, I find but two lamps shown and
1306 described, and these are the lamps described and shown in
patents No. 205,144 and 210,809; now did you regard the lamps shown and described in these patents as practical incandescent lamps for commercial purposes?

Objected to as incompetent, irrelevant and immaterial

A. Yes, we did consider them practical for commercial purposes and they were so at the time.

X Q. 927. Did you ever construct any lamps substantially like the lamps shown in these patents?

Same objection.

A. Yes, a great many.

X Q. 928. Do either of these patents represent in substance the type of lamp you had decided upon producing for commercial purposes?

Objected to as immaterial.

A. Yes, they both represent, in whole or in part, types of lamps which we intended to introduce.

X Q. 929. At the time you applied for these patents did you consider the lamps shown in them as the best lamps for commercial purposes that you had made?

Objected to as immaterial.

A. I cannot recollect as to the first one; as to both, we considered them good lamps. As to the second one, I think that at the time of the application for the patent for it, we had made a lamp which in some of its features we considered better than either of these.

X Q. 930. Did you ever apply for a patent for this lamp that you considered better, or show or describe it in any application?

A. Yes, before the application for the patent No. 210,809, which was filed November 5th, 1878, we had presented to Mr. Broadnax (counsel for the Electro Dynamic Light Company) the features or particulars of a lamp differing from this in some respects, and which we considered better than the one for which we were then ap-
1307 plying for patent, or the one which we had previously pat-
ented, and asked him to apply for patents for the same. Mr. Broadnax had the subject before him for this purpose up to the time of the separation of Sawyer and Man in March, 1879, and from that

time forward until an application was at last made for these features, or some of them, in the early part of January, 1880.

After the word "yes" the answer is objected to by defendant's counsel.

X Q. 931. Now taking these two patents, 205,144 and 210,809, and the application for the patent in suit as originally filed, did you consider that lamps constructed substantially according to the lamps shown and described in these patents and that application as the best lamps you had made and best adapted for commercial purposes?

Same objection.

A. No; the drawings and description in all these applications do not show the best lamps we made accurately; they only illustrate the invention sufficiently to obtain the patents for which we were applying.

X Q. 932. Did you intend, and do you think that the two patents as granted and the application for the patent in suit as originally filed, described the lamps sufficiently accurately to enable a person skilled in the art of incandescent lighting as it then existed, or in the art to which it was most nearly allied, to make and construct such lamps?

Same objection again as immaterial.

A. Yes, we so intended, and I think the illustrations and description sufficient for that purpose.

X Q. 933. I notice letters patent 210,809 refer to letters patent 205,144, and state that in letter-patent 205,144 you "have shown and described an electric lamp differing not essentially in so far as its main features are concerned from that of our present invention," and the object of the invention of patent 210,809 is stated to be "to produce a lamp more tasteful in appearance and better 1308 adapted to afford a successful electric light;" in the application for the patent in suit, as originally filed, the invention is stated as constituting an "improvement upon the apparatus shown in letters patent 205,144;" now if a person skilled in the art should take these two patents and this application, as originally filed, and construct a lamp according to the drawings and specifications of the two patents and the application for the patent in suit, as originally filed, would that lamp represent the type of lamp you considered as the best lamp you had made?

Objected to as immaterial and speculative.

A. It would doubtless be of the general type of our best lamps, but would not be the same as our best lamps in all probability unless made by ourselves or our assistants.

X Q. 934. Did you consider that the size or resistance of the incandescent conductor as being of importance to the construction of the lamp, the arrangement of the lamps, or the kind of generators to be employed?

Same objection.

A. Yes.

X Q. 935. In lamps constructed according to patent 205,144, what was the resistance of the incandescent conductor?

A. The lowest resistance that I remember in any such conductor was a fraction of an ohm, it seems to me now about one-half an ohm; I cannot recollect the highest resistance; the nearest approximation I can now give was thirty or forty ohms; if they have been higher and could practically have been higher, a conductor for such a lamp could have any resistance between the resistances I have named, or up to a much higher resistance, and still be operative, if proportioned to the current used.

X Q. 936. You don't answer my question, as it seems to me; what I wish to know is what the resistance of an incandescent conductor would be in a lamp constructed according to patent 205,144.

Objected to as immaterial.

1309 A. It might be any resistance, if proportioned to the current used.

X Q. 937. What would be the length and diameter of the incandescent conductor of the lamp constructed according to this patent?

A. It might be of any length up to one inch and a half or two inches or longer; its diameter would have to be proportioned to the length in such manner as to give the resistance required for the current used.

X Q. 938. If you considered the resistance of the conductor, or its length or size as important, why did you make no mention of these things in the patent?

Same objection and request.

A. Because the resistance, length and size are of relative importance only within practical limits, and could be safely left to the electrical expert who should build lamps to estimate and proportion to the currents available to them for use; in this answer I am not to be understood as stating anything in regard to the advantages or disadvantages of using currents of higher or lower electro-motive force, but only as speaking of an operative lamp.

X Q. 939. Did you designedly omit in this patent any statement of what the resistance of the incandescent conductor was to be?

Same objection and request.

A. I do not think we had any such design; I suppose we did not think it was necessary.

X Q. 940. Now, turning to patent 210,809, what would the resistance of the incandescent conductor of a lamp constructed according to this patent be?

Same objection and request.

A. I answer the same as in regard to the previous lamp.

X Q. 941. Now, take the application for the patent in suit as

originally filed, what would the resistance of the incandes-
1310 cent conductor of a lamp constructed in accordance with the description therein contained be?

Same objection and request.

A. It might be anything from the fraction of one ohm up to one hundred and fifty ohms or more, if proportioned to the current available, and be an operative lamp.

X Q. 942. These two patents, and this application, as originally filed, being entirely silent as to what the resistance of the incandescent conductor should be, a person constructing a lamp under these patents and this application would be called upon to exercise his own judgment as to what the resistance, length and diameter of the conductor should be?

Same objection and request.

A. He would be at liberty to do so, I suppose, in accordance with the currents available to him; he must exercise the knowledge and intelligence of an expert having certain currents available to proportion his resistance to his currents, and also to proportion his conductors or leads to the incandescent portion of his lamp, so that the resistence of the conductors and leads would be so much less than that of his lamp that the work would be done where he wanted it, to wit: in the incandescent conductor of the lamp.

X Q. 943. At the time the application for the patent in suit was filed had Sawyer and Man determined upon what the resistance of the incandescent conductor of the lamps shown in the patents and in the application for the patent in suit should be?

Same objection and request.

A. They had not determined upon any fixed or given resistence for their lamps, to the best of my recollection. They had ascertained the advantages and disadvantages of higher and lower resistance in their lamps for the currents which they used.

1311 X Q. 944. Had they determined, at the time of filing the application for the patent in suit, how their lamps were to be arranged, whether in series or multiple arc?

Same objection and request.

A. They had determined that for some purposes and in some places lamps would be used singly and alone; and that in some places and for some purposes they would be arranged in series; in some, in multiple arc; and in some in multiple-arc series.

X Q. 945. Had they decided upon any one form of arrangement of lamp as being the best for general commercial purposes?

Same objection and request.

A. I do not remember that we had settled upon any one system to the exclusion of any or all others.

Adjourned till Saturday, the 8th inst., at 1 p. m.

New York, *October 8th*, 1887.

Met pursuant to adjournment.

Present: Counsel as before and cross-examination of Mr. Man continued as follows:

X Q. 946. Was it the intention of Sawyer and Man to use the same lamp if arranged in series or in multiple arc?

Same objections and request.

A. That would depend on circumstances and the current available. The same types of lamps.

X Q. 947. You have repeatedly spoken of "currents available," was it your intention to make the lamps conform to such generators as might be possessed, and not to make the generators conform to the character of the lamp?

Same objection and request.

1312 A. It was our intention to make lamps suitable for different currents, and also to make or procure generators or sources of electricity, such as dynamos and batteries, to run a fixed number in each case of particular lamps, the lamps being in each such case of the same kind.

X Q. 948. In your answer to question 944 you say "Sawyer and Man had not determined upon any fixed or given resistance for their lamps," had they determined approximately what the resistance of the incandescent conductor should be?

Same objection and request.

A. They had determined what the resistance of lamps should be for different currents and different arrangements of lamps, as these resistances varied in most cases of actual use; they had not determined or fixed upon one certain resistance for all incandescent electric lamps, either approximately or positively.

X Q. 949. According to the art as it exists, do you know whether it is true that where the lamps are arranged in multiple arc the lamps are of higher resistance, one hundred ohms or more, and where they are arranged in series, they are of low resistance, less than ten ohms?

Same objection and request.

A. No; such is not the fact, without reference to other things which you do not state; a few lamps of low resistance, ten ohms or less, are frequently run in multiple arc; if very many lamps are to be used, or if the lamps are quite distant from the source of the electricity, to be run in multiple arc would require enormous quantity of current and expensive leads or conductors, where the lamps are distant from the source of electricity; for this reason and for others, lamps run in multiple arc are of high resistance. This matter is largely a question of distribution of currents and expense and of nothing inherent in the lamp. It is one of those questions of the currents available. Again, lamps run in series, 1313 each one in itself a resistance, add resistance to resistance for every lamp added to the series. It is evident that if higher-resistance lamps were used, in such cases the total resistance of a large number of lamps would become enormous, requiring currents of correspondingly high electro-motive force, soon reaching the limit of generators of electricity or passing beyond control and becoming dangerous. It is evident, therefore, that lamps in series should be of low resistance. This then is a question of currents available, but there is no such general practice as precludes the running lamps of low resistance in multiple arc or the running of lamps of high resistance in series, within the limits of practicability.

X Q. 950. Do you know how, in isolated and central station plant at the present time, the lamps are arranged?

Same objection and request.

A. I understand that they are usually arranged in series or multiple arc. I am not familiar with the details of recent work.

X Q. 951. Are you familiar with the incandescent lamps that had been patented prior to the labors of Sawyer and Man?

Same objection and request.

A. I have not them in mind at present.

X Q. 952. Would a lamp constructed under patent 210,809 be of higher resistance than one constructed under patent 205,144?

Same objection and request.

A. Not necessarily; it might be and it might not.

X Q. 953. I understand from your testimony it would depend upon the wish of the person constructing the lamp and upon anything contained in the patents?

Same objections and request.

A. I think largely so; a person could make a lamp of higher or lower resistance of either kind.

1314 X Q. 954. Now take the application for the patent in suit, as it was originally filed. I understand from your testimony that a person constructing a lamp following it and the patents to which it refers, is left in ignorance as to what the resistance of the lamp should be?

Same objection and request.

A. That depends upon whether he is an ignorant person, or an expert; he is left at liberty to adopt such resistance as he wants.

X Q. 955. Is it now your opinion that at the time letters patent 205,144 were granted, a person skilled in the art could construct a lamp according to that patent and make his lamp either a fraction of an ohm, or forty or fifty ohms resistance?

Same objection and request.

A. Yes.

X Q. 956. What change, if any, would have to be made in the lamp to make it in the one case the fraction of an ohm, and in the other, forty or fifty ohms resistance?

Same objection and request.

A. Simply to make the incandescent conductor of the resistance be required, and adapt the other portions of the lamp to this conductor.

X Q. 957. How could he make the resistance of the conductor in one case the fraction of an ohm, and in the other forty or fifty ohms?

Same objection and request.

A. By making the conductor of the resistance short and large and of carbon of high conductivity; in the case of high resistance, by making the carbons long and small and of carbon of high resistance.

X Q. 958. And this, you think, would be known to a person then skilled in the art?

Same objection and request.

A. Yes.

1315 X Q. 959. Well, what carbons were then known to be of high resistance and what of low?

Same objection and request.

A. The different qualities of French carbons, so called, were known to electricians to be of less resistance than the ordinary gas-retort carbons. They were also known to be of less resistance than charcoal and vegetable carbon. I think the resistances of different carbons were tested by electricians before that time.

X Q. 960. Was it then your opinion, that electricians knew that the resistance of the conductor would depend upon its length and cross-section and the kind of carbon of which it was to be made?

Same objection and request.

A. Yes, it was well known to electricians that increasing the length of a conductor increased its resistance and that increasing the size or section of a conductor diminished its resistance, and it was known that different carbons had different resistance of same size, section and length, and electricians knew how to test the resistance of carbon and other substances.

X Q. 961. Now I understand you to have made lamps shown in patent 205,144, where the resistance of the carbon of such a lamp was the fraction of an ohm. What was the length and cross-section of the incandescent conductor in drawing marked E′?

Same objection and request.

A. I do not know whether I can recollect with accuracy the size of those carbons; I can get an approximation. They were less than half an inch in length and more than a twentieth of an inch in cross-section; I should say between a twelfth and twentieth; I recollect one of a tenth of an inch cross-section.

X Q. 962. Are you answering my question with reference to an incandescent conductor having the resistance of a fraction of an ohm?

1316 Same objection and request.

A. Yes.

X Q. 963. What was the character of the carbon?

Same objection and request.

A. We used several kinds of carbon in those low resistances, some of them French carbons treated and untreated, some of them of deposit carbons pure and simple. I think some of gas-retort carbons and some of vegetable-fibre carbons, treated and untreated; with all these carbons it is my recollection we made lamps of less than one ohm resistance.

X Q. 964. Now, if a person wanted to make a lamp under this patent with an incandescent conductor of fifty ohms resistance, what would he have to make the length or cross-section of this carbon?

Same objection and request.

A. I cannot tell without knowing the carbon that he was using and its resistance, and then only by experiment.

X Q. 965. Cannot you tell me approximately; I understand you have made such lamps with such carbons?

Same objection and request.

A. Yes, we made lamps of forty or fifty ohms resistance. I cannot recollect the size and length of the carbon with accuracy.

X Q. 966. I don't ask you to tell me with accuracy, but approximately?

Same objection and request.

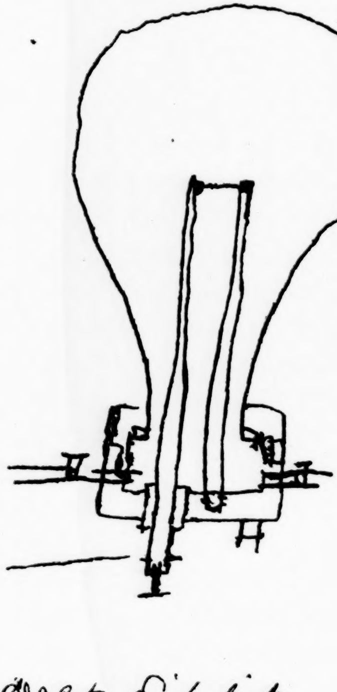
A. From general recollection only, which may be quite inaccurate, my impression is, two inches or more in length and less than a thirty-second of an inch in diameter.

X Q. 967. What was the total length of the conductor between D and *a*?

Same objection and request.

A. I mean by the length I have given, the length of the incandescent portion of the conductor; we did not make all our
1317 lamps under that patent with the clamp G, but omitted it in
many of the lamps as shown in Fig. 9 of that patent; the length was anything above the clamp G; a small fraction of an inch would be sufficient, but we used carbons of more than three inces total length including the incandescent portion and the portion above the clamp G, this total distance from D to *a*.

No. 286.
E. E. Light Co.
v.
McK. Light Co. } p 1318



Defts Exhibit
Man Sketch No 1
October 11 1887

X Q. 968. Now, this patent describes very minutely the lamp and its construction, and contains a drawing in illustration of the lamp. Do you think that following the patent a person could use an incandescent conductor two inches in length and a thirtieth of an inch cross-section in this lamp?

Same objection and request.

A. Yes, I think so, and my recollection is that we did so.

X Q. 969. In your patent 210,152, applied for October 19th, 1878, you state "we have found that the internal resistance of a lamp such as that of letters patent 205,144 is not far from six-tenths of an ohm." Was that statement true?

Same objection and request.

A. Yes, if it was made of that resistance. I do not think that we ever intended to say that it could not be made of higher resistance.

X Q. 970. Now you are one of the applicants for this patent, cannot you give me what the resistance of a lamp such as is here shown was?

Same objection and request.

A. I could only tell you by measuring it; if you desire to have me state what the ordinary resistances of lamps made by us was, I can tell you or approximate it.

X Q. 971. You cannot then say whether a lamp constructed in strict accordance with this patent would be a high or low resistance lamp?

Same objection and request.

(Here follows diagram marked p. 1318.)

1319 A. I can only say that they might be made of a resistance less than one ohm or of a resistance of forty ohms.

X Q. 972. Equally well?

Same objection and request.

A. There would be more difficulty in making the higher-resistance lamp.

X Q. 973. In making the higher-resistance lamp, would any alteration have to be made other than in the length, cross-section or material of the carbon?

Same objection and request.

A. No, only in proportioning the other parts of the lamp to the carbon used.

X Q. 974. Would the high-resistance lamp be as durable as the low-resistance lamp?

Same objections and request.

A. Probably not.

X Q. 975. All that you have said concerning the lamp of patent 205,144 is equally true, as I understand you, of the lamp constructed under patent 210,809?

Same objection and request.

A. Yes, I think so.

X Q. 976. A lamp under this patent could be made, and, as I understand you, was made of either less than an ohm or more than forty ohms resistance?

Same objection and request.

A. Yes, up to forty ohms.

X Q. 977. Now, did you ever make a completed lamp, such as shown in patent 205,144?

Same objection and request.

A. Yes, substantially.

X Q. 978. How many completed lamps?

Same objection and request.

A. I do not know.

X Q. 979. Before you left Centre street, how many?

Same objection and request.

1320 A. Several; I don't know how many.

X Q. 980. What is your best recollection?

Same objection and request.

A. My recollection is that we made a considerable number of lamps like that complete and entire; that we used the same parts of the lamp put in different conductors into the same globe, modifying the internal works of the lamp and using different conductors in the same lamp or globe a great many times. I cannot say how many.

X Q. 981. What is your best recollection as to the number of lamps substantially like that shown in patent No. 205,144, you made in Centre St.?

Same objections and request.

A. I have no recollection of it, other than I have stated.

X Q. 982. Can you not give me any idea whatever whether it was as many as a hundred, or as few as two or three?

Same objection and request.

A. It was not so few as two or three; I do not think it was a hundred.

X Q. 983. Do you think it was fifty?

Same objection and request.

A. I don't know.

X Q. 984. Do you think it was twenty-five?

Same objection and request.

A. I think it was more than twenty-five.
X Q. 985. As many as thirty, do you think?

Same objection and request.

A. Yes, I think it was more than fifty, but I don't know; I mean by this, not separate entire lamps, because the parts were used over and over again.
X Q. 986. What I want to get at is, your best recollection as to the number of separate and entire lamps, as shown in patent 205,144, were made by, or for, you and Mr. Sawyer while you were at 43 Centre St.?

1321 Same objection and request.

A. That I cannot give you.
X Q. 987. Can you not give me any approximate idea?

Same objection and request.

A. I can guess at it and that is all I can do.
X Q. 988. Can you not state between certain limits?

Same objection and request.

A. Yes, I can state to the best of my judgment within certain limits, and that is at present, and I might think differently upon calling to mind other circumstances, from fifteen to twenty-five separate and entire lamps of the kind shown in this patent, or similar to it, while we were at 43 Centre St., and perhaps a hundred separate and distinct lamps, counting those in which the parts were used over.
X Q. 989. Now, what is your best recollection as to the number of separate and entire lamps of the kind shown in letters patent 210,809 made by you while at 43 Centre St.?

Same objection and request.

A. I don't remember.
X Q. 990. Tell me your best recollection.

Same objection and request.

A. We made some, I don't remember how many, perhaps as many as of the other, but I could not say, nor could I say that they were exactly like those shown in that patent; they were similar.

Adjourned till Monday, the 10th inst., at 1 p. m.

1322 Monday, *October 10th*, 1887.

Met pursuant to adjournment.
Present: Counsel as before, and the cross-examination of Mr. Man was continued as follows:

X Q. 991. Do you mean to be understood, that according to your best recollection at the present time, you made about fifteen to twenty-five separate and entire lamps of the kind shown in letters patent 210,809, while at 43 Centre street?

Objected to as irrelevant and immaterial and counsel is requested to state upon the record how this line of examination is either competent or material for cross-examination. No response.

A. While at 43 Centre street, yes; but I mean to be understood at the same time, that I do not know the number, and that is a mere impression left on my mind. It is between eight and nine years since we made them.

X Q. 992. Now, of the kind of lamps shown in patent 205,144, were the conductors of about the same resistance in these complete and entire lamps?

Same objections and request; no response.

A. No; I should think not.

X Q. 993. Were they of the same general length and diameter?

Same objection and request; no response.

A. No; I should think not.

X Q. 994. Do you remember between what limits the resistance varied, and the length and diameter of the conductor varied?

Same objection and request; no response.

A. No; I do not, to state it with accuracy.

X Q. 995. Do you remember approximately?

Same objection and request; no response.

1323 A. Yes, I think so; that is to say, I have an impression in regard to it in my mind.

X Q. 996. If you have, state it.

Same objection and request; no response.

A. The resistance from the fraction of one ohm up to forty ohms, or possibly fifty or more; the size from less than ha*ve* an inch in length to two or three inches in length; the diameter from a tenth of an inch or more to a thirty-second of an inch or less.

X Q. 997. As I understand you, you had not determined upon any standard size or resistance for the conductors of these lamps.

Same objection and request; no response.

A. I have testified fully in regard to that matter. Your generalization is too large. We had not determined to make any one of the lamps to the seclusion of another.

X Q. 998. Well, you did think that the lamp of this patent would be a practical lamp for commercial purposes, with either a comparatively short, thick, low-resistance conductor, or a long, thin, high-resistance conductor?

Same objection and request; no response.

A. Yes; and we had most urgent requests, or demands, to sell lamps of both kinds.

X Q. 999. What we have been saying of the lamp under 205,144 is equally true of the lamps under 210,809?

Same objection and request; no response.

A. Yes.

X Q. 1000. Now, while you were at 43 Centre street, did you make any lamps in which the conductor was of paper, or carbonized fibrous or textile material?

A. Yes.

X Q. 1001. About how many complete and entire lamps were made having such conductors, at 43 Centre street?

A. That I can't say.

1324 X Q. 1002. According to your best recollection, about how many?

A. I have no distinct recollection in regard to the number. I have no record of them, and as we continually used over the parts of lamps with different carbons substituted in the same lamp, I do not think I could even approximate the number.

X Q. 1003. Can you give me no idea?

A. No, I can't, for the reason that we so often changed our lamps, and changed the internal works and carbons, using the same globes or glass envelope, that I cannot distinguish one from another.

X Q. 1004. Can you not give me some idea, whether as many as a hundred or as few as two?

A. We made more than two separate, distinct and complete lamps, and less than one hundred, in which this kind of carbon was employed.

X Q. 1005. Were as many as ten separate and distinct lamps in which this kind of carbon was employed made at 43 Centre street?

A. I cannot tell.

X Q. 1006. As many as twenty?

A. Same answer.

X Q. 1007. As many as fifty?

A. Same answer.

X Q. 1008. As many as seventy-five?

A. I should think not.

X Q. 1009. As many as sixty?

A. I should think not.

X Q. 1010. As many as fifty?

A. I think not, but I can't tell.

X Q. 1011. As many as forty?

A. Same answer.

X Q. 1012. As many as twenty?

A. I will tell you simply what I think, and my impression
1325 is based upon a review in my own mind of the work we did
at Centre street. I think we set up one or two complete sets of lamps, in which the vegetable-fibre carbon was employed, and in which the parts of the lamps had not been used with any other carbons. The sets were composed of from eight to twelve lamps. Now I may be mistaken in regard to all the parts of these lamps not having been used with other carbons, and it may be that we set up more entirely distinct lamps with these carbons, or less. I think we set up and ran of all kinds of lamps with these carbons, in

the neighborhood of fifty to a hundred lamps. It may have been more and it may have been less, while we were at 43 Centre street.

X Q. 1013. Are you confident that as many as ten lamps were run to incandescence in Centre street, which lamps had conductors of fibrous or textile material?

A. Yes, very many more than that; from fifty to a hundred.

X Q. 1014. Do you remember the first completed lamp made by you in Centre street which had a conductor of this kind?

A. No, I do not, as a separate and distinct lamp. I remember the form of the globe in which we first used conductors of that kind.

X Q. 1015. Do you remember — the first attempt to run to incandescence a conductor of carbonized, fibrous or textile material was *whether* in what might be called a lamp or in rude experimental apparatus?

A. I do remember it.

X Q. 1016. Now please to state what the first experiment was which you and Mr. Sawyer conducted at 43 Centre street on running to incandescence a conductor of carbonized, fibrous or textile material?

A. It was an attempt to pass the current through a piece of paper on Mr. Sawyer's desk.

X Q. 1017. What kind of paper?

1326 A. My impression is that it was a piece of blotting paper.

X Q. 1018. Had it been carbonized?

A. No.

X Q. 1019. What was its size and shape?

A. I should think about an eighth of an inch wide, more or less, and a couple of inches long, a long, narrow slip cut from a sheet of ordinary blotting paper.

X Q. 1020. How did you connect your conductors with this blotting paper?

A. It lay upon the table and we put the terminals down upon the paper as it lay there.

X Q. 1021. Well, what happened?

A. Nothing, no current passed.

X Q. 1022. Was the paper injured?

A. No, sir.

X Q. 1023. What was your object in trying this experiment?

A. I forgot what we had in view at the moment.

X Q. 1024. What information did you derive from it after it had been tried?

A. That the paper formed a good electrical resistance or insulator.

X Q. 1025. Didn't you know that before?

A. No, we did not know how good that particular kind of paper would be as an insulator.

X Q. 1026. Did you know what the electro-motive force of your generator was at the time?

A. I don't think we did.

X Q. 1027. Did you know about what it was?

A. No, I don't think we did; only that it was a considerable number — volts.

X Q. 1028. About how many?

A. I don't recollect that we thought of it at the time.

X Q. 1029. Which of the dynamos that you had in Centre street were you using at this time?

1327 A. I think the one in the basement, an arc lighting dynamo.

X Q. 1030. Do you remember what the next thing that was done by you and Mr. Sawyer at 43 Centre street was, in relation to the use of fibrous or textile material as an incandescent conductor?

A. Yes.

X Q. 1031. Please state.

A. We next drew a fine line with a piece of graphite on this same slip of paper or a similar one, put a little pile of graphite at each end of the line, pressed it down and placed the electrical terminals on the piles and endeavored to pass the current through it. Not succeeding, we increased the size of the line and approached the pile of graphite to each other at the extremities until the current finally passed along the line. We had made by repeated markings and indentation on the line which we filled up with graphite, increasing the size of the lines, and pressed it down. The current passed by a series of sparks along the line of graphite and the paper was burned along the line, and charred through to the under side of it.

X Q. 1032. With reference to the time of the first experiment, when was this done?

A. Immediately afterward, following at the same moment continuously.

X Q. 1033. What was your object in trying this experiment?

A. Mr. Sawyer had a theory somewhat similar to Mr. Edison's, as I have understood it, that a very high 'electrical resistance in the incandescent conductor would be highly advantageous and he was endeavoring to illustrate to me the effect of such a resistance by this crude experiment, and that was the object of the experiment.

X Q. 1034. I do not understand your answer. How did this experiment illustrate anything?

1328 A. Mr. Sawyer said that if he could get a conductor that would stand the "racket" as he called it, as fine as a hair or the smallest pencil line, it would be perfection for a conductor. I said to him that we could not get a current through it with any electro-motive force we had available or that would be safe. He insisted that it could be done and this led to the experiment.

X Q. 1035. Did he say what kind of a conductor?

A. I don't remember.

X Q. 1036. Was this experiment then merely to ascertain the electro-motive force of the machine?

A. No, it was to demonstrate that with the electro-motive force we had available and which was safe to use, we could send a current of sufficient strength through a very high resistance to heat it up to incandescence.

X Q. 1037. Did you expect to run this paper up to incandescence?

A. No, sir; Mr. Sawyer expected to run the plumbago up to incandescence.

X Q. 1038. Did he or you think that the first fine pencil line you made would become incandescent?

A. I don't know.

X Q. 1039. Now, as I understand, you kept adding plumbago to the paper and shortening the length of the line until you could get a current through; is that correct?

A. Yes.

X Q. 1040. Did you or he expect that when you reached a point where the current would pass through the plumbago it would become incandescent?

A. Yes.

X Q. 1041. What part did the paper play in this experiment, and would not any insulating substance, such as rubber, have answered the same purpose?

A. I think it would; the paper was a convenient article.

X Q. 1042. Was there then no special object in using the
1329 paper, other than as an insulating holder for the plumbago?

A. That was all.

X Q. 1043. Did this experiment inform you of anything or suggest anything?

A. Yes.

X Q. 1044. What?

A. It gave us some knowledge of the conductivity of the plumbago we were using, and we proceeded immediately to further experiments.

X Q. 1045. Was this the only suggestion or information you derived from this experiment?

A. Yes, I believe so. I don't recollect anything else.

X Q. 1046. How could you have learned of the conductivity of the plumbago you were using, without knowing the electro-motive force of your machine and the exact amount of plumbago placed upon the paper?

A. The only information we obtained was relative and not positive; we found that we could pass the current from that dynamo through a certain length and size of packed plumbago.

X Q. 1047. What now was the next thing that you did?

A. The paper being charred and burned in the last experiment and the line of plumbago broken so as to break electrical connection, we took a slip of paper, soft and porous, filled it with plumbago to the best extent we could, rubbed it with plumbago in a groove in a piece of iron with a burnisher, pressed it, put it on the desk with a sheet of mica underneath it and applied the electrical terminals.

X Q. 1048. What was your object in this?

A. We thought, in that way, possibly we might demonstrate what Mr. Sawyer had said in regard to high resistance, and that there was less liability of the breaking of the conductor and that we could continue to pass a current through it a longer time before it would be destroyed.

1330 X Q. 1049. What had Mr. Sawyer said in reference to high resistance that you expected this experiment would demonstrate?

A. I have already stated that before. I will repeat it if you desire; as I said, Mr. Sawyer had a theory that a very high-resistance conductor of small section, even as small as a hair or a pencil-mark would be highly advantageous if the conductor could be made to endure; on the other hand, I said that I did not think that such very high resistance would be advantageous and stated that no electro-motive force available to us or that would be safe, would pass a current of sufficient strength through such a conductor to make it incandescent; Mr. Sawyer contended to the contrary of my views and that a current could be passed through such a conductor to make it incandescent from the dynamo we were then using.

X Q. 1050. Now you could not have expected that this experiment could show anything in regard to the durability of such a conductor. I, therefore, infer that the object was to ascertain whether your machine would drive a current through it; am I correct?

A. Yes, a current of sufficient strength to make it incandescent.

X Q. 1051. In this experiment, as in the former was the paper used simply as a vehicle to hold the graphite?

A. Yes, as a holder of the graphite.

X Q. 1052. What information or suggestion did you gather from this experiment?

A. The conductor remained incandescent longer than we had anticipated, and when it finally broke, and broke the electrical connection, portions of the paper charred and condensed were left upon the mica, took fire and slowly burned up; we were in trouble about getting carbons for incandescent conductors and the thought occurred to both of us that we had possibly hit upon a way in which such carbons could be produced of the size and shape and 1331 resistance which we desired, if we could prevent the consumption of the paper; we therefore at once proceeded to further experiments.

X Q. 1053. In order that there may be no misunderstanding, had you at this time determined upon what size, shape and resistance of incandescent conductor you desired?

A. Only tentatively; we had been making conductors out of French carbons in straight pencils, working down the pencils to get them small; we had also been making carbons out of thin sheets of French carbon which we formed into an arch to rise above the holders of the lamps; we had great difficulty in working down these carbons to size and shape such as we were then trying to use.

X Q. 1054. I do not understand from your answer whether you had or had not determined what the size, shape and resistance of the incandescent conductor should be?

A. I have answered your question, it seems to me, as fully as I can; perhaps I should add that we were endeavoring to make our conductors as small as possible in section in accordance with Mr. Sawyer's theory of the advantages of high resistance; we certainly had not determined on any fixed resistance or any fixed size of conductor, and we were trying different shapes of conductors.

X Q. 1055. Am I then to understand that you saw in this way a possibility of overcoming the mechanical difficulty of getting a carbon of small size and of any desired shape?

A. Yes, that is what I mean to be understood; that is, we would avoid the difficult operation of shaping carbons, and sizing them, by shaping and sizing the material from which they were made.

X Q. 1056. Now at the time of these experiments, for I understand they were all on the same day, had you as yet made what you would call a lamp; I do not refer to rude experimental apparatus, such as chemical flasks with improvised holders and carbons, but a lamp mechanically constructed. 1332

A. I say yes. We had before then made some lamps, which, considering their cheapness and practicability, would be useful today, if the present improved lamps could not be obtained and in places where those lamps were not at hand for use.

X Q. 1057. If then you had at this time made lamps as you say, in view of your statement that you then "were in trouble about getting carbons for incandescent conductors," and "had been making conductors out of French carbons in straight pencils, working down the pencils to get them small," and "had also been making carbons out of thin sheets of French carbon," I infer that these experiments must have been made some time after you had been at work in Centre street. Am I correct?

A. We had been there for a little time, I cannot now remember how long, but it was after we had set up and tried a good many lamps.

X Q. 1058. Now let me recall your attention to the fact that you did not go to Centre street until the 7th of March, 1878, that no experiments had been conducted before you went to Centre street except the one at the coal and iron exchange. That when you went to Centre street you had no facilities, apparatus or tools for experimentation, but had to get them, that your working force in Centre street was limited to Sawyers, the elder and junior, to Kaeting and Sharp, that the working down of carbons or the making of lamps must have taken considerable time, and that the lighting machine which you say you used was in the basement of the building, and, if you remember, was only open to your use for a day or two after you went to Centre street. I call your attention to these facts with the view of refreshing your recollection as to the time of these experiments, for it seems to me that if the experiments which your answers would imply had been conducted, these particular experiments must have been made at a comparatively late day, or if they were performed immediately on your arrival they could not have been preceded by the amount of work your answers import? 1333

A. In answering at this day in regard to events taking place between eight and nine years since, I cannot hope to reach positive accuracy. My recollection accords with yours in regard to all the matters testified to, except the length of time during which Arnoux & Hochausen's lighting machine was in the basement. I think it was certainly while that machine was there that we tried the experiments I have related, and reviewing the subject in my own mind I cannot fix the time of these experiments within a few days after our going to Centre street, and before making these experiments we had certainly made a large number of conductors from the French carbon, and experienced the difficulty of which I spoke in their manufacture, and had exhausted, as I think now, all the stock of that kind of carbon, or nearly all, that we could get hold of. Therefore, I think that it was the fact that before these experiments we had made the lamps of which I have spoken. From other circumstances, it seems to me that these experiments took place soon after the agreement of the 19th of March, between Mr. Sawyer and myself. It may be that I am wrong in regard to the time of the arc-light machine being there, or it may have been that Arnoux & Hochausen, who were continually experimenting, took out the first machine and were experimenting with another one, or, they may have cut us off from the use of that machine for a while and then subsequently we used it, or it is barely possible, though I think it highly improbable, that these experiments took place earlier than I think.

Adjourned till Tuesday, 11th inst., at 1 p. m.

1334 TUESDAY, *Oct. 11th*, 1887.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. MAN was continued as follows:

Witness says: I wish in this connection to call attention to my answers to cross-question 332 and cross-questions following to 400, in which it will appear that I had not endeavored to fix with any certainty the time during which the arc-lighting machine remained in ths basement.

X Q. 1059. Are you positive, however, that it was while the arc-lighting machine was in the basement and you had a current from it, that these experiments were performed?

A. No.

X Q. 1060. Are you positive that prior to the conduct of these particular experiments you had been making the carbons mentioned in your 1055th answer and had made lamps as stated in your 1058th answer?

A. I am as positive in regard to the carbons as I can be at this length of time and I am confident, but not positive, as to the lamps. It seems to me that I cannot be mistaken in regard to it; nevertheless, it is too long a time since then, unless some positive fact in regard to which the date could be definitely fixed should be brought to my attention, that I should be absolutely positive.

X Q. 1061. Can you remember what the first lamp was which was made in Centre St. By "lamp" I do not mean rude experimental apparatus, such as chemical flasks or a globe with improvised carbon supports and stoppers, but a mechanically and completely constructed lamp?

A. I do not recollect any one in particular, but of types of lamps I recollect the earlier or first ones. The globes were made 1335 of Florence flasks. The second kind, as I recollect it, were globes like Florence flasks with wider mouths and flanges which I got blown at the glass factory.

X Q. 1062. I want to make myself clearly understood. I assume that at some time there was made in Centre St. a lamp complete and mechanically constructed. If such a lamp was made, I assume it must have been made by some one, proper tools must have been employed, and as the making of this lamp must have necessitated the construction of special parts, few of which existed in trade and most of which must have been specially constructed, which parts must afterwards have been put together, and the lamp must have been either exhausted or charged, the entire work being done, I assume, under intelligent direction; moreover, for the making of these parts instructions, drawings and the like, must have been given. Now, do you not remember whether such a lamp was made, what its character and construction was, and by whom and where it was made?

A. The difficulty of your question is that you do not distinguish by proper words what you mean. The first lamps we made or caused to be made during the first week we were in Centre St. answered the description you give. They were intelligently planned by Mr. Sawyer and myself. We procured the glasses and caused the metal parts to be mechanically made, caused them to be set up or set them up ourselves and run. From that time forward, we made other and different lamps continuously, which answer your description, up to the time when we left 43 Centre St. in May or June. I cannot distinguish or tell the time, nor positively describe with accuracy the different kind of lamps nor the time of their production. You will see them pictured, or some of them, rudely, in the testimony of Mr. Church and possibly of Mr. Sawyer in the interference case. You have endeavored in this case to obtain an acquiescence from me, in the limiting of the number of persons engaged on the work of the lamps or their construction in 1336 parts to certain persons you have named, omitting all work done out of the shop by other parties, of which a large amount was done by different parties.

Answer objected to as irresponsive.

X Q. 1063. I am anxious to learn the facts in regard to the making of lamps in Centre street, by whom they were made, what their constructions were, where they were made, or your best recollection in regard to these things. Now, I have endeavored to explain what I meant by a lamp, and I shall endeavor to make myself clear. A Florence flask filled with an inert gas, with an improvised stopper, with rude conductors and carbon, I do not understand to be anything but experimental apparatus. A lamp could not have been a simple thing to make. The question of globe, base, holders for the carbon, connection of the carbon to the holders, adaptability for charging or exhausting, must have all entered into the construction of a lamp. If, in point of fact, such a lamp was made in Centre street, the first lamp, or if more than one were made, set of lamps, must have been the subject of discussion and explanation. Now, can you not remember the circumstances surrounding the making of such a lamp, or set of lamps, what its general character was, and what its parts were?

A. The very first lamps we made in Centre street with Florence flasks for globes answer your description of a lamp. They were intelligently planned for lamps, their parts adapted for all the purposes of which you speak, and more. They were lighted up and run as lamps. In answer to your desire expressed in the first part of your question, their parts were gathered together by purchase of the glasses, manufacture of the bases, cast and worked up at places and nicely finished with conductors insulated through the bases by appropriate insulation, with platinum tips for the holders of the carbon, and with an inert or carbon preservative gas as an atmosphere; part of the work being done by jewelers, part by instrument-makers, part in our own shops, part by Mr. Keating, 1337 part by Mr. Sharp, perhaps (I don't recollect whether he was there at first), and very probably parts by other parties assembled and put together in our shop, or in Mr. Sharp's place in Brooklyn, the whole being run by Mr. Sawyer and myself as electric lights, from that time forward; lamps, each perhaps an improvement in some particulars upon the other that had gone before it, were certainly made by and for us while at 43 Centre street, until we reached lamps that were satisfactory to us for the time being. Now, I have to say that I cannot give the time of any of these steps with any considerable degree of accuracy. I can give you the impression that remains in my mind, as to the time when we got lamps that were satisfactory to me and that I considered practical lamps.

Answer objected to as irresponsive.

X Q. 1064. As near as you now recollect you went to Centre street on the 7th of March, did you not?

A. 6th or 7th of March.

X Q. 1065. Do you bear in mind your testimony in regard to the fitting up of the rooms?

A. Generally; not in particular.

X Q. 1066. Do you remember the first time in 43 Centre street you ran a conductor to incandescence, the conductor being in a glass globe of some kind?

A. Yes.

X Q. 1067. Do you remember generally what the conductor was, what the globe was, and how the conductor was placed upon the conducting wires?

A. Yes.

X Q. 1068. You say you remember; now tell me what the incandescent conductor was; what the globe was and how the incandescent conductor was fastened to the wires.

A. The incandescent conductor was a pencil of gas-retort carbon or of French carbon; the glass was a Florence flask. The incandescent conductor was held between two metal supports in depressions made in the support by the pressure of the support against the ends of the conductor. 1338

X Q. 1069. Please make a drawing illustrative of the apparatus you have just described.

(Witness makes a sketch.) Same offered in evidence and marked Defendant's Exhibit "Man Sketch, October 11th, 1887."

X Q. 1070. What was the atmosphere in the flask?

A. Ordinary illuminating gas.

X Q. 1071. Who constructed this apparatus?

A. I don't recollect.

X Q. 1072. Was it constructed in your presence?

A. It was put together in my presence and Mr. Sawyer and I together bought the flasks.

X Q. 1073. What was the base of this apparatus?

A. It was of cast brass, one ring cemented to the Florence flask, and the other screwed upon that with an insulation through the base for one of the holders.

X Q. 1074. There appears to be two holders. Please state how these holders passed through or were attached to the base.

A. One of the holders was simply screwed down into the bottom of the base or cup on the inside; the other passed through a piece of hard rubber, screwed into the base and thus insulated from it, terminating in a binding screw. The other binding screw was fastened to the outside of the base. There were orifices in the base, with stop-cocks for passing the gas in and out of the lamp in charging it.

X Q. 1075. Now, who made this base with its binding posts and stop-cocks?

A. I don't know. Mr. Sawyer got it done. I presume I knew at the time.

X Q. 1076. Who furnished the instructions by which the mechanic made this base and its parts?

A. Mr. Sawyer had talked it over, made some rude sketches, Sawyer made more perfect ones, gave the instructions and employed the people to do the work. 1339

X Q. 1077. How long after the mechanic had the drawings, &c., did it take before the base and its parts were delivered to you?

A. I don't know. It was done before we went to Centre street.

X Q. 1078. About how long do you think it took to make?

A. I have no recollection definitely.

X Q. 1079. Well, with reference to the 6th or 7th of March, the time you went to Centre street, when was this base delivered to you and Mr. Sawyer.

A. Well, I think Mr. Sawyer had them. They had been delivered to him before we went to Centre street, or the evening before. A day or two before that, I bought the platinum for facing the holders.

X Q. 1080. You say "them;" was more than one base and its parts ordered?

A. There were six or eight of them.

X Q. 1081. The same in design and construction?

A. Yes, nearly, if not quite.

X Q. 1082. If they differed at all, do you now remember what the difference was?

A. Some one or two of these bases were not like the rest and were, I think, got up by old Mr. Sawyer; whether they were in addition to the six or eight that Mr. Wm. E. Sawyer got manufactured, or a part of them, I can't recollect.

X Q. 1083. You don't tell me that for which I inquire, to wit: the point of difference?

A. That I don't recollect. I don't know they were different.

X Q. 1084. You don't remember who made them; do you remember who paid for them?

1340 A. Yes, I paid for them, or gave the money to Mr. Sawyer to do so.

X Q. 1085. Well, which was it?

A. My impression is that I gave him the money to pay for them.

X Q. 1086. Now, have you any check, voucher, bill or memorandum of any kind that would show who made these bases and their parts, or which would aid you in remembering who made them?

A. No, sir.

X Q. 1087. You have spoken of platinum for facing the holders in your 1079th answer, which you say you bought; where did you buy it?

A. I don't recollect.

X Q. 1088. Now, platinum is not on sale everywhere and not an easy thing to purchase; does nothing occur to you that would enable you to remember where you bought it?

A. No; and, on the contrary, it is an easy thing to *thing to* purchase; it may be bought of almost any dealer in precious metals, and at almost any jeweler's shop.

X Q. 1089. Have you ever bought any before?

A. Yes.

X Q. 1090. More than one?

A. Yes, I think so.

X Q. 1091. Do you remember where you bought it?

A. No.

X Q. 1092. Do you remember whether you bought the platinum for facing the holders at the same place as you had bought the platinum previously?

A. No, I do not recollect.

X Q. 1093. Did you buy it in New York or Brooklyn?

A. I think I bought it in New York, but I don't recollect.

1341 X Q. 1094. Did you buy it personally or send some one for it?

A. I bought it personally.

X Q. 1095. Was it delivered to you personally at the place where you bought it, or was it sent to you?

A. It was delivered to me personally at the place where I bought it, and I gave it to Mr. Sawyer.

X Q. 1096. Do you remember what you paid for it?

A. I do not.

X Q. 1097. Can't you tell me about how much?

A. I cannot.

X Q. 1098. How much did you buy?

A. That I don't recollect.

X Q. 1099. Can't you tell about how much?

A. No.

X Q. 1100. Can't you give me any idea whatever as to how much you bought and how much you paid for it.

A. No, only that it was a very small quantity.

X Q. 1101. Well, did you pay as much as a thousand dollars or as little as ten dollars for it?

A. I did not pay either sum.

X Q. 1102. Do you think it was less than ten, or more?

A. If you ask my judgment of the amount I will give it to you.

X Q. 1103. Well, do so.

A. I should think two, three, or four dollars, possibly five.

X Q. 1104. What kind of store did you buy it in?

A. I don't recollect where I bought it, probably at a goldsmith's, or goldsmith supplies.

1342 X Q. 1105. Now, I understand you are positive that these metal bases and their parts were delivered before you went to Centre street, or on the first day you were there?

A. Yes, I think the day before; perhaps not all of them the day before.

X Q. 1106. What use was made of the platinum in these bases and their parts?

A. It was not used on the bases; it was cut up into small pieces, a little less than an eighth of an inch square or round, brazed to the inside face of the holders at their top end, and a small hole drilled or punched not quite through the platinum, to receive the ends of the carbon conductors.

X Q. 1107. Who did this work—the mechanic that made the bases?

A. No, I do not know the individual who did it, but some jeweler brazed the pieces to the copper holders.

X Q. 1108. Who was the jeweler?

A. I don't know; Mr. Sawyer got it done.

X Q. 1109. Were the holders taken to the jeweler before the entire base was made, or afterwards?

A. I do not know; it was probably after they were fitted to the bases.

X Q. 1110. Did you ever see the jeweler, or give him any instruction?

A. No, sir.

X Q. 1111. Who paid the jeweler?

A. I paid out for all the work.

X Q. 1112. Now, have you any bill, check, voucher, or memorandum that would either enable you to state who the jeweler was, or refresh your recollection as to who he the jeweler was, or refresh your recollection as to who he was?

A. I have lost my memoranda of those payments, or mislaid them so that I cannot find them.

X Q. 1113. Do you remember about what the bases and holders cost?

1343 A. I do not.

X Q. 1114. Now, I understand it was with these bases and holders, and with a Florence flask as a globe, that you ran your first conductor to incandescence in Centre street; am I right?

A. Yes.

X Q. 1115. How long was it before you either had made, or made other bases or holders than these?

A. I cannot recollect, but it was within a week, I think.

X Q. 1116. Then you think you used these, and only these, during the first week you were in Centre street?

A. No.

X Q. 1117. Defendant's Exhibit Man sketch shows a distinct type of apparatus with very carefully prepared base and holders, and this, I understand, was the first apparatus you used. Now, when did the first modification of, or departure from this apparatus take place, and what was the modification and departure?

A. Instead of the Florence flask we used a straight glass tube with a metal cap at either end, the conductors screwed into the metal caps on the inside, the caps cemented to the tube and the incandescent conductors extending from the end of one holder to the end of another.

X Q. 1118. Please illustrate by a sketch.

(Witness makes a sketch.) Same offered in evidence and marked Defendant's Exhibit Man Sketch No. 2, Oct. 11, 1887.

Adjourned till Wednesday, 12th inst., at 1 p. m.

1344 WEDNESDAY, *Oct. 12th*, 1887.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination — Mr. MAN proceeded as follows:

X Q. 1118½. In this sketch No. 2, how was the incandescent conductor attached to its supports?

A. It was stuck into one end of one support and the other support was pressed up against the other end, small holes or depressions being made in the ends of the supports to receive the ends of the carbons.

X Q. 1119. Were the brass caps used in this second apparatus, parts of the brass bases to which you have referred, or were they made specially for this second apparatus?

A. I think they were made specially.

X Q. 1120. When were they made—before you went to Centre street, or after?

A. I think afterwards.

X Q. 1121. Were they colored afterwards or before?

A. I cannot say.

X Q. 1122. Were they ordered after the first apparatus had been tried?

A. My impression is they were. I cannot positively say.

X Q. 1123. Is it then your best belief that they were ordered after the Exhibit No. 1 had been tried?

A. Yes.

X Q. 1124. In the apparatus shown in Exhibit No. 1 did you try other atmosphere than illuminating gas?

A. Yes.

X Q. 1125. Did you try a vacuum?

A. My impression is that we did; I am not positive.

X Q. 1126. Was it after you had experimented with the
1345 apparatus of Exhibit No. 1, employing as its atmosphere
something other than illuminating gas for exhausting chamber, that you ordered the parts for apparatus No. 2?

A. No, I should think not.

X Q. 1127. Do you — that the parts for Exhibit No. 2 were ordered before you had tried the apparatus of Exhibit No. 1 with an atmosphere other than illuminating gas?

A. Yes, I think they were.

X Q. 1128. What was the object, or what suggested the making of this apparatus in Exhibit No. 2?

A. I have no recollection, but from the difference between the two apparatus, it is evident that the second apparatus was made to avoid any insulation of the leads and conductors other than the glass of the tube or globe.

All after "recollection" defendant's counsel will move to strike out as incompetent.

X Q. 1129. I understand you then to argue that the object of making this second apparatus, as you state, was that you have no recollection now as to why you made it?

A. I make no argument upon the matter. I simply state that the apparatus itself shows the object sought in its construction.

X Q. 1130. The trouble is we have not got the apparatus; I understand you to remember what the apparatus was, but to have entirely forgotten why you made it?

A. My sketch shows the apparatus, and illustrates the point of avoidance of insulation of the conductors, or either of them, by any means other than the glass tube or globe.

X Q. 1131. And you therefore think this must have been its sole object, and you now have no recollection of its having been made for any other purpose?

A. That, I think, is correct.

X Q. 1132. Who made the brass caps and holders for this apparatus?

A. That I don't know.

1346 X Q. 1133. Were they made in the shop, No. 43 Centre street?

A. No, I think not.

X Q. 1134. Have you no recollection whatever as to who made them, or where they were made?

A. No.

X Q. 1135. Who gave the order or instructions to the mechanic who made them?.

A. I believe Mr. Sawyer did.

X Q. 1136. Who paid for them?

A. I paid for everything.

X Q. 1137. Did you pay directly or give Sawyer the money?

A. I don't know. The manner of payment of things was, either to hand Mr. Sawyer the money when he showed me the bills, or to send the money by a messenger with the bills to make payment. Sometimes and frequently Mr. Sawyer paid bills as the things were sent into the shop, made memorandum of the payments he made, and afterwards I gave him the money for them.

X Q. 1138. Have you any voucher, paper, receipt, check, or anything that would show or aid you in remembering by whom or where the caps and holders of the apparatus shown in this exhibit were made?

A. No.

X Q. 1139. Did these holders have platinum tips?

A. I think they did, but I am not certain.

X Q. 1140. The holders used in this apparatus were not, or were they, the holders of the first apparatus altered?

A. They were not, I think.

X Q. 1141. Who made the holders and put the platinum tips upon them?

A. I don't know; my impression is they were made at the shop.

1347 X Q. 1142. Now, as the caps and holders had to be specially made from drawings or instructions, can you tell me how long it was after they were ordered before they were delivered?

A. No; a very short time, however.

X Q. 1143. When you say "a very short time," what do you mean?

A. A day or two; or two or three days.

X Q. 1144. When did you get the glass tubes that were used in this exhibit?

A. My recollection is that it was a piece of a large glass tube about an inch and a quarter in diameter, which I had at my house: we cut it into two pieces, I think, at the shop.

X Q. 1145. The cap must have been made with reference to the size of the tube, must it not?

A. Yes, I think they were.

X Q. 1146. Was more than one apparatus of this kind made or did you order the parts for more than one?

A. Yes, we had two sets, but I don't think we ever used or set up but one.

X Q. 1147. What was the next departure or modification in the way of apparatus in which a conductor was run to incandescence?

A. I cannot pretend at this time to give the order with exactness in which different things were done. I remember getting from Haggarty Brothers in Platt street, some glass globes with a neck and flange at the bottom end, and with stoppers in them level with the flange, ground and fitted. These glass stoppers we ground or had ground more nicely by a glass-cutter in Chambers street, and I took them to a diamond-cutter in Ann street and had them perforated for the conductors. I think that this was the next thing after the Florence flasks and tube—I have mentioned calling the globes which I had blown over in Brooklyn in the shape of Florence flasks substantially, Florence flasks.

1348 X Q. 1148. You speak of globes you had blown over in Brooklyn. To what are you referring, globes used in Exhibit No. 1?

A. Yes, I have spoken of them before in this examination.

X Q. 1149. I was not aware that you had had special globes blown for the apparatus in Exhibit No. 1. Were these globes ordered before you went to Centre street?

A. No, I think not.

X Q. 1150. Were they ordered before or after the metallic bases of Exhibit No. 1 were ordered?

A. After.

X Q. 1151. After they were delivered?

A. Yes, after they had been delivered, and the lamps run.

X Q. 1152. These globes must have been made with reference to the size of the base, must they not?

A. Yes.

X Q. 1153. Did you take the base over to the glass-blower?

A. Yes; the ring of one of the bases.

X Q. 1154. Who was the glass-blower from whom you ordered these globes?

A. I can't remember his name. The factory was in First street, or the continuation of First street, east of South Fourth street; I may not get the names of the streets right, but that indicates the location; three or four blocks to the right, as you cross from New York, by South Seventh-street ferry.

X Q. 1155. Can you ascertain the exact situation of such factory, and if you can will you do so?

A. I cannot do so without going there specially. The factory is there; anybody can find it. It is or was a large glass factory.

1350 X Q. 1156. In your 1147th answer you have described the third form of apparatus used. Please illustrate the same by a sketch.

BROADNAX & BULL.
COUNSELLORS AT LAW,
120 Broadway,
NEW YORK.

Especial attention given to the Law of Patents.

AMOS BROADNAX
J. EDGAR BULL.

A. Glass vessel
B " Stopper
C Tube
D outlet
E carbon

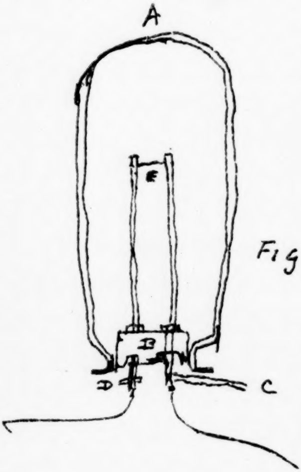
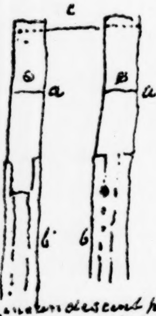


Fig 1

Fig 4



c. incandescent pencil
a. a carbon holders
b. b. metal conductors

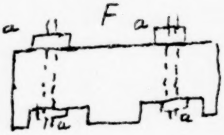
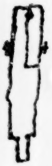


Fig 2

Enlarged view of glass stopper
---- perforation
a nuts

A
Fig 4. Side view



Defts Exhibit
Man ~~Exhibit~~ Sketch no 3
Oct 12 1887

No 286.
E. Light Co.
v.
McK. Light Co.
p. 1349

(Witness makes a sketch.) Same offered in evidence, and marked Defendant's Exhibit Man Sketch No. 3, October 12, 1887.

(Here follows diagram marked p. 1349.)

X Q. 1157. Did you order from Haggarty Bros. more than one globe and stopper as shown in this Exhibit No. 3?

A. I bought them ready made.

X Q. 1158. Do I understand that they were articles in stock?

A. I found them there and bought them.

X Q. 1159. Do you know whether they were articles in stock or had been ordered for some special purpose?

A. I assume that they were articles in stock or articles like some that had been ordered from them. They were articles such as are used in the windows of shops to exhibit oils, seeds and chemicals.

X Q. 1160. Were they then like bottles that could stand on their ends and had a glass stopper fitted into a flange and which could be inserted and removed?

A. Yes; except that I don't know that they had glass stoppers fitted to them; I think they had not when I bought them.

X Q. 1161. How many did you buy?

A. Three or four.

X Q. 1162. In your 1148th answer you say you ground or had ground the glass stoppers more nicely by a glass-cutter in Chambers street. What is your recollection, that they were ground by you in Centre street, or had them ground by the glass-cutter in Chambers street?

A. We had them ground by the glass-cutter I have mentioned.

X Q. 1163. So as to make a better fit?

A. Yes.

1351 X Q. 1164. Who was the glass-cutter?

A. I don't know his name. His place was on the right side of Chambers street going east, a little way from Chatham street—a block or two.

X Q. 1165. Did you take them to the glass-cutter?

A. Yes.

X Q. 1166. How did you find him, by looking up at the signs, or were you sent to him?

A. No; somebody told me of him.

X Q. 1167. Do you remember who told you about him?

A. No.

X Q. 1168. Who was the diamond-cutter in Ann street?

A. I don't know his name.

X Q. 1169. Whereabouts in Ann street was his place?

A. On the right-hand side going from Nassau to William, up four or five flights of stairs.

X Q. 1170. How did you find this diamond-cutter? By looking at signs, or were you sent to him?

A. I found him out by inquiring among the jewelers.

X Q. 1171. Did you buy these bottles and stoppers, take them to the glass-cutter and have them cut by the diamond-cutter the same day?

A. No, I think not. I bought them and took them to the glass-cutter, I think, in the afternoon of one day, and the next morning took the stoppers to the diamond-cutter and got the stoppers from the diamond-cutter the same day I took them there. The diamond-cutter had done work for me before. I did not find him out for this work.

X Q. 1172. You say this diamond-cutter had worked for you before. Now can't you tell me his name?

A. No; he was perhaps more properly a lapidary than a diamond-cutter.

1352 X Q. 1173. I presume you must have had the holes cut through the base with reference to the size of the tubes or conductors passing through the base?

A. No; I think we adapted the conductors to the holes, the holes being all of one size and about three-thirty-seconds of an inch, as I recollect it. The leading-in conductors were hollow.

X Q. 1174. What supports for the carbons did you use in this apparatus? and who made the tubes and stop-cocks?

A. I don't remember any stop-cocks in connection with it. The conductors were tubular, flattened together at the upper end and brazed, with an orifice below the flattened portion. We may have had stop-cocks on them, but I think not. I think we pressed them together and soldered them up. The carbons were held at first, as in the first lamp I mentioned, by the spring of the conductors. We bought pieces of tubing, threaded them, put nuts on them, and did the work in the shop. We afterwards modified the manner of holding of carbons, both in these lamps and in the ones I first described.

X Q. 1175. Do I understand that all the metallic work of this apparatus was made in 43 Centre street?

A. Yes, I think so; there was not much of it.

X Q. 1176. Who did the mechanical work?

A. I think old Mr. Sawyer did it.

X Q. 1177. Where did you get the tubing?

A. At Frasse's, I think. He has two places. I cannot tell which it was; we bought things at both. One was in Fulton street, the other was in Chatham.

X Q. 1178. What kind of tubing was it?

A. Brass tubing in stock, all sizes.

X Q. 1179. Now, in apparatus No. 3, none of the parts of the previous apparatus, as I understand, were used?

A. None, unless the carbons.

1353 X Q. 1180. What was the object or design of this third form of apparatus?

A. To obtain a better sealed chamber of glass than with the brass caps, and avoid insulating either of the leading-in conductors otherwise than by the glass through which they passed. The form of the stopper and neck, in which it was placed, enabled us to cover the whole with sealing wax, which we did. Another object was to avoid separation of the parts by unequal contraction or expansion by heat, by making them all of glass.

X Q. 1181. What was the next form of apparatus used in your experiments at 43 Centre street?

A. A slight modification of this by closing up one of the tubes of the leading-in conductors at the lower end, leaving only one opening into the lamp. This was to enable us to charge the lamp by first exhausting and then allowing the gas to flow into the exhausting lamp, the open tube being branched outside of the lamp and fitted with stop-cocks for that purpose.

X Q. 1182. How many separate and entire apparatus of the kind shown in Exhibit No. 3 were made?

A. I think, of that exact kind, only three or four.

X Q. 1183. What was the next apparatus in which a conductor was run to incande*n*scence at No. 43 Centre street?

A. Another modification of this last, which consisted in using iron wire for conductors, with a shoulder coming down upon the glass stopper inside the lamp, accurately fitted to the hole in the stopper, and with nuts at the lower side of the stopper, and one of the conductors was drilled out at the lower end to make it a tube opening to the air, and a hole drilled into this tube on the side of the conductor in the lamp.

X Q. 1184. Did you use for this modification globes and stoppers bought at Haggerty's?

1354 A. Some of them, and some of them we broke and bought others.

X Q. 1185. Were the others of the same kind, and procured at the same place?

A. No; I think I bought all Haggerty had the first time, and I got others, but I don't remember where.

X Q. 1186. Did you have the stoppers for these new bottles reground and holes drilled in them?

A. No; I think they were of smaller size in the neck and we had the same stoppers, so far as they were not broken, reground into the new bottles.

X Q. 1187. Who did this regrinding?

A. This same man in Chambers street. I also got new stoppers for some that were broken and had them perforated by the same lapidary.

X Q. 1188. Who did the work in the metallic work on this modification?

A. I think old Mr. Sawyer. I have no definite recollection. It might have been he or Mr. Sharp.

X Q. 1189. What was the next form of apparatus?

A. Still another modification of this, in having the glass stoppers shouldered so that the shoulder would rest on the end of the neck of the bottle, so that atmospheric pressure when the atmosphere was exhausted from the bottle or globe would not force in the stopper and split the neck of the bottle.

X Q. 1190. These stoppers with shoulders must have, as I infer, been specially made. Who made them?

A. The same glass grinder or cutter in Chambers street.

X Q. 1191. You must also, I take it, have bought new stoppers?

A. We only made one of them, as I recollect; it may have been two, at most three.

X Q. 1192. These stoppers must also have had holes cut in them for the leading-in tubes; who cut them?

1355 A. The same lapidary perforated this stopper.

X Q. 1193. What was the next modification?

A. To use a plate of glass perforated for the conductors and ground and fitted to the flange of the globe, or bottle as you call it, instead of the stopper.

X Q. 1194. Was the plate of glass especially made and ground?

A. No, not at first; we used pieces of plate glass for the purpose, and ground them with the flange until they were fitted tight.

X Q. 1195. Who made the perforations in the plate glass for the conductors?

A. We made them ourselves.

X Q. 1196. In what way?

A. In a lathe revolving a drill made of a copper tube, and using emery.

X Q. 1197. Who did this work?

A. Some Mr. Sharp did, and some old Mr. Sawyer did; some of it I did myself.

Adjourned until Thursday, the 13th inst., at 1 p. m.

1356 THURSDAY, *13th October*, 1887.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. MAN was continued as follows:

X Q. 1198. Was this work done in your shop at 43 Centre street?

A. Yes.

X Q. 1199. How many of such pieces of plate glass were so ground and perforated?

A. I think all our bases which we used on our lamps at 43 Centre street were made of plate glass, but I may be mistaken in this, and it may be that some of them were blown in moulds while we were there. My recollection in regard to the matter is not distinct, and, therefore, I cannot state the number; we had several dozens of them perforated by Mr. Sharp at his shop in Brooklyn; they were of different sizes.

X Q. 1200. You have not understood my question; in Exhibit No. 3, as one of its modifications, you have said the glass globe or bottle was placed upon a piece of plate glass, holes or perforations being made in the plate glass; what I wish to know is, how many pieces of plate glass were perforated for this specific modification of the apparatus referred to?

A. I think only three, or at most four.

X Q. 1201. Have you described all the modifications made up to this time, in the apparatus referred to in Exhibit- 1, 2, and 3?

A. No, I have latterly followed out the modifications in the glass simultaneously, and other modifications were made in the holders of the incandescent burners.

X Q. 1202. Well, what were those modifications?

1357 A. The metal tops of the holders were cut off and pieces of carbon rod, in some cases square, and in some round, were substituted for the metal tops of the holders; at first these were fastened to the leading-in conductors by being wired to them, afterwards by drilling the metal tops of the holders and inserting the rods of carbon into the hole thus drilled in the metal, so that the carbon tops of the holders extended above the metal of the leads or leading-in conductors. At first the carbons of the incandescent conductor were inserted at their ends in pits drilled in the carbon-holder, that is, the opposing faces of the carbon-holders had depressions in them in which the ends of the incandescent conductor which extended between them were inserted, thus supporting the incandescent conductors. Afterwards a groove was made across the top of the carbon-holders sufficiently deep to receive the incandescent conductor, which was laid in this groove across the tops of the two holders and packed in with powdered carbon; with this form of holders carbons of an arch shape were used, rising above the tops of the holders; a modification of the tops of the holders was also made, omitting the grooves just mentioned and making grooves in the tops of the holders at right angles to those last mentioned, to receive the ends of flat arch-shaped conductors.

Another modification was made in the tops of the conductors by omitting the grooves and filing notches out of the inside tops of the opposing conductors to receive flat arch-shaped conductors.

Another modification was to split the tops of the carbon-conductors to a depth of about three-quarters of an inch, more or less, cut off one side of the top of each conductor, drill through the remaining portion of the top and the piece cut off, insert in the drill-hole a small bolt with a nut, so that the piece cut off could be used with a bolt and nut as a clamp for holding the ends of the conductors.

Where straight round pencils of carbon were used for the
1358 incandescent conductor, the parts were clamped together and
holes drilled in the slit close to the tops of the conductors a little less in diameter than the carbon pencils, so that they could be clamped in the conductors by tightening the screw-bolts, thus, as shown by Fig. 4 and Fig. 4 (A) of Exhibit 3, which figures I have just drawn on said exhibit.

Another modification, where other than ordinary illuminating gas was used as an atmosphere, was to first run the incandescent conductors after being placed in the holders, and after the whole interior works of the lamp were set upon the plate-glass base—was to run these conductors up to the high incandescence in an atmosphere of hydrocarbon, usually illuminating gas, first to heat the conductors, and second, by deposit of carbon, to perfect their electrical connection with the holders, then to take off the globe of the lamp, leaving the works all attached to the glass base, and cleanse and purify all the parts, including the globe, set them up in the globe again and charge the lamps with the atmosphere or vacuum we wished to use.

Still another modification was the introduction of spirally wound leading-in conductors, the convolutions of one conductor laying between the convolutions of the other conductor, making a double spiral tube, with short, straight ends to the conductors, which passed through the glass bases of the lamp, and short, straight ends at the tops electrically connected with the carbon holders of the incandescent conductors, the tops of the spiral conductors being held in place by a clamp electrically insulated from them. Following this clamp was the diaphragm of soapstone or other insulating material shown in our first lamp patent, at first used for the same purpose of supporting and clamping the spirally formed leading-in conductors. At the same time that we were using and setting up the Florence flask and seed vessels, or sample holders for globes I procured from Mr. Hahn, a glass-blower in North William street, near Chatham, several straight glass tubes closed at one end and 1359 open and with flanges at the other end. These were used simultaneously as globes for our lamps with the Florence flasks and with the seed bottles or sample holders, using with them plate-glass bottoms perforated as I have described. Simultaneously with the introduction of the plate-glass bottoms, were introduced metal clamps to fasten the globes and plate-glass bottoms together. Several modifications of these clamps were used, finally resulting in metal rings, one above the flange of the globe and one below the plate-glass bottom, through which screws were passed outside of the flanges and plate glass, to fasten them together. In cases where the tops of the globes were larger than the diameter of their flanges, the upper ring above the flange was made in two parts overlapping one another and halved together, so that they could be put upon the flanges and make one continuous ring, when applied and screwed down to the lower ring. Now, I have spoken only of the apparatus of the lamp.

X Q. 1203. Were all those modifications which you have rehearsed at such length performed with the Florence flasks, purchased on the day you went to Centre street, and the three or four seed bottles purchased at the time you have mentioned?

A. All the apparatus which I have mentioned was made and modified, as I have stated, while we had in use Florence flasks and seed bottles, so-called, as globes for our lamps, and while we had in use at the same time we had in use for globes for our lamps the tubular globes which I bought from Mr. Hahn, as I have stated, and while we had in use globes which I procured to be blown at two glass factories in Williamsburg, Brooklyn. We had all four kinds of globes, which I have mentioned, and also Florence flask globes, or globes of the general shape of Florence flasks which I had blown at the glass factory I have mentioned in Brooklyn, all at the same time.

1360 X Q. 1204. When we adjourned yesterday, as I understood, the only globes you had referred to were the Florence flasks, bought by you on the day you went to Centre street, the piece of tubing you brought over from your house, which was used in the second exhibit, the three or four seed bottles that you bought at Haggerty's, and the others referred to in your 1188th answer, and a few globes like Florence flasks, which you had made at the glass-house in Williamsburg the only stoppers, were those ground by the glass grinder or cutter, whose name and place of business you have forgotten, and which were perforated by the diamond-cutter or lapidary to whom you referred. You also mentioned that you yourselves cut holes in a piece of plate glass as a base. The only metal parts you had got were those bases and parts you had ordered before you went to Centre street, and the caps and holders for the apparatus of the second exhibit which were made for you. Now, in the numerous experiments to which you have referred in your answer to the 1202nd cross-question, were none other than these globes and bases or caps used?

A. I have already stated that glass bases were used. No other metal bases like those we ordered before we went to Centre street were used, at least not to my present recollection; but other globes than those that I mentioned yesterday, and other than any I have mentioned to-day, were used by us while the modifications and changes I have mentioned were being made, and while still the Florence flask lamps and the seed-vessel globes were being made by us.

X Q. 1205. What I would like to know is, whether any metal base other than those made by you before you went to Centre street, or made after you went there for the apparatus of the second exhibit, were used in the series of experiments mentioned in your answer to the 1202nd question?

1361 A. I do not recollect any others until outside metal covers, spun caps, for the whole base of the lamp were used by us, and these were later on.

X Q. 1206. Did you use other glass stoppers or bases than these few you have described? I understood you only to have referred up to the present to the stoppers ground by the glass-cutter in Chambers street, and perforated by the lapidary in Ann street, on the one occasion you went to these places, some pieces of glass perforated by Mr. Sharp, and the pieces of plate glass which you yourselves perforated and ground, by rubbing the flask or bottle upon the glass, it first being powdered with emery?

A. I will state the fact, and if I have not stated it before, or have not made myself clear, this will be a correction. At first we got a few pieces of plate glass, some of them cut in circles, and some square. We perforated, or got perforated for the conductors, one of these. We ground the face of the flange on one of the seed bottles, on a lap or face plate, with emery, to make it level and true, until we got it substantially polished. The plate glass was already true and polished. We then ground the flange and plate glass together until their junction was air-tight. We then set up a lamp upon it—the internal parts of a lamp. After this we got more pieces of plate glass at different times. We perforated and ground some of them ourselves, and Mr. Sharp perforated and ground a large number of them at different times for us. There were only comparatively a few of them used upon the seed-vessel lamps, so called; a much larger number being used upon globes of other forms, such as the tubes I got from Mr. Hahn, like big test tubes, and other globes of which I have not yet given an enumeration.

Adjourned till Friday, the 14th inst., at 10 a. m.

1362 FRIDAY, *Oct. 14th*, 1887.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. MAN proceeded as follows:

X Q. 1207. What are the globes to which you last referred and where were they bought?

A. I got them blown at two glass factories I have mentioned in the eastern district of Brooklyn, Williamsburg. They were like the tubes I bought of Hahn with a flange at the bottom, open at the bottom, parallel sides rising from the flange and a bulb blown at the upper end which was closed. They were similar in shape to a broken globe, an exhibit in this case heretofore introduced and marked "Exhibit No. 29, globe of lamp produced by Albon Man, April 15th, 1887."

X Q. 1208. How many about of these were bought?

A. I can't tell; I have no distinct recollection in regard to numbers. It was a large number, I think more than a hundred; I can't be certain. At first, a few only, and afterwards more and more.

X Q. 1209. These were specially ordered, as I understand?

A. Yes, and they were of varying proportions and sizes and shapes, but the Exhibit Broken Globe is a type of them.

X Q. 1210 Am I correct in understanding, that in all the apparatus to which we have been referring the incandescent conductor extended across, from or near the tops of two parallel supports or leads, running perpendicular to the base of the lamp, as shown in substance in Exhibit No. 3?

1363 A. Yes, as shown in substance in Exhibit No. 3, but in this exhibit the incandescent conductor is shown as extending straight across from one holder to the other; in some of our lamps of this type this conductor was of an arched or circular form rising above the tops of the holders.

X Q. 1211. Now as I understand, before you went to Centre street you ordered in the neighborhood of ten metal bases which had been delivered on the 6th or 7th of March, and that you, on the same day or evening of the day previous, bought between half a dozen and a dozen Florence flasks to use as globes with these caps, and that you also had had made the supports or holders for the conductor, so that on the first day or two after going to Centre street you had these parts ready to assemble?

A. Yes, we bought the globes on the evening previous and we had the parts all ready to assemble when we went there.

X Q. 1212. Did you have any carbon conductors ready to put in these parts?

A. Yes.

X Q. 1213. Conductors made previously to going to Centre street, or after you were there?

A. I think the conductors were bought by Mr. Sawyer before we went to Centre street, but it may have been on the morning of the day we went there.

X Q. 1214. Did you put these parts together on the first day and run the conductors to incandescence?

A. Yes, Mr. Sawyer and his father did, and I was present when the current was turned on to the lamps.

X Q. 1215. Was more than one so-called lamp made that day and run to incandescence?

A. Yes, six or eight of them; as many as Mr. Sawyer and his father could get ready were lighted up.

X Q. 1216. What atmosphere was used on this day?

A. Simply illuminating gas.

X Q. 1217. What was the kind of carbon used on this first day?

1364 A. Small pencils cut from rods of French carbon about the diameter of the smallest knitting needles, perhaps less than that; rods of that diameter.

X Q. 1218. And these, as I understand, had been cut to the desired size so as to be adapted to the other parts of the lamp which had been previously ordered, and that all that you had to do on this day was to put the parts together?

A. The carbons were already of the desired diameter and only required to be cut off of the length we wished to use; and the ends were cut, smoothed off. I think this cutting off was done by Mr. Sawyer as the lamps were set up.

X Q. 1219. Will you please describe the construction and material for the supports for the carbons? I mean the leads in this apparatus.

A. They were made of copper rods, screw-threaded at the lower end; were attached to the base and hammered out flat at the upper ends and filed off to be of the same width after hammering flat as the diameter of the copper rods. One was simply screwed into the inside of the base, the other passed through an insulation in the base, had a hole through it in which to insert the electrical connecting wire outside the base with, I think, a binding screw to hold the wire. They were between a quarter of an inch and half an inch in diameter and the flattened part at the upper ends was about an eighth of an inch or less in thickness; I have mentioned the facing of these leading-in conductors with platinum at the points where they held the ends of the incandescent conductors; I think this platinum facing was not on the first holders that we used, but was put on almost immediately after first using them; these leading-in conductors or holders were about six inches in length inside the globe.

X Q. 1220. How long did you use these apparatus before any change whatever was made in the construction of the caps, carbons or holders?

A. I cannot recollect how long; I think the first change 1365 we introduced in that kind of apparatus was the facing of holders with platinum; this was done almost immediately, in a day or two.

X Q. 1221. With the exception of the facing the supports with platinum, did you try these apparatus without change of any kind for two or three days?

A. Yes, I think so, and longer, but am not certain.

X Q. 1222. In running these conductors to incandescence did you use the arc-light machine in the basement?

A. Yes.

X Q 1223. What trials, tests or experiments did you make to ascertain the efficiency of these apparatus and their parts, and what did you conclude from these tests?

A. We lighted them up and at first the carbons soon fell out of the holders. We discovered that the copper holder was fused where it touched the incandescent conductor. We, therefore, faced them with platinum which only melts at a very high heat. After we had done so, we discovered that a deposit of carbon was being made upon the incandescent conductors from the hydrocarbon gas, at first hard and dense, and as the deposit went on and the incandescent conductors increased in size their resistance was decreased, and the deposit became sooty and loose, and grew rapidly to such a size that the carbons were no longer luminous. We coupled them up in series, and in single multiple arc and in multiple-arc series, to see which was the best method of coupling with the current we were using. I do not now recollect anything else. Yes, I do recollect something else. The dynamo was run from an engine, driving all the machinery in a very large building. It was driven faster or slower, as more or less work was done in different parts of the building, and we discovered that its electro-motive force was very variable, and that some regulation was needed. We discovered that the electrical connection between the holders and the incandescent carbons was not suitable, and that with the variable electro-
1366 motive force of the dynamo machine an electric arc was liable to form at the points of junction between the incandescent conductors and the holders, by which the holders were fused and the carbons dropped out.

X Q. 1224. Was this last before you had the holders faced with platinum?

A. Both before and after.

X Q. 1225. Do I understand then that the first defect in the construction of the apparatus you ascertained was the heating of the copper holders at the point where the carbon was inserted in them?

A. Yes, that was the first, I think.

X Q. 1226. And to obviate that you had the holders faced with platinum?

A. Yes.

X Q. 1227. Now, about how long from the time you first run the lamp did you notice this defect and determine to try the facing of the holders with platinum?

A. I think it was the first day we run them. It was almost immediately, I think, after we commenced lighting the lamps.

X Q. 1228. As I understand you, then you went out and got some platinum and had the holders faced. Did you use the same holders as had held the conductor when incandescent, or did you get new ones made?

A. Used the same holders.

X Q. 1229. Who was it that faced the holders with platinum?

A. I have already told you that I don't know.

X Q. 1230. In what form did you buy the platinum?

A. I do not remember; either in wire or a straight flat strip, I think.

X Q. 1231. About how long was it before you received the holders, tipped with the platinum, and put them in the apparatus?

A. I cannot tell. My best judgment in regard to the
1367 thing is, that perhaps only one pair of holders was first tipped
with platinum, and afterwards the others. Looking back upon the matter now, I should think that we had one or more pairs of holders tipped and put to use the next day after we got there, but it would not surprise me if told by some one who absolutely knew, that it was several day- or a week; I do not think it was as long.

X Q. 1232. It was Sawyer that got the holders tipped with platinum, was it not, or was it yourself?

A. I think it was Sawyer.

X Q. 1233. As I understand, you found that the platinum also heated and fused?

A. Yes.

X Q. 1234. What did you then do to correct this defect?

A. We introduced a side circuit, or circuits with a switch, to turn more or less resistance into the side circuit, so as to turn more or less of the current into the lamps, and in some measure compensate for, or regulate the variable current coming from the dynamo, so that we would not get in the lamps at any time a current sufficient to fuse the platinum of the holders, or establish electric arcs between the holders and the carbon.

X Q. 1235. Did this have the desired effect?

A. Only partially, as it was not automatic.

X Q. 1236. This endeavor was not in improvement of the apparatus, but in the regulation of current; what did you next do in the way of alteration of parts, or modification of parts, to overcome the arc of heating at points of contact between the carbon and the holders?

A. I cannot at this length of time pretend to give with accuracy in their regular order of series, the different things that we did, and I wish to be understood in all my answers in that way. I give the next thing that now occurs to my mind. We cut off the metal tops of the holders, and substituted for the metal, carbon tops

1368 X Q. 1237. Were the lamps required to be run any time
to ascertain this heating of the holder at the points of contact with the carbon?

A. I think we discovered it almost at first.

X Q. 1238. Was a day, or two or three days required to convince you?

A. I think it was the first day.

X Q. 1239. As near as you now remember, how many days was it after going to Centre street that you tried putting carbon tops on the supports?

A. I can't tell.

X Q. 1240. Can't you tell me about?

A. I can only guess at it; I guess, a week, or more.

X Q. 1241. During the time that you were trying this first apparatus, and endeavoring to overcome the heating of the points of contact of the carbon at the holders, by trying platinum, and before trying the carbon tops, were you experimenting with other parts of the apparatus, the globes, bases, atmospheres or carbon?

A. Yes, I think we were.

X Q. 1242. Please tell me what parts you were experimenting with, what defects you had noticed, and how you endeavored to overcome them. I am referring to a period anterior to the time of the carbon tops.

A. We discovered in a day or two that the sealing of the lamps was defective. Leaving them standing over night charged with illuminating gas or hydrogen gas, I forget which, the current was turned on the next day upon one of the lamps, or more, and they exploded, showing plainly that they had taken in atmospheric air, which mixed with the atmosphere with which the lamp was charged, formed an explosive mixture, showing that the lamps leaked. This necessitated our frequently and continually renewing the atmosphere of the lamp, recharging it. The Florence flasks were too thin at their necks to be ground for stoppers; we
therefore got the seed vessels of which I have spoken,
1369 which were thick enough to be ground for glass stoppers,
as I have already described; we endeavored to remedy the production of the arc by inserting the ends of the carbon more deeply in the holders, and we endeavored to form a deposit of carbon at the ends of the incandescent conductors, to make better electrical connection between them and the holders. We packed around the ends of the incandescent conductors in the holders powdered carbon in a paste to make better connection; we enlarged the ends of the incandescent conductors by using larger carbon rods to make them, and working them down small between the enlarged ends; it is impossible for me to distinguish the globes or vessels in which these things were first done. I know we did them in the Florence flask which we first had and afterwards bought, or in some of the Florence flask-shaped globes which I had blown in the glass factory in Brooklyn, a sample of which I now produce; it is altogether probable, too, that some of these things were done, and I think they were, in the seed vessel globes I have mentioned. In this period anterior to the carbon tops we were endeavoring to get a better sealed lamp in the manner I have described; we were also endeavoring at the same time to get a better atmosphere for our lamps; we first used hydrogen for this purpose and next nitrogen;

we also pumped the lamps out before sealing them when filled with hydrocarbon or illuminating gas, to prevent the rapid deposit upon the incandescent carbons.

Adjourned till Monday, the 17th inst., at 1 p. m.

1370 MONDAY, *Oct. 17th*, 1887.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. MAX was continued as follows:

X Q. 1243. Is it your present recollection that while using the metal caps and apparatus of Exhibit No. 1, and before the glass stoppers were tried, instead of the caps, you deposited carbon around the ends of the incandescent conductor, or packed powdered carbon in a paste around the ends, or enlarged the ends of the carbon, as described in your last answer?

A. I think so, but at this length of time I cannot be positive in regard — it, except as to the deposit and enlarged ends; I feel confident that those things were done in the Florence flask lamps with the metal bases.

X Q. 1244. Is it also your recollection that while using the flasks and metal bases of Exhibit No. 1, and before the use of the glass stoppers, you had tried in the lamps of the flasks and metal bases, atmospheres of nitrogen and hydrogen and had also exhausted them with an air pump?

A. It is, according to the best of my recollection in regard to the matter, and I cannot pretend to be positive in regard to it at such a length of time, that before getting globes with glass stoppers we had exhausted the lamps, or partially so, by an air pump and had used the atmosphere of hydrogen. I cannot remember the order of events well enough to say whether or not we used nitrogen up to the time we got the lamps with glass stoppers.

X Q. 1245. Then while still using the Florence flasks and metal bases of Exhibit No. 1, and before trying the glass stoppers, it is your present recollection that you had an air pump, or the use of one, and had obtained or made hydrogen?

1371 A. Yes.

X Q. 1246. With these flasks and metal bases and before glass stoppers were used or tried, did you try different kinds of carbon?

A. I don't recollect any; we may have done so; I think only the one kind of carbon; I recollect we used more than one kind with the first apparatus; we got some lead-pencil leads and baked them, and used, or tried to use, some of them.

X Q. 1247. Was the object of trying the glass stoppers, instead of the metallic bases, to obtain an apparatus which would better preserve the atmosphere of the lamp?

A. Yes; it could be better sealed up and better insulation of the wires from each other was obtained for the leading-in conductors.

X Q. 1248. When these glass stoppers were tried I also understand the supports or leads, as you call them, were made hollow and were used for exhausting or charging the globes?

A. Yes, with various modifications; this was first done in globes of that kind.

X Q. 1249. With the use, then, of the glass stoppers, I understand, three objects were had in view: one an apparatus better adapted for the preservation of the atmosphere within the chamber; two, the insulation from each other by the structure of the apparatus itself of the leads or supports; three, the use of these leads or supports in charging or filling the globe by having them hollow?

A. Yes, those are the salient points.

X Q. 1250. So far as the carbon itself was concerned, or the means of attaching the carbon to the supports, these points were independent of the other features of the apparatus of either Exhibit 1 or 3?

A. Yes, we might improve the interior works of the lamp and the incandescent conductor, using either.

1372 X Q. 1251. Do you remember whether you had succeeded in so attaching the incandescent conductor to the leads as that an arc would be prevented in the flask and metal base lamps, and before trying the glass stoppers?

A. You refer to the arcs at the ends of the incandescent conductors. Both kinds of these lamps were being run while this matter still troubled us. We did not consider it altogether due to the lamps, but to the want of regularity in the currents, and we had not got, up to the time of getting the glass stoppers, a regular current or a means of regulation sufficient to prevent this trouble; nor had we remedied it completely in any other way.

X Q. 1252. In the lamp of Exhibit No. 1 of the flasks and metal bases, had you found difficulty in insulating or preserving the insulation between the supports and the metal base?

A. Only mechanical, and the difficulty of sealing up due to the construction. It was a complexity of structure which we desired to avoid.

X Q. 1253. Now, in this apparatus of Exhibit No. 1 of the flasks and metal bases, you discovered, as I understand, two defects—one. the arcing at the point of contact of the carbons and the holders; and two, the difficulty to preserve an atmosphere. Was this apparatus sufficiently good as a lamp to enable you to make any tests of the relative efficiency of different gases as an atmosphere or the use of a vacuum?

A. Yes.

X Q. 1254. Did you make such tests?

A. Yes.

X Q. 1255. What were the tests?

A. We first used hydrocarbon gas—ordinary illuminating gas from the gas main. With such gas, I have explained that the deposit of carbon soon prevented the incandescence of the incandescent carbon. By pumping them out or exhausting them, we 1373 found that the incandescence was much longer preserved, but that with the vacuum we got, the atmosphere was still not appropriate. We next used hydrogen gas, because we had not nitrogen, and found it better than the hydrocarbon gas. We next, in these lamps, used nitrogen gas, and found it the best. We exhausted our lamps with all three kinds of the gas. We found that there was danger of explosion with the hydrogen and hydrocarbon gas. Perhaps it would be better to say that we knew this before, and found that there was danger of leaking, by which the explosive mixture would be formed. This, of course, did not exist with the nitrogen gas.

X Q. 1256. Did you ascertain these results by taking different apparatus of the character of Exhibit No. 1 and running them under the same conditions—that is, the same current, same carbons, same methods of attachment between carbons and leads, same leads, same forms of globes and bases, same methods of attachment between globes and bases, but different atmospheres or gases, including a vacuum?

A. With the hydrocarbon gas we set up all the lamps; charged them all with hydrocarbon gas; exhausted some; we run them all with the same current. The test for hydrogen gas was made by charging the same lamp with hydrogen instead of hydrocarbon and running them by the current and observing that no deposit was formed; the same with the nitrogen. I don't think we discovered any particular difference in these lamps charged with a hydrogen or nitrogen atmosphere, whether they were exhausted or not. We may have done so; but if so, I do not recollect it.

X Q. 1257. While, then, you did not determine in this apparatus what the most efficient atmosphere was, you did ascertain that these metal bases were not adapted to the preservation of any atmosphere?

A. We discovered that the construction was not suitable
1374 to the permanent preservation of any atmosphere, and we
proved that certain atmospheres were unsuitable, to wit,
hydrocarbon.

X Q. 1258. What was the longest time you succeeded in running at continuous incandescence a conductor in the apparatus of Exhibit No. 1?

A. That I cannot recollect; I kept no memoranda of it. I can only say that people came in to see the lamps, stopped there and watched their running as long as they wanted to, and then the lamps were put out.

X Q. 1259. Do you know of one ever having run at continuous incandescence as long as ten minutes?

A. Yes, and very much longer.

X Q. 1260. As long as an hour?

A. Yes; I think longer than two or three hours.

X Q. 1261. Did you ever make, while at 43 Centre street, a lamp containing the different parts described and shown in letters patent 205,144?

A. In detail exactly like that?

X Q. 1262. Yes.

A. I do not know; in detail similar to that, yes.

X Q. 1263. What parts in this lamp are you doubtful about being in the lamp substantially like the description in this patent?

A. I do not know that any part was omitted; if any, the part G, and I know that lamps were built by us there with the part G in them, in which the construction was not in all respects like this lamp.

X Q. 1264. In what respects did it differ?

A. At this length of time I cannot tell in what minute respects differences occurred in our lamps. In one lamp that I recollect, in which the part G was included, the leading-in conductors, instead of being separate spirals, were concentric spirals. In another, I remember straight leading-in conductors were used; in another, I remember conductors of flat metal, folded upon themselves. In another, I remember a spring used as a substitute for the 1375 weight of the part F. In a great many lamps I remember the omission entirely of G; some with springs substituted for the weight of F, and some in which the weight F was used. I remember a number in which neither springs nor weights were used as a substitute for weight F, in which the leading-in conductor with which F connects was made sufficiently flexible to allow the insertion of the incandescent carbon. So that it was held, you may say, by the spring of the whole leading-in conductor.

X Q. 1265. In the lamp of this patent, several differences and additions appear to have been made from the apparatus or lamps of Exhibits 1 and 3. The conductor is straight and perpendicular to the base of the lamp instead of being supported between two parallel leads. The leads are made spiral so as to give greater length. A soapstone disk to prevent downward radiation of the heat is introduced in the centre of the lamp and the base consists of several parts fitted elaborately together. Why were these modifications made?

A. They grew up through a long series of modifications from Exhibit 1, as you call it, for different purposes, and I doubt whether I can now recollect or recall all these changes, or the reasons for them moving us to make them. In fact, I know I cannot remember all. If you desire I will go on to state some of them; I have already mentioned how the diaphragm arose. I have also mentioned the substitution of carbon for metal in the connections with the incandescent conductor. I have also mentioned the clamping of the carbons of incandescent conductors in straight carbon holders, some straight and some arched, so as to rise above the ends of the holders. The arrangement in this lamp is evidently intended to allow for expansion and contraction of the incandescent conductor. The upright position of the incandescent conductor is evidently more favorable to the radiation of light from it in a horizontal direction than a horizontal position of a straight 1376 incandescent conductor, with its holders preventing radiation of light at the ends of such conductors in two directions, casting upright shadows. The diaphragm introduced first for support was supposed to prevent radiation of heat also from the base of the lamp where it was sealed up and where, by expansion and contraction, leaks were most likely to occur. The extended lengths obtained by convolution of the leads was intended to prevent conduction of heat to the glass base where it was sealed in the same. The construction of the base was intended to obtain perfect hermetical sealing of the lamp, so as to preserve its atmosphere uncontaminated.

X Q. 1266. This patent was applied for on the 16th of May, 1878. At this date you and Mr. Sawyer had about completed your experimental work at 43 Centre street, had you not?

A. I do not remember whether we had or not. We did some work there, how much I don't know, according to the best of my recollection, after the application for that patent; the great majority of the work we did was done before this time.

X Q. 1267. When you filed this application I understand you to have considered the lamp described in this patent an incandescent lamp adapted for use?

A. We considered that the lamp there described contained the elements of a practical electric lamp.

X Q. 1268. The lamp of this patent shows a straight carbon fed down upon the block D to compensate for fracture or slight consumption of the carbon. Had you found in your experiments with the apparatus of Exhibit 3, where the carbon was supported between parallel leads, that fracture or consumption of the carbon occurred?

A. In a great many cases the carbons were fractured, and in others some consumption at the ends occurred. In a great many other cases neither fracture nor consumption occurred in the incandescent carbons; the fracture and consumption were considered accidental by us, and it was to compensate, as far as possible, or provide against accident, that this provision in the lamp was made, and also to cover it, this feature, in a patent for a lamp. 1377

X Q. 1269. When you say in your last answer that you consider the fracture and consumption accidental, what do you mean?

A. That it ought not to occur in a well-constructed lamp, properly used and run, but that it was possible that it — occur through faulty construction or charging or accidental use of currents of too great a strengh, as happens to-day in incandescent electric lamps in both respects.

X Q. 1270. Were your lamps well constructed?

A. Yes.

X Q. 1271. Am I to understand then, that if the lamps were properly constructed, charged and run, as yours were, this fracture and consumption would not occur, but that if the lamps were improperly constructed, charged and run, it would occur?

A. I mean that it might occur with all the care that would be ordinarily bestowed in careful manufacture and charging of the lamps and in ordinarily careful use of the same, as it occurs to-day in the incandescent lamps now manufactured, and I mean in this to make a distinct admission that as much was not known then in regard to the manufacture of incandescent lamps as is to-day, nor of the life of a lamp which would render it commercially acceptable. We meant to provide against possible contingencies.

Adjourned till Tuesday, the 18th inst., at 10 a. m.

1378 NEW YORK, *Oct.* 18*th*, 1887.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. MAN continued as follows:

X Q. 1272. I do not quite understand from your previous answers whether, prior to May 16th, in lamps where the carbon conductor was supported by parallel leads, you had or had not been able to prevent fracture or consumption of the carbon conductor at the point of contact between the conductor and the leads?

A. In some case we had, and in some cases there was fracture, and in some cases consumption.

X Q. 1273. You say that in some cases fracture and consumption did occur and in others not. Had you found any means by which sufficient good contact could be obtained to prevent fracture and consumption?

A. Yes; we did not attribute the fracture to the points of contact; nor did it frequently occur there; nor did we attribute the consumption to the points of contact, but to impurity of the atmosphere of the lamps ordinarily; or, in cases other than that, in using too great current, so as to cause arcs where they would not occur with a proper current. In other cases, fracture occurred by the putting of too great tension, or pressure, upon small carbons.

X Q. 1274. I do not as yet understand you. When you began your experiments, one of the first difficulties you encountered was destruction of your carbons, by consumption or fracture, at the points of contact between the carbons and the holders. In your first patent for a lamp, filed May 16th, in enumerating the reasons why, up to your time, no lamp had as yet been devised which would be practically operative, you say:

1379 "Third. The unequal expansion of the carbon and its holders has resulted in fractures of the former, so that, however perfect the atmosphere in the globe, the lamp has never been permanent."

To obviate this defect, you describe in the patent a rod of carbon resting upon a block of carbon D, so held and arranged that as fracture or consumption occurs at the point of contact between D and A^1, the carbon is fed downward. This arrangement does not appear to be to prevent fracture or consumption, but to prevent the disastrous effects of such fracture and consumption, the patent seeming to state that fracture and consumption, by unequal expansion of the carbon and holders, cannot be prevented. Now, was it true, at the time you filed the application for the patent, that you had been unable to devise a method of rigidly holding the carbon conductors and of so connecting them as to prevent fracture and consumption?

A. You cannot expect me to answer yes or no, and so adopt your answer as my testimony in cases like this. You confound two separate and entirely distinct things and apply the wording of the patent to a matter to which it does not refer and then ask me to adopt your question and answer yes or no. I referred in my previous testimony, to which you refer in your question, to the imperfect electrical connections between the holders and the incandescent carbons the consequent formation of electric arcs, the consumption of the ends of the carbons, and melting away of the metal points of contact. Now, you confound this matter with a breakage expressed to be due, not at all to the difficulty to which I referred, but to the unequal expansions of the incandescent conductors and the leading-in conductors and to compensations for this latter difficulty, of which I have not before spoken at all. Again, you confound the kind of destruction or consumption at the ends of the incandescent conductors by the electric arc, of which I have spoken, with 1380 consumption, wearing away or oxidization of the substance of the conductor itself by reason of an imperfect atmosphere, of which I have not spoken. If you ask me the question without your premise, to which I am expected to assent in my answer, I will answer it.

X Q. 1275. Whatever the cause of fracture or consumption may have been—whether due to an arc resulting from imperfect contact, and thus consuming the carbon or metal, or a break or fracture due to unequal expansion or contraction of the carbon and holders—the result would be, would it not, the destruction of the lamp?

A. Yes, if the fracture occurred or the consumption took place, and if, also, there was no automatic compensation provided in the lamp by which the fracture or consumption could be remedied.

X Q. 1276. Now, in order then to rigidly connect the incandescent conductor to its supports and make this connection practical and durable, you would have to so connect them as to prevent fracture or consumption, whatever the cause might be, would you not?

A. Yes, so far as fracture or consumption are influenced by or depend upon the connections.

X Q. 1277. In patent 205,144 you state: "At the present day it is not new to produce a light by causing the electric current to heat a carbon conductor to incandesence in a vacu-m, or in nitrogen, or in other gas; but no lamp has yet been devised which would be practically operative, and for these reasons." You then enumerated as your reasons the following:

"First. The methods that have been employed for charging the lamp with the artificial atmosphere * * * are imperfect.

"Second. It has been found practically impossible, under the varying degrees of heat and pressure, to maintain perfect joints, and the result is that expansion of the artificial atmosphere by the heat from the luminous conductor expels a portion of the same, and 1381 the contraction of the atmosphere, upon cooling, causes a portion of the external air to penetrate the globe." * * *

The third reason you give, why no lamps has as yet been devised which had been practically operative, is that "the unequal expansion of the carbon and its holders, has resulted in fractures of the former, so that however perfect the atmosphere in the globe, the lamp has never been permanent."

Later on you say: "Our arrangement for avoiding fracture of the carbon will be fully described hereinafter."

The patent then describes a structure wherein the incandescent conductor is not final nor rigidly attached to, but rests and is held by pressure upon a carbon, block D, "with a mechanism by which, in the language of the patent, should fracture or slight consumption of the carbon occur at the first lighting, or any subsequent lighting of the lamp, the necessity of taking down the same, renewing the carbon, and recharging the globe, is obviated inasmuch as the weight of rod F gently forces the carbon through the clamp G until a new contact between E and D is established."

As this patent states, that however perfect the atmosphere in the globe, one of the reasons why a practical operative lamp has never been devised, is that unequal expansion of the carbon and its holders has resulted in fractures of the former and shows and describes no method by which a rigid or firm attachment between the incandescent carbon and its support can be made so as to avoid this fracture or consumption, but on the contrary describes an arrangement by which fracture or consumption is not prevented, but the destructive consequences are compensated for by new contact being made, I desire to know whether, at the time you filed this application, you had found a means of firmly and rigidly uniting the incandescent carbon conductor to its electrodes or supports, so that fracture or consumption would not occur?

1382 A. Up to the present time, so far as I know, no positively permanent incandescent electric lamp has ever yet been made. Among the reasons for this are those given in this patent. In answering this question, then, I must be understood as speaking relatively and use the word "permanent" in a relative sense. Using it in such sense, and meaning it permanent, I answer the question, yes, in at least two forms, one of which was intended to be shown in figure 8 of the patent, employing a straight pencil, and the other of which employed an arch form of incandescent conductors held between clamps and rising above the holders, in each of which the connections were rigid and packed with carbon or united to the holders by a deposit of carbon. It will be observed that in figure 8, by description, the clamp G is omitted.

X Q. 1278. You do not mean in your last answer to say that figure 8 of the patent shows a permanent attachment of the carbon E to the block D, or that the patent describes such a connection?

A. No, I do not know that it does. I referred in that figure merely to the form.

X Q. 1279. Do you mean by your 1277th answer to be understood as saying that at the time of the filing of this application, May 12th, 1878, you had devised a means of attaching the carbon conductor to its supports or holders so that fracture or consumption of the carbon would not occur?

A. Yes, any fracture or consumption due to imperfect connection between the incandescent carbon and its holders, or due to unequal expansion and contraction between the carbon and its holders to a practical extent.

X Q. 1280. If that be so, was not such a construction much simpler than the one shown in patent 205,144?

A. Yes, but it did not serve the same purpose as that described in the patent, and perhaps it was nothing new, except possibly the deposit carbon.

1383 X Q. 1281. Do you mean by your last answer that at the time you filed the application, means were known by which a rigid and firm attachment could be made between the carbon and its holders or supports, so that fracture or consumption would not occur by reason of defects in the joint?

A. Yes; or at least they were so simple that we supposed they must have been used.

X Q. 1282. Was it then true, as stated in the patent, that one of the reasons why no practically operative lamp had been devised, was fracture due to unequal expansion or contraction of the carbon in its holders?

A. Yes.

X Q. 1283. Was this statement in the patent intended as a historical statement of fact, or a statement that no fixed joint could be made in which fracture could not occur?

A. It was a statement simply of our views as to the cause of previous failures and in explanation of what we desired to remedy.

X Q. 1284. What made you think that one of the reasons of previous failures was due to fracture at the joint, if, as you have said in your answer to 1281st question, means were known by which a rigid and firm attachment could be made between the carbon and its supports, so that fracture or consumption could not occur by reason of defects in the joint, or were so simple that you supposed they must have been known?

A. I call your attention to the fact that the patent does not state that the fracture is due to unequal expansion of the carbon and its holders at the joint, but simply states that "the unequal expansion of the carbon and its holders has resulted in fracture of the former," omitting "joints." Answering your question directly, I have already stated in my testimony that we found that electric arcs were formed at the joints by reason of imperfect electrical connec-
1384 tion, resulting in the consumption or wearing away of the carbons at those joints. It was so obvious, I suppose, that we assumed that others had observed the same thing, if we did, but we do not state so in the patent, and I do not remember to have so testified.

X Q. 1285. You do state in the patent, do you not, as one of the reasons why no lamp had yet been devised which would be practically operative, that unequal expansion of the carbon and its holders has resulted in fracture of the former, so that, however perfect the atmosphere in the globe, the lamp has never been permanent?

A. Yes, and we show a means of counteracting the injurious effects of this unequal expansion and contraction.

X Q. 1286. In your 1283d answer you say this statement was a statement of your views as to the cause of previous failures and an explanation of what you desired to remedy. In your 1281st answer you say that at the time you filed the application you thought means were known, or they were so simple you thought they must have been known, by which a rigid and firm attachment could be made between the carbon and its holders, so that fracture or consumption would not occur by reason of defects in the joint. If, then, it was so easy to connect the carbons and holders so that fracture would not occur, why did you think that previous failures had been due to imperfect union?

A. I do not know that I have anywhere testified, and have not intended to do so, that previous failures had been due to imperfect union, and the patent does not so state, but that it is due to unequal expansion between the carbon and its holders, to wit, the carbon expanded more or less than its holders and was broken thereby, and not by imperfect connection.

Adjourned till Monday, the 24th inst., at 1 p. m.

1385 MONDAY, *24th October*, 1887.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. MAN was continued as follows:

X Q. 1287. Do I understand from your last answer that you mean to say, not that a fracture occurs at the joint necessarily by reason of the unequal expansion and contraction of the carbon and its holder, but that from this cause a fracture is liable to occur in any part of the carbon unless prevented by some proper means?

A. That is what I mean, especially if the carbon is rigidly held by the holders.

X Q. 1288. In the case of a carbon rigidly held by the holders, there are, as I understand you, two elements of danger to be guarded against: first, consumption of the carbon at the ends by the formation of an arc due to imperfect electrical connection or contact, and, second, fracture of the carbon at any point due to inequality of expansion and contraction of the carbon and its holders?

A. Yes, those dangers exist.

X Q. 1289. Now, this patent 205,144, in describing the device or mechanism for feeding the carbon rod down upon the carbon block, states "thus should fracture or a slight consumption of the carbon occur * * * the necessity of taking down the same, renewing the carbon and recharging the globe is obviated." Had you found, at the time of the application for this patent, that consumption of the carbon at the point of contact with the holders, had occurred in practice?

A. Yes, it did sometimes occur in some of our lamps, not always or usually.

X Q. 1290. Would the feeding mechanism of this lamp be
1386 effective in compensating for the fracture of the carbon pencil
at any point other than at the point of contact between the
pencil and the block D, or immediately above it?

A. Yes, up to the part G, provided the pencil above was long enough to reach from G to the block below it.

X Q. 1291. Where, in actual practice did you find that such fracture usually occurred in such lamps as are shown in this patent?

A. At the block D, or at the part G, but fractures were very rare in this form of lamp.

X Q. 1292. If fracture or consumption occurred the pencil E slid down through the pencil G onto the carbon D, and new contact was made, was it not?

A. Yes.

X Q. 1293. Now the current came through the support G, did it not?

A. Mostly, but not entirely.

X Q. 1294. Now G was of metal, was it not?

A. No, I think it was of carbon usually, but I don't remember.

X Q. 1295. The pencil E, being adapted to slip through the support G, did you find in practice that an arc was likely to occur at this point?

A. It sometimes did occur at this point, but was not very likely to occur there, inasmuch as the pencil throughout its whole length was a conductor, and above G carried a portion of the current which caused the illumination of the pencil below G, through which the whole current passed.

X Q. 1296. Now, the pencil E rested upon the block D, being held in position by pressure. Did an arc usually occur at this point of contact?

A. No, it did not usually occur at any point, but in lamps in
which the carbon was not rigidly attached to D, it did sometimes
occur at that point, but rarely.

1387 X Q. 1297. Did D or G, or the part of the pencil which
was inserted in G, or passed above it, become incandescent
when the lamp was lighted?

A. No, it was not intended to do so, but in some of our lamps, before we got them adjusted, it sometimes happened that the upper part of the pencil above G was heated up to a dull red. This showed that the electrical contact at G was not sufficiently good, and the lamps were taken down and adjusted so that they would not heat above the piece G. I am confining my answers to lamps in which the part G was introduced, and have not referred to the other forms shown in the patent in which the part G was not used.

X Q. 1298. Now, a lamp which did not require this feeding mechanism, and in which the carbon conductor could be rigidly held without fracture or consumption form the causes mentioned, would be much simpler in construction and more economical to make than the lamp shown in this patent, would it not?

A. Yes, than the lamp shown in Fig. 1 of that patent, and such a lamp is shown in Fig. 8 of the patent, and we made other forms much more simple of this kind that you speak of.

X Q. 1299. Prior to filing the application for the patent?

A. Yes.

X Q. 1300. When you filed the application for this patent, had you made, or did you think there could be made, practically operative lamps employing a straight stick of carbon in which no feeding mechanism was required and where the carbon conductor was rigidly attached to its holders, and in which fracture of the carbon or consumption at the points of contact did not occur at so early a time as to make the lamp inoperative?

A. Yes, we had made such lamps, a good many of them, and of course I thought and knew they could be made.

1388 X Q. 1301. Why then did you in your first patent describe a lamp in which this more expensive and inferior mechanism was employed?

A. Because we thought that if we did not cover the device of a feeder lamp by our patent others would do so, and we thought it desirable to patent the feeding feature of a lamp.

X Q. 1302. If at the time you filed this application you had, as you say, made lamps simpler and cheaper in construction, and equally efficient, and not having the defects which this feeding mechanism was designed to compensate for, why did you not patent them, or the inventions of such lamps?

A. We did, in this very patent, or intended to do so, so far as the straight pencils are concerned.

X Q. 1303. Please point out where in this patent you have described lamps not employing the feeding mechanism and not having the defects which the feeding mechanism was designed to compensate for.

A. Fig. 8 in the patent is an illustration of such lamp, and Fig. 8 is described in the patent.

X Q. 1304. Please read from the patent what you assert to be a description of a lamp not employing a feeding mechanism, and not having the defects which a feeding mechanism was designed to compensate for.

A. "In Fig. 8 we have indicated a modification of the single-carbon lamp, the clamp G being dispensed with and the bent rod F being provided like the rod I of Fig. 1 with a carbon piece X wired to it precisely as carbon D is wired to rod I," and the whole of the carbon E is rendered incandescent, no part of it being reserved for feeding down upon the block D.

X Q. 1305. And is what you have just read what you assert to be a description of lamps not employing the feeding mechanism and not having the defects which the feeding mechanism was designed to compensate for?

1389 A. Yes, taken in connection with the rest of the patent, it is an illustration and description of a lamp of that character, and is one form of lamps of that character which we made. In this case the part F simply acts as a compensating device for unequal expansion and contraction of the incandescent carbon and its holders.

X Q. 1306. Is there any statement in the patent that the modification in Fig. 8 does not employ the feeding mechanism which you have described in the patent?

A. There is an omission in Fig. 8 of any carbon to be fed and of any holder for a new carbon or part of a carbon to be fed (such as the part G), which amounts to the same thing. It would be unnecessary, it seems to me, to state that anything that was not a feeder lamp was not a feeder lamp; the drawing being part of the description.

X Q. 1307. All that I see in the patent concerning Fig. 8 is the statement that in Fig. 8 you have indicated a modification of the single-carbon lamp, the modification being stated to consist in the omission of the clamp G, and in such case providing the bent rod F with a carbon piece X wired to it as the carbon is wired to rod I. Now, the single-carbon lamp employed the feeding mechanism of the bent rod F sliding in the part H. Now, what is there to indicate that after you have performed the modification shown in Fig. 8 that the rod F does not still slide in the part H?

A. There is nothing, but the total omission of a carbon to be fed shows that it is not and cannot be a feeder lamp; again, the omission of any holder or receptacle for a carbon or part of a carbon to be fed, which is the office of the part G in Fig. 1, also shows that Fig. 8 is not an illustration of a feeder lamp. In Fig. 1 the part F exercises two functions, the first of which is to maintain electrical connection or contact between the carbon and its holders and compensate for unequal expansion and contraction between the incandescent carbon and its holders, the second of which functions
1390 is to feed a new part of the carbon down upon the block D
in case of fracture or consumption. In the illustration, Fig. 8, the rod F only serves in its function of maintaining contact and compensating for unequal expansion and contraction by the movement or sliding to which you refer.

X Q. 1308. You think then that Fig. 8, taken in connection with the description you have quoted, shows a lamp in which no feeding mechanism is employed?

A. Yes, and the absence of any method or attempt to introduce any compensation by which the electrical resistance of the lamp should be maintained the same or substantially the same, a function which the part G exercises in Fig. 1 further confirms me in that opinion.

X Q. 1309. Is there anything in the patent which states or indicates how in Fig. 8 the carbon E was held between the holders?

A. I think the illustrations, figures of the patent, show it. I don't remember whether it is referred to in the text or not.

X Q. 1310. Well, please tell me how you think the patent states that the carbon E in figure 8 is held?

A. Figure 8 shows that it is held between X and D. I don't know that there is anything further than that.

X Q. 1311. Is it rigidly and firmly held?

A. I do not know that there is anything in the patent to show whether it is rigidly held or simply kept in place by insertion into the parts D and A, and by the weight of F and X.

X Q. 1312. Now the feeding mechanism of the lamp was, as we agree, to compensate for fracture of the carbon or consumption at the points of contact between the carbon and its holders. What is there in the patent or in any of the drawings to show that in the modification of Fig 8 fracture or consumption would be avoided.

1391 A. The movability of the part F, and the fact of its weight, the movability of the part F being a compensation for unequal expansion of the incandescent carbon and its holders, and the gravity of F acting to maintain the electrical contact notwithstanding expansion or contraction in the length of the incandescent carbon, differing from the expansion or contraction in the length of its holders.

X Q. 1313. Then the part F, in the modification of Fig. 8, does slide in the part H?

A. It does, as shown in the patent.

X Q. 1314. If in this modification, consumption of the carbon at the points of contact with its holders should occur, F would also slide in the slot H and preserve the contact?

A. Yes, and the arc being established, the resistance of the incandescent carbon would be reduced as its length was diminished, and in all probability the arc re-established by a greater current due to diminished resistance, and this process would be continued and increased and the carbon consumed.

X Q. 1315. Would not that likewise occur in the lamp of Fig. 1?

A. Not to the same extent, the distance between G and D being maintained in the lamp of Fig. 1, the resistance of the lamp would remain more nearly constant and the arc would not be likely to be renewed, as the current mainly and almost entirely passes through G.

X Q. 1316. If, as you now say, the modification of Fig. 8 preserved the sliding of F in H, so that if there was consumption at the points of contact the carbon would be fed down, as would also occur if a fracture occurred in the carbon at or near the block D, how can it be true as stated in your 1302d answer that this patent, patented a lamp in which no feeding mechanism was employed and which did not contain the defects which feeding mechanism was designed to compensate for?

1392 A. I say so, because we made such lamps; they were practical lamps without any feeding, and they were not feeder lamps, in any practical sense. If the carbons broke, or if an arc occurred it was a practical end to the life of the lamp of that kind.

X Q. 1317. If, as stated in your 1300th answer, at the time the application for this patent was filed you made and thought there could be made practically operative lamps employing a straight stick of carbon in which no feeding mechanism was required, and where the carbon conductor was rigidly attached to its holders, and in which fracture of the carbon or consumption at the points of contact did not occur at so early a time as to make the lamp inoperative, and inasmuch as the modification of Fig. 8 still employs the sliding of F in H, what explanation, other than as given in your 1301st answer, have you to give for the description in this patent of this expensive and unnecessary construction?

A. I do not think any further explanation is required; I remark that if one's foresight were as good as his hindsight, you would not now be asking me this question: but again, if further explanation is required, it will be found in the fact that this art was then new and substantially unpracticed, nevertheless, incandescent lamps and semi-incandescent lamps or feeder lamps had been made, or tried to be made, before that time. We did not know which would prevail; the present state of the art has after years and years, as it appears at present, answered that question; we did a great many unnecessary things without doubt, which under the light of the present day we would not have done.

X Q. 1318. Why did you not at this time describe or patent the lamp employing a straight stick of carbon held rigidly between its supports which did not require this complicated, expensive and useless mechanism?

A. I do not know that we did not do so. I think that some of the elements of this lamp which we patented are in the incandescent lamps of to-day. If we did not patent anything that we
1393 ought to have patented, it was perhaps due to the fact that
my coworker, Mr. Sawyer, was to pay all the expenses of obtaining patents, and desired to avoid all expense that he could in that direction, and alleged that when the company was formed (that was to be formed), patents could be taken out for less and minor things and details; it was largely due to this fact that more patents were not taken out.

Adjourned till Tuesday, 25th inst., at 1 p. m.

TUESDAY, *25th October*, 1887.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. MAN was continued as follows:

X Q. 1319. The second patent granted to Sawyer and Man for an electric lamp is patent No. 210,809, the application for which was filed November 5, 1878. Does not the lamp of this patent employ a mechanism to provide against expansion or contraction of the carbon, and by which mechanism, if the carbon were consumed by arcs at the point of contact between the carbon and the holders, contact would still be preserved by the holders approaching each other through the action of a spring?

Objected to as incompetent, irrelevant, immaterial and not proper cross-examination; the patent referred to not being the patent in suit, and having nothing whatever to do with the issues in this controversy.

A. It contains the kind of mechanism which you mention, but not for all the purposes which you mention, nor would it practically so act; the object of the device referred to in the lamp was to provide for expansion and contraction, and make and keep good 1394 electrical connection between the incandescent carbon and its holders. It was not a feeling device; it would not practically so act, because when the electrical connections between the incandescent carbon and its holders were not sufficiently good to prevent an arc being formed between the carbon and its holders, the practical life of the lamp was ended.

X Q. 1320. In the lamp of this patent, was not the incandescent carbon held in position by the pressure of the spring W acting upon the stirrup V, and was not the operation of the mechanism as follows: Upon any expansion of the carbon additional pressure being exerted against L, the spring yielded before fracture of the carbon occurred; if the carbon contracted, contact was preserved by the spring pressing upon the holder L?

Same objection.

A. Your description of the working of the apparatus is substantially correct, but it does not wholly explain the working of this part of the apparatus. The ends of the incandescent carbon were in practice by us rigidly attached to the holders in most cases: where not so done, in the working of the lamp, they became so, soon after it was heated up. Now, if the holders were rigid and kept at a fixed distance from each other when the carbon was heated up it would be expanded in length, and if by compression at high heat it endured the strain of such expansion, when it was cooled off it would be shorter than the distance between the holders and would be pulled apart by contraction either at some point in its length or at its ends, breaking the electrical connection.

X Q. 1320½. Is there anything in this patent showing or stating that the incandescent carbon was rigidly attached to its holders?

Same objection.

A. No, but such was the fact of practice and such became the fact by use.

1395 X Q. 1321. Now, if an arc in such a lamp as is shown in this patent should form at the points of contact between the carbon and its holders and the carbon at this point begin to consume, would not the spring operate to bring the holders nearer together until the carbon was consumed?

Same objection.

A. Yes, until the carbon was consumed or fell out of the holders, which would soon take place; the practical life of the lamp would ordinarily be ended when the arc was formed.

X Q. 1322. Now, did not the strength of this spring have to be adjusted with reference to the size and strength of the carbon conductor?

Same objection.

A. It did.

X Q. 1323. In the lamp of patent 205,144 the sliding mechanism had to be adjusted with reference to the strength and size of the carbon conductor?

Same objection.

A. Yes.

X Q. 1324. Did you consider at the time you filed the application for patent 210,809 that the spring mechanism of this lamp was superior to the sliding mechanism of the lamp of patent 205,144 as avoiding fracture from expansion or contraction?

Same objection.

A. I cannot recollect, but I suppose that we did; I am confident of it so far as the lamp shown in Fig. 1 of patent No. 205,144 is concerned, and I believe we did so far as the device shown in Fig. 8 of that patent is concerned.

X Q. 1325. Now, if at the time you filed the application for the patent 205,144, some six months before this patent 210,809 was filed, as stated in your 1300th answer, you had made practically operative
lamps employing a straight stick of carbon in which no feed-
1396 ing mechanism was required, and where the carbon con-
ductor was rigidly attached to its holders and in which fracture of the carbon or consumption at the points of contact did not occur at so early a time as to make the lamp inoperative, what was your reason for describing and claiming in this patent this spring mechanism for preventing fracture of the carbon?

Same objection.

A. I have already explained the difference between a feeding device and a compensation for expansion and contraction, and although some parts of the one may be employed in the other, they are not employed as feeding devices, nor have I intended to state that no compensation was introduced into our lamps for expansion and contraction.

X Q. 1326. I do not wish any misunderstanding to occur. Now, in patent 205,144 is shown and described a sliding mechanism, which, as the carbon lengthens or shortens, either yields or follows the shortening; in patent 210,809 is shown a spring mechanism which gives as the carbon lengthens or follows it as it shortens; whatever other functions these devices may perform I understand we agree that they are intended to prevent or avoid fracture of the carbon due to its expansion or contraction. Now, please tell me whether prior to the filing of the application for the patent 205,144, on May 16th, 1878, you had made lamps and thought there could be made, lamps practically operative employing a straight stick of carbon in which no mechanism was required of the kind shown in either of these patents for providing against fracture of the carbon by its expansion or contraction, and where the carbon conductor was rigidly attached to its holders, and in which lamps fracture of the carbon or consumption at the point of contact, did not occur at so early a time as to make the lamps inoperative?

Same objection.

1397 A. In nearly all of our lamps, substantially all, some expedient was used to compensate for and prevent the injurious effects of expansion and contraction of the incandescent carbons, sometimes one device and sometimes another. The sliding device shown in patent 205,144, as applied to lamps of the form shown in Fig. 8 of that patent, relying simply upon gravity for that purpose, were deemed, at the time that patent was taken out, equivalent for all other forms, such as springs; we had made a few lamps at that time, and only a few, in which all the conditions existed which you state in your question; the carbons usually broke in these lamps at the second or third time they were lighted up; after that, some compensation was always introduced by us for contraction and expansion; I have reference now only to straight pencils, to which I understand your question to refer.

X Q. 1327. You say in your answer, that nearly all of your lamps employing a straight stick of carbon had some sliding or spring mechanism to compensate for expansion or contraction, and thus avoid fracture. You also say that you had made a few lamps having the conditions mentioned in my question, but that in these lamps the carbon usually broke at the second or third lighting. I do not understand from your answer whether at the time you filed your application for patent 205,144, you had made lamps which you considered practically operative, employing a straight stick of carbon rigidly held to its supports, and in which no spring or sliding mechanism was required to compensate for expansion or contraction of the carbon, and in which fracture did not so early occur as to render the lamp practically inoperative; please tell me whether you had or had not at that time made such lamps?

Same objection.

A. I have stated the facts in regard to the matter and I do not
desire in any way to seem by my answers to avoid explicitly
1398 answering your question; the few lamps to which I refer
were practically operative during their first lighting up,
some of them during their second and probably their third lighting up; beyond that the carbons broke, and they were not further practical lamps; they were practical lamps to the extent only that I have stated; they were not enduring lamps beyond that extent.

X Q. 1328. Did the fracture occur at so early a period in the life of the lamps as to render them, in your judgment, inoperative as lamps?

Same objection.

A. No; they were operative to a limited extent, such as I have stated.

X Q. 1329. I cannot yet understand from your answers whether you had made lamps of the kind mentioned in my question 1326 which you considered practically operative as lamps?

Same objection.

A. Yes, practically operative, so long as the carbons were not broken, but not enduringly operative.

X Q. 1330. What I want to know is whether the carbon broke at so early a stage in the life of the lamp as to make the lamp practically inoperative as an incandescent lamp?

Same objection.

A. Yes, for those purposes and uses where a lamp was required to be used with the same carbon and in the same atmosphere, beyond its first, second or third lighting up. No, for those lamps whose requirement in use was only to be lighted up once, or at most twice or thrice, without putting in a new carbon and recharging the lamp.

X Q. 1331. Now, a lamp which was so made that the straight carbon pencil did not break and have to be renewed was superior to a lamp the same in other respects in which the pencil would break and have to be renewed?

Same objection.

1399 A. Yes.

X Q. 1332. If such a lamp as is shown in patent 205,144, the carbon pencil would not break by reason of its expansion or contraction, and if an arc did not occur to consume it, the feeding or compensating mechanism would be entirely unnecessary and useless, would it not?

Same objection.

A. Yes; but it would fracture were it not for the compensating mechanism.

X Q. 1333. Did you then, at the time you filed the application for patent 205,144, believe, and had your experience taught you, that a straight pencil of carbon used as an incandescent conductor would fracture by reason of its expansion or contraction, and that a compensating mechanism was necessary?

Same objection.

A. Our experience was that straight carbons held rigidly without compensation for expansion and contraction—that is, some device allowing them to expand or contract in their length—would be broken soon after, but not at their first lighting up, and we thought some compensating device allowing for such expansion and contraction highly desirable.

X Q. 1334. Sufficiently desirable to justify the additional cost of the compensating mechanism?

Same objection.

A. We thought it might be, and, I believe, we thought it was.

X Q. 1335. You began your experiments, you have said, by holding the carbon between two parallel holders. Did you ever devise a compensating mechanism for a straight piece of carbon so held?

Same objection.

A. Yes.

X Q. 1336. When you filed the application for patent 205,144,
did you consider the apparatus there shown as the simplest
1400 and most efficient compensating mechanism you had then
made where a straight stick of carbon was employed?

Same objection.

A. No.

X Q. 1337. Why did you describe in the patent this, when you had a simpler and more efficient one?

Same objection.

A. Because Mr. Sawyer thought that the device shown in that patent was the equivalent of the other devices which we used, and we desired, or rather he did, to patent the feeder-lamp feature of that patent, which showed at the same time the compensation for expansion and contraction.

X Q. 1338. When you applied for patent 210,809 the spring mechanism there described the simplest and most efficient you had obtained for compensating for expansion and contraction where a straight stick of carbon was employed. This lamp, I understand you to have said, did not have the feeder principle?

Same objection.

A. At the time when the directions were given to the solicitor to apply for that patent, we deemed the compensating device shown in it the best, all things considered, and taken in connection with the other parts of the lamp for the purpose for which it was intended, not perhaps in all its details, but in its main features.

X Q. 1339. Did you at that time consider where a straight stick of carbon was employed a device compensating for the expansion and contraction of the carbon desirable?

Same objection.

A. Yes, I think that we did.

X Q. 1340. Sufficiently so to justify the expense of the compensating mechanism?

Same objection.

A. I think that we did.

Adjourned till Wednesday, the 26th inst., at 1 p. m.

1401 WEDNESDAY, *Oct.* 26, 1887.

Met pursuant to adjournment.

Present, counsel as before, and the cross-examination of Mr. MAN was continued as follows:

X Q. 1341. In view of the fact that a carbon conduc- of such a lamp as is shown in patent 205,144, had to support the weight of the sliding mechanism, and that the carbon conductor of lamp

210,809 had to resist the pressure of the springs, could a delicate, small carbon be used in lamps of the kind shown in these patents?

Same objection.

A. Not carbons of the smallest size in the first form 205,144. In 210,809, very thin and tenuous carbons could be used.

X Q. 1342. What was the weight of the sliding mechanism in 205,144?

Same objection.

A. I cannot state. We made them of various sizes and weights. The weight of all was slight, unless in lamps where large carbons — used.

X Q. 1343. What was the pressure upon the carbon rods exerted by this sliding mechanism?

Same objection.

A. Substantially the same as the weight of the sliding part F.

X Q. 1344. What was the lightest one you ever made or used in a lamp about?

Same objection.

A. I don't know, and I never weighed one. I can only express it by saying it was of very small weight.

X Q. 1345. Lighter than an ounce?

Same objection.

A. A very small fraction of an ounce, I should think.

X Q. 1346. As light as the tenth of an ounce?

1402 Same objection.

A. I don't know. I should think much less.

X Q. 1347. Less than the twentieth of an ounce, should you think?

Same objection.

A. I don't know.

X Q. 1348. Was it made of metal?

Same objection.

A. No, ordinarily we made them of carbon. Some were made of metal.

X Q. 1349. Now, where the carbon expanded the part F slid upward, pressed by the carbon, did it not?

Same objection.

A. Yes.

X Q. 1350. And when it contracted it slid down upon the carbon?

Same objection.

A. It slid down with the carbon, keeping in contact with it.

X Q. 1351. In view of these facts and in view of the fact that the pressure was not in the same line as the line of movement between the parts, but was exerted on a cross-piece at right angles to the line of movement, which would require a greater force to cause the parts to slide than if it were in the same line, can you not tell me what was the smallest carbon in length or cross-section which you used in an operative mechanism of this character?

Same objection.

A. Not from the data you give, but I can give my recollection in regard to the carbons that we did use. They were somewhat less than a twentieth of an inch in diameter ordinarily, and some of less diameter and of an ordinary length of about five-eighths of an inch in the incandescent portion, and some of slightly greater length.

X Q. 1352. What was the smallest carbon in cross-section 1403 you ever used in a mechanism of this character which would cause the parts to slide as it expanded or contracted?

Same objection.

A. The smallest carbons, to the best of my recollection, used in such a mechanism, were from a thirty-second to a fortieth of an inch in diameter. It would not be right to say that these carbons by their expansion or contraction moved the sliding parts upon each other, the sliding motion being due more to the expansion and contraction of the sliding parts themselves and that due to the expansion and contraction of the incandescent carbon was almost infinitesimal in amount.

X Q. 1353. Did not the carbon have to stand the strain necessary to cause movement of the parts, whether that movement was caused by the expansion and contraction of the holders or of the carbon?

Same objection.

A. Yes, in the one case as the fulcrum for the movement, in other case as causing the movement.

X Q. 1354. You have given the diameter of carbons that would stand this strain and operate this mechanism as from the thirty-second to the fortieth of an inch. Now of carbons of this small size what was the greatest length of the incandescent part of the carbon that would so operate and work this mechanism?

Same objection.

A. About half an inch, according to the best of my recollection. Some were perhaps longer, but I cannot be certain of it.

X Q. 1355. The thinner the carbon, the shorter it had to be to work this mechanism; as you increased the length of the carbon, you would have to proportionately increase its diameter?

Same objection.

A. Yes.

1404 X Q. 1356. In such a lamp as is shown in patent 210,809, what was the pressure of the spring there shown upon the holders?

Same objection.

A. Very slightly in excess of the weight of the lower block, which held the lower end of the carbon; as nearly the weight of that block as we could make it.

X Q. 1357. Now, what was the smallest carbon in cross-section and greatest in length, that you ever used in a lamp of this character, in which the spring mechanism operated as designed?

Same objection.

A. I cannot at this length of time remember exact dimensions. The best of my recollection is, that we used carbons in this form of lamp as small as a sixty-fourth of an inch in diameter, but they may have been larger; but less than those we used in the other form of lamp. In length the longest, I should think, that we used, was two inches. Whether this length was of the smallest size of carbons or not I cannot recollect. They were less in diameter than the ordinary carbons that we used, and I think the nearest approximation would be a thirty-second of an inch in diameter. I think we used carbons of this small diameter of two inches in length, but at this length of time I would be unwilling to swear that they were so long; our ordinary carbons of the smallest size that we used were from half to three-quarters of an inch long. I am referring in my testimony to straight pencils.

X Q. 1358. Did you think at the time the application for the patents No. 205,144 and 210,809 were respectively filed that they described operative mechanisms and practical lamps?

Same objection.

A. Yes, I knew they did.

1405 X Q. 1359. Now, on the 31st of March, 1880, you individually applied for a patent upon a lamp, upon which subsequently letters patent No. 227,118 were issued, a copy of which patent I hand you. In that patent you say, "Tension, torsion or compression upon the pencil acts in the end by continual repetition to destroy it." At the time you filed the application for this patent, were you still of opinion that a practical lamp could be made, in which tension, torsion or compression was exerted upon the incandescent carbon?

Same objection.

A. I do not recollect any impression in regard to it at the time. I think the statement in that patent is correct, that in the end tension, torsion or compression operate to destroy the carbon, if other causes do not destroy it before it is destroyed by those things. I knew before then that tension, torsion and compression had been so compensated for by us, that is, Sawyer and Man, that operative practical electrical lamps had been made and used by us.

Defendants' counsel offer in evidence U. S. letters patent to Albon Man for electric lamp, dated May 4th, 1880, No. 227,118 and the same is marked "Defendant's Exhibit Man Patent No. 227,118, October 26th, 1887."

Exhibit objected to as incompetent, irrelevant and immaterial, having nothing to do with patent in suit and having no reference to anything mentioned in the bill or answer, and notice of motion is given to strike it out.

X Q. 1360. Now, on such lamps as were shown in patents 205,144 and 210,809, tension, torsion or compression was exerted on the carbon pencil, was it not?

Same objection.

A. Compression was exerted in the lamp of the first patent to a very slight extent, but not tension or torsion. In the lamp of the second patent it might happen that tension or compression might take place to a very slight extent, and to this extent only, if the lamp was not in all respects properly adjusted. 1406 If properly adjusted, tension and compression were substantially eliminated, certainly sufficiently so to avoid any practically injurious effects therefrom. In neither form of the lamps was torsion exerted.

X Q. 1361. It would seem from this patent, that at the time you filed the application for the patent you regarded as a defect any tension, torsion or compression upon the incandescent conductor; was that your opinion?

Same objection.

A. Not as stated. My opinion is better expressed by saying that such tension, torsion or compression as would end the life of the lamp before it would otherwise naturally be ended, was to be avoided, if possible.

X Q. 1362. Well, you thought then, that these were defects, and that the extent of the defect was commensurate with the extent of the tension, torsion or compression; am I right?

Same objection.

A. I don't remember to have thought in that way. I did think, in all probability, that it was desirable to avoid tension, torsion or compression, especially excessive tension, torsion or compression.

X Q. 1363. If then, when you filed the application for patent 227,118 on March 31st, 1880, you regarded any tension, torsion or compression on the incandescent conductor as a defect, were not the lamps of patents 205,144 and 210,809 defective in so far as they by their structures exerted compression on the conductor, and if lamps could have been made in which the straight carbon pencil never had any such compression upon it, would it not have been desirable?

Same objection.

A. First, I did not, then, to the best of my judgment, regard or believe that suitable tension or compression, such as the carbons would endure throughout their life without being destroyed as injurious, because it had no practical effect upon the life of the 1407 lamp; excessive or unsuitable compression or extension, such as would interfere with the life of the lamp before it would be destroyed by other causes, I must have regarded as injurious. The lamp of the patent 205,144, I think, had not as good compensation as the lamp of the patent 210,809. Perhaps the lamp of the first patent might be considered defective in this particular, although we made many lamps of that kind that were good. The lamp of the patent 210,809 was not defective in my judgment by reason of any excessive pressure upon the carbons, and my patent 227,118 was taken out simply as another way, I thought, possibly, better and cheaper, to avoid pressure than the lamp 210,809. It is manifest that by removal of all pressure, tension and torsion, the danger of excessive pressure, tension and torsion is removed. It would, therefore, in that sense, be desirable to make lamps in which no tension, torsion or compression existed upon the straight pencil of the carbon. I am speaking here simply of tension, torsion and pressure in their effect upon the carbon, and not with reference to the use of pressure for any purpose in the lamp.

X Q. 1364. Now, let us see. Upon the carbon of patent 205,144 there was a pressure equal to the weight of the entire upper holder. On March 31st, 1880, you applied for a patent in which you say, among other things, compression upon the pencil acts in the end to destroy it. Now, when you filed this application on March 31st, had you any opinion as to whether the pressure on the carbon in a lamp like patent 205,144 was a defect which would destroy the pencil?

Same objection.

A. No, I don't remember to have had.

X Q. 1365. Then this defect of pressure on the pencil, which in this late application you say would destroy it was an imaginary conclusion of yours, and not the result of experience; or, in other words, you were speaking of a defect which you had not found to exist?

1408 Same objection.

A. No, that is not so. We had found that excessive pressure was injurious, and I was not speaking of any imaginary thing.

X Q. 1366. But you say excessive pressure did not exist in such a lamp as 205,144, and that a lamp like 210,809 was still better. Now, at the time you applied for this patent on March 31st, 1880, there had issued to Sawyer and Man two patents showing electric lamps. In each of these patents the lamps respectively shown are so constructed that there is pressure upon the straight carbon pencil, and it is by this pressure, or the removal of it, that the conductor is allowed to expand and contract, so as to avoid fracture. This patent of yours states that compression on the pencil will in the end destroy it. Now, I would like to know, whether at the time you filed this application, you considered the pressure necessarily exerted on the pencil in such a lamp as 205,144 a defect, and whether, if you so thought, your opinion was based on experience with such lamps? If you did so think, please tell me?

Same objection.

A. I do not remember to have thought anything about either of those lamps at the time of my applying for the patent 227,118, and don't think I did, and my patent was not applied for to remove or remedy any defect in either of those lamps peculiar to them or because it existed in them. It was applied for by me because it was my own invention, belonged to me, and I thought it was a simple way of avoiding tension, torsion or compression upon a straight pencil—things which I had before then discovered might be injurious if excessive. The patent has always remained mine, and is mine to-day. I have never assigned it.

Adjourned till Thursday, the 27th inst., at 1 p. m.

1409 THURSDAY, *Oct. 27th*, 1887.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. MAN proceeded as follows:

X Q. 1367. Then, as I understand you, you have never thought that if the lamps of these patents were properly made, the compression or pressure on the conductors was sufficient to be a defect of the lamp?

Same objection.

A. No, not with carbons adapted to the lamps.

X Q. 1368. I understand the smallest carbons were not adapted to these lamps, or rather, these lamps to such carbons?

Same objection.

A. No; not well adapted to the smallest carbons.

X Q. 1369. Am I correct in understanding that, according to patent 205,144, the lamp of such patent had an atmosphere of nitrogen at ordinary atmospheric pressure?

Same objection.

A. The pressure of the gas in the lamp, as described in that patent, at the time of its sealing up was the same as that of the atmosphere, but as soon as it cooled off it was at less pressure than the atmosphere was, because in its passage through the heated tube for purifying it its temperature was raised and the gas in the lamp at the time of sealing up was hot, and at a higher temperature than after it had cooled off.

X Q. 1370. Was the heated gas passed through the lamp sufficiently long before sealing to heat the lamp to near the temperature of the gas?

Same objection.

A. Yes, the lamp itself became warm.

1410 X Q. 1371. As I read this patent, you state, that in a lamp containing an artificial atmosphere at atmospheric pressure, when the conductor was run to incandescence, the heat generated would cause expansion of the atmosphere tending to force it out of the lamp, and upon the current being turned off and the atmosphere cooling, air from the outside would rush in and therefore a tight seal would have to be made?

Same objection.

A. The statement contained in the patent, is a statement of what we understood the facts to be before our work. The inference which you draw from this statement is perhaps correct. The lamp should be tightly sealed.

X Q. 1372. Had you found that when the lamp was not tightly sealed the atmosphere would be forced out when the lamp was run to incandescence, and atmospheric air come in when the current was turned off?

Same objection.

A. I do not recollect any such finding. It is manifest that such would be the case if the atmosphere of the lamp were at atmospheric pressure and the same temperature as the air, before it was heated up by the current or incandescent carbon.

X Q. 1373. You say in this patent, "As a safeguard against an infinitesimal leakage we prefer to place in our lamps a small quantity of sodium, potassium or other agent having a great affinity for oxygen," and claim doing so in the 17th claim of the patent. At the time you filed the application for this patent, did you prefer placing in your lamps a small piece of sodium, potassium or other agent having a great affinity for oxygen?

Same objection.

A. Yes, I think so.

X Q. 1374. Was the object of this sodium or potassium to absorb any oxygen that remained or got into the lamp?

Same objection.

1411 A. It was.

X Q. 1375. Had you found that oxygen got into the lamps after their sealing?

Same objection.

A. Yes, I think we had in our earlier lamps, before the lamp of this patent, or rather before the method of sealing up the lamp described in this patent was adopted by us.

X Q. 1376. In lamps such as are shown in this patent, had you found, up to the time of filing the application, that oxygen got into the lamp chamber?

Same objection.

A. No, I do not remember that we did, other than oxygen or air set free in the lamp chamber after it was charged from the walls of the lamp and its interior work, and I do not remember any trouble from oxygen, so set free in lamps of the character of those in this patent; I think we had got rid of that difficulty before these lamps were made.

X Q. 1377. Then at the time you filed this application did you know that in a lamp, such as is described in this patent, and properly made, there was no necessity or use in placing sodium or potassium in the lamp?

Same objection.

A. No, I do not think we knew that there was no use in doing it. We introduced it as the patent says, as a safeguard in case the lamps were not properly sealed and the workmanship absolutely perfect, or nearly so, against, as we say, "infinitesimal leakage." I believe that we at times thought that it would not be necessary to put sodium or potassium in lamps well and perfectly made and sealed, but as absolute perfection of workmanship and manipulation could not be obtained, it was well to put it there, and we thought that its use might be valuable as an independent thing in lamps of any kind made by ourselves, or others, in which the construction was not so nearly perfect as to avoid infinitesimal 1412 leakage; we, therefore patented it as a precautionary expedient.

X Q. 1378. But you know that in a lamp made according to the description of this patent, where the best and most skillful workmanship was employed, this was entirely unnecessary?

Same objection.

A. I do not think, and I have said that I did not think, that at the time we knew "it was entirely unnecessary," but we believe it to be so; we believed that it was not necessary in such perfectly constructed lamps.

X Q. 1379. The patent also says "as an additional safeguard we prefer to place in our lamps a quantity of freshly burned lime" as an absorbent of carbonic acid gas, and in the 16th claim of the patent this idea is claimed; why was this lime put in the lamps?

Same objection.

A. By reason of its higher affinity for carbonic acid gas than sodium or potassium has.

X Q. 1380. What was the desirability of an absorbent of carbonic acid gas in the lamps?

Same objection.

A. To purify the atmosphere of the lamp from that gas and keep it pure.

X Q. 1381. Where did the carbonic acid gas come from?

Same objection.

A. It might come from two or three sources; it might be with the atmosphere with which the lamp was charged, or the interior walls and works of the lamp, and be gradually freed in the latter case by diffusion, or it might come from union of the oxygen of any infinitesimal portion of air that should get into the lamp, or be left in it, combining with the carbon of the incandescent conductor when highly heated up.

1413 X Q. 1382. At the time you filed this application what had been your experience; did these things, or any of them, occur which you mention, and have you found that carbonic acid gas was present in the lamp chamber?

Same objection.

A. Yes; prior to the filing of the application we had found carbonic acid gas in the chambers of our lamps and traced its source, as we thought, as I have stated in my last answer.

X Q. 1383. Did you, then, when you filed this application, consider it important to place lime in the lamp chamber?

Same objection.

A. I do not know that I could state it so strongly as that; we considered it sufficiently desirable as an expedient and precaution to patent it.

X Q. 1384. If, in practice, no carbonic acid gas was present in the lamp chamber this lime would perform no useful function; what I would like to know is whether, when you filed the application you believed carbonic acid gas would be developed in the chamber and, therefore, thought it would be useful; or whether you believed no such carbonic acid gas would be present and therefore thought it useless. Which was the case?

Same objection.

A. Neither; we knew that in all probability oxygen in some proportion would be in these lamps, as it is in those of to-day; that that oxygen would sooner or later unite with the carbon of the incandescent conductor and form carbonic oxide or carbonic acid gas, for which freshly burned quicklime would have a very high affinity and would take it out; now, the practicability of a lamp would depend upon the amount of this oxygen; lamps with an atmosphere containing so high a percentage of oxygen, or subsequently receiving it, as to be impracticable by reason of their short life might be rendered more practicable by the absorption of that oxygen and by the absorption of
1414 the carbonic acid formed from it, if the atmosphere of the
lamps was sufficiently good, no lime was needed; we, therefore, as I said, patented it as an expedient or precaution.

X Q. 1385. I am not asking about hypothetical lamps but lamps made in accordance with this patent. Now, when you filed this application did you think it was necessary to put lime in the lamps, or did you not think it was necessary, or had you no opinion whatever on the subject?

Same objection.

A. I have not talked of hypothetical lamps. I have spoken of the atmosphere of this lamp and all other lamps. I do not think that in a properly constructed lamp, made upon the plan of this patent, we, at the time, deemed it necessary to use quicklime in them; I believe that we thought and knew that in some lamps freshly burned quicklime was useful. The fact is, that we found quicklime useful in some lamps that we made before this form of lamp; we did not, to the best of my recollection and belief, find it necessary in this lamp when properly constructed and charged.

X Q. 1386. It is stated in the specification of this patent, 205,144:

"It has been found practically impossible, under the varying degrees of heat and pressure, to maintain perfect joints, and the result is that expansion of the artificial atmosphere by the heat from the luminous conductor expels a portion of the same, and construction of the atmosphere upon cooling off causes a portion of the external air to penetrate the globe, thus supplying oxygen, which at the next lighting feeds upon the carbon."

Later on the specification says:

"To guard against great heating and unequal expansion at the joints, which would imperil the lamp and soon render it useless, we isolate the incandescent carbon from the lower part of the 1415 globe where the joints are situated by a disk or diaphragm of some refractory substance, preferably soapstone or porcelain, whereby we prevent all downward radiation of the heat and keep the joints comparatively cool at the same time that the upper part of the globe may be very hot.

"Furthermore to prevent conduction of the heat from the incandescent carbon to the joints by the metallic connections communicating therewith, we arrange the two conductors leading upward from the base in a spiral volute, or fluting form, so that we obtain considerable length of conductor in a limited space and very little of the heat reaches the base."

Now, when you filed this application did you consider this soapstone disk necessary on such lamps as are shown in this patent?

Same objection and the further objection that it does not appear by the question what lamps are referred to as containing the defects mentioned in the first part of the matter quoted from the specification, whether of the lamp of the patent or lamps that had gone before.

A. The lamps constructed as those shown in this patent are, were run by us to an extremely high incandescence, much higher and giving much more light than the ordinary incandescent lamps of to-day—several times the candle power now ordinarily employed; we used the large currents and this high incandescence because at the time we considered it highly desirable in our incandescent electric lamp. In such lamps run to the high incandescence I have spoken of, much greater heat was developed than in the lamps of to-day. I believe that at the time we thought this high incandescence and great light necessary to the introduction of incandescent electric lighting. To provide against the effect of this large heat the devices of which you have spoken, were introduced by us into the lamp. I believe we considered them necessary under the circumstances of use which I have stated.

1416 X Q. 1387. You say you believe you considered them necessary. Was this opinion theoretical, or had you found that where the disk was not employed perfect joint could not be maintained. I am speaking, of course, of lamps of this patent?

Same objection.

A. We found that the use of the disk and of the long conductors, or conductors formed specially to radiate heat, prevented heating of the base of the lamp, and that perfect joints could be maintained by their use. In lamps where they were not used, the bottoms of the lamps became hot, and leakage did occur there sometimes, and sometimes breakage, when run up to high incandesence, as we ran the lamps.

Adjourned till Monday, the 31st inst., at 1 p. m.

New York, *Nov. 7th,* 1887.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. Man proceeded as follows:

X Q. 1389. On May, 31st, 1878, you filed an application for an "improvement in electric lighting systems," which application resulted in letters patent No. 205,303. This patent was reissued on an application for reissue filed May 14th, 1881, and June 6th, 1882, and is reissued letters patent, 10134. These patents cover a device by which the current is gradually turned onto the lamps. Did you think it important to turn the current gradually onto your lamps?

Same objection.

A. With the larger-size carbons, yes; and where the lamps were filled with gas at atmospheric pressure, or near that with any sized carbon.

1417 X Q. 1390. In lamps such as are shown in patent 205,144, was it necessary to turn the current on gradually?

Same objection.

A. I can only give the same answer as I did before, and add that we did not endeavor to preserve a vacuum in those lamps that I remember, and finally sealed up for use while we were at 43 Centre St.

X Q. 1391. Question repeated.

Same objection.

A. I can only repeat the answer as I have given it to that question, and say that with the conditions under which the lamps were used at 43 Centre St., yes; when filled with nitrogen gas, yes.

X Q. 1392. Is this a correct statement?

"In lighting a lamp such as that shown and described in letters patent 205,144, we found it important to turn on the current gradually."

A. We did find it important to turn on the current gradually, because we were using a lamp filled with gas.

X Q. 1393. Why was it important?

Same objection.

A. Because the carbon was sometimes broken when the current was turned on full force suddenly.

X Q. 1394. At the time you applied for a patent on this switch patent 210,142, did you consider its use necessary for your lamps?

Same objection.

A. I do not remember. I knew we thought it important in this system of electric lighting.

X Q. 1395. You have been interrogated as to the very first experiments performed by you and Mr. Sawyer, with reference to paper and fibrous carbon. The last experiment you described was the taking of a slip of paper soft and porous, filling it with plumbago, pressing the plumbago into the paper and burnishing
1418 it, and then attempting to run a current through. What was the next experiment with paper or fibrous material?

A. The next experiment was filling the paper with graphite by soaking it in water in which graphite was suspended, drying it and repeating until it was well filled with the graphite or plumbago, rubbing it in the paper after dry, burnishing it and pressing it in and then using the slip of paper thus prepared in a lamp or the incandescent portion of an electric lamp, endeavoring to carbonize the paper by the heat produced by the current while in an inert atmosphere used to prevent consumption.

X Q. 1396. Do you remember the size or kind of paper used for that purpose?

A. I think in these first experiments we used ordinary white blotting paper, as to size I cannot recollect. I should think, however, perhaps an eighth or tenth of an inch in width, the thickness of from one to three sheets of the blotting paper, a total length of three-quarters of an inch to an inch between the holders when placed in the lamp about an half inch, perhaps more.

X Q. 1397. In this case was the paper merely used us a support or holder for the plumbago or graphite?

A. No, the intention was to carbonize the paper. We had used pencils of graphite before.

X Q. 1398. Did you get a current through this piece of paper?

A. Yes.

X Q. 1399. What happened?

A. It was heated up and carbonized and broken, as we thought, by the shrinkage due to carbonization.

X Q. 1400. What was the next experiment?

A. We soaked the same kind of paper in different mineral salts and partially reduced the salts, so as to make an electric conductor, using them in the same manner as we used those filled with
1419 plumbago. We heated them up by the passage of the current and carbonized them, but not with as good success as with the slips filled with plumbago. In neither case did the carbons produced last before breaking but a moment or two. Those filled with plumbago lasted the best, and the carbons aside from breakage seemed to be of good quality.

X Q. 1401. What were the mineral salts to which you refer, and how did you reduce the salts?

A. Two of the salts which we used, or tried to, were nitrate of silver and acetate of lead. Perhaps we used others—I don't recollect. I forgot what reaction we used to reduce the salts, probably in the case of the lead the reaction of sulphuretted hydrogen or hydrogen. We did very little of it, however.

X Q. 1402. As I understand you, after soaking, the paper was allowed to dry, and the object of this treatment was to have the paper absorb the mineral salt in order that its resistance might be reduced so as to enable you to force a current through?

A. Yes.

X Q. 1403. What was the next thing you did?

A. The next thing we did, that I recollect, was to carbonize the paper in a close vessel covered with powdered carbon or plumbago in a furnace.

X Q. 1404. Until you carbonized paper or fibrous material by the heat of a fire, do I understand that you had not succeeded in getting a conductor in which paper or fibrous material was employed that was good for anything?

A. No. Rather, up to the time when we carbonized the paper in a furnace in a closed box we had not succeeded in making a practical conductor for an incandescent electric lamp out of the *the* fibrous or textile material. We had only succeeded in producing a carbon suitable for the purpose of such a conductor, but which broke in the process of making it. We practically could not carbonize with the current as we used it. We thought, however, at the time,
1420 that holders might be devised by which the operation might be rendered practical, but we did not go further in that direction; at least I have no recollection of it. We simply succeeded in producing a good quality of carbon, not a good illuminating conductor; with the mineral salts we did not get a good carbon.

X Q. 1405. What information or suggestion had you derived from these experiments which induced you to try carbonizing by fire?

A. We had discovered that the paper made a good quality of carbon.

X Q. 1406. Had you discovered whether it would make a good incandescent conductor?

A. I don't know; we thought it might.

X Q. 1407. What is your best recollection as to how long it was after you went to Centre street that you first tried the carbonizing of fibrous material or paper by fire.

A. I cannot recollect; but taking everything into consideration, an approximation to it would be two or three weeks after we went there. It might have been earlier.

X Q. 1408. Please tell me where you got the iron box in which you did your first carbonization, what material you carbonized, what were the sizes and shapes of the material, where they were put into the box, and where the carbonization was done?

A. The iron box was one got by Mr. William Sawyer, father of William E. Sawyer. It was adapted to use from some piece of iron, I think, that he got from some of the shops at 43 Centre street. The material carbonized, to the best of my recollection, was ordinary blotting paper and card paper, or drawing paper. Some of the sheets cemented together in several thicknesses; the pieces carbonized first, I think, were flat sheets an inch or two square. The box was filled by old Mr. Sawyer and myself at 43 Centre street, and was clamped or wired up after being filled with the powdered carbon and the paper to be carbonized, and then taken by me to my house, 118 Putnam avenue, Brooklyn, and carbonized in my kitchen range. 1421

X Q. 1409. Now, first as to the size and character of the box. Please give me, as near as you now recollect, the dimensions of this box, stating the thickness of the iron, the kind of iron, and how the box was closed or fastened?

A. I think it was a piece of cast iron, with flat ends, with a hole through it lengthwise, from the best of my present recollection, about three inches in diameter. Its outside was, I think, irregular in shape, leaving the thickness of its walls uneven; I should say an average of about one-half or three-quarters of an inch. The ends were closed, making it a box by flat pieces of iron. My impression is that they were of wrought iron, but they may have been cast, and the ends in its first use were, I think, fastened on by wires around the whole thing. I don't pretend that I can recollect with accuracy with regard to this thing such details as you ask me. I simply give the best and only impressions I have in regard to it. I testified in regard to this matter in the interference case between Edison and Sawyer & Man several years ago, when my recollection in regard to the matter was perhaps better than at present. I think that testimony is correct.

Adjourned till Wednesday, the 9th inst., at 1 p. m.

1422 NEW YORK, *Nov. 9th*, 1887.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. MAN was continued as follows:

X Q. 1410. What, as near as you remember, was the length and diameter of this box?

A. Outside about four inches in width or diameter; inside about three inches in diameter; the length of inside from open end to open end, I should think about two or two and a half inches—it might be three inches.

X Q 1411. How were the pieces of paper and powdered carbon put into the box?

A. First a layer of powdered carbon put into the box, which was leveled off, smoothed down and pressed level with a follower, then a layer of paper laid on top of this powdered carbon, then another layer of powdered carbon smoothed down, leveled off and packed, then a layer of paper on top of this, then another layer of carbon, another layer of paper and another of carbon, until the box was filled. On top of the last layer of paper, powdered carbon packed in until the box was completely filled, and the powdered carbon rose a trifle higher than the top of the box. The covering piece was then put on, pressed down upon the upper open end of the box to close it, and pack in the carbon. The whole was then taken and bound together with wire.

X Q. 1412. Had the paper been treated in any way?

A. No, except where more than one thickness of paper was used; in that case sugar, molasses or treacle was used between the layers of paper, and they were pressed and dried. I do not know, but we may have compressed the other paper before putting it into the box. I do not recollect; we sometimes did so.

1423 X Q. 1413. Was the sugar, molasses or treacle used as a glue solely?

A. Yes.

X Q. 1414. This box, as I understand, you took home and placed in the fire of your range?

A. Yes.

X Q. 1415. What was the make of range in your house?

A. It was a McCann range.

X Q. 1416. What, about, was the size of the fire-box?

A. As near as I could judge (I never measured it) about twenty to twenty-two inches long by nine or ten inches in width, and about fourteen inches in depth.

X Q. 1417. What sort of fire did you use?

A. Coke fire.

X Q. 1418. How long did you leave the box in the fire?

A. I cannot recollect, until the whole thing was heated up as high as I dare to heat it, for fear of melting the box, and kept hot for a considerable time, perhaps half an hour, more or less.

X Q. 1419. Did you sit and feed the fire with fresh fuel?

A. I think so. I know I stayed and watched it until I thought the carbonization was complete.

X Q. 1420. Had you ever carbonized anything before?

A. No, I do not recollect.

X Q. 1421. You say you kept it in the fire until you thought the carbonization was complete; what fact, in your mind, determined this question?

A. I do not know of any fact further than it had been heated up to a bright red heat for a considerable length of time.

X Q. 1422. By considerable length of time what did you mean?

A. I kept it red hot half an hour, more or less.

1424 X Q. 1423. Did you then take the box from the fire?

A. Yes. I took the box off.

X Q. 1424. What did you do with it?

A. I think I put it in the hot ashes under the grate, covered it up and shut up the range, and left it there till the morning. The work was done that evening.

X Q. 1425. As I understand then, the box was in the fire a sufficient length of time to enable it to become red hot, and was kept red hot for half an hour?

A. I should judge so.

X Q. 1426. Was the box heated to a red heat as rapidly as your fire could be made to heat it, or gradually?

A. I do not recollect. I do not think it could be immediately so heated up.

X Q. 1427. Did you open your box at your house next morning, or did you take it to Centre street?

A. No, it was fused together, or the bindings were so fused to it that I could not open it.

X Q. 1428. Where was the box opened?

A. At the workshop, 43 Centre street, by old Mr. Sawyer.

X Q. 1429. Were you present when it was opened?

A. Yes.

X Q. 1430. How was it opened?

A. I don't recollect; I suppose with a file and cold-chisel.

X Q. 1431. You had to cut or file the wires that were wound round the box, had you not?

A. Yes.

X Q. 1432. Were the tops or ends fused to the sides or walls of the box?

A. No; I should think that they were, perhaps, slightly welded; at all events, they were adherent to the box, so that they had to be
pried off or wedged off with a cold-chisel, after the wires
1425 were cut, or one of them, at least, had to be so pried off or
wedged off; I think the other was left on.

X Q. 1433. Do you remember whether it took some time to open the box?

A. A few moments only, I should think.

X Q. 1434. Who took the carbons out of the box?

A. I don't recollect; probably I did it myself, or I and Mr. William E. Sawyer.

X Q. 1435. In what condition did you find the paper that had been put into the box?

A. Some of the pieces were nicely carbonized, and intact. If I recollect correctly, some of the pieces near the open ends of the box were partially consumed at their edges.

X Q. 1436. Did you notice any difference in carbonization between the blotting paper and the card-board?

A. I do not recollect to have noticed any.

X Q. 1437. Did you notice any difference between the carbonization of the pieces that had been glued together and the pieces that were not?

A. I don't remember any; they were thoroughly carbonized.

X Q. 1438. Had you ever seen carbonized paper before?

A. Yes.

X Q. 1439. Where, and when?

A. I do not recollect; I had often seen it.

X Q. 1440. For what use was it intended?

A. I do not know that any use was made of it. It was carbonized for other operations than those for the production of carbon.

X Q. 1441. What did you do with this paper that you carbonized at your house?

A. We cut it up and used it for the incandescent conductor in our lamps.

X Q. 1442. How did you cut the sheets?

1426 A. I don't know whether with scissors or with knife.

X Q. 1443. Did you break many sheets in cutting?

A. Yes.

X Q. 1444. Who did the cutting?

A. I think mostly Mr. William E. Sawyer; he was most skillful at it.

X Q. 1445. Were you present when the cutting was done?

A. Some of it.

X Q. 1446. About how many sheets were taken from the box?

A. I cannot recollect; I should think eight or ten, or more.

X Q. 1447. How many conductors did you succeed in cutting from the sheets?

A. Only a few; perhaps a dozen or twenty, perhaps not so many.

X Q. 1448. Were they cut at the same or at different times?

A. They were cut at different times.

X Q. 1449. Were they all cut before any further carbonization was done?

A. That I don't recollect; I should think not.

X Q. 1450. You say you run some of this carbonized paper to incandescence, do you remember the dimensions of the first conductors you used, or whether they were cut from one sheet or several thicknesses, of from card-board or blotting paper?

A. I do not remember definitely in regard to the matter, further than this, that we used up all the carbons which we had made, in our lamps, of all the kinds that we first made; the impression I have, is that the thickest carbons were the ones we made most use of and found most successful. I could not now state the size of carbons or their length to distinguish these from others that we used.

1427 X Q. 1451. Inasmuch as you had to cut the carbons from the sheets of carbonized paper and could have cut them in any size you desired, and inasmuch as upon the size of the carbon would depend their resistance and the amount of current which would be required to run them to incandescence; and inasmuch as the resistance, the carbons and the quantity of the current required must have had direct relation to the generators of electricity you used, can you give me no idea of the dimensions of the carbon conductors you cut from the paper? You will bear in mind also, that the size and shape of these carbons must have had some close relation to the kind of lamp in which you tried to use them.

A. From the considerations spoken of by you, and from others and possibly from recollection, I proceed to give you my idea of their size and shape. First as to shape. I think these first paper carbons were all cut into straight strips and into low, flat arches, the carbons were too tender to stand pressure between holders and were stretched across tops of the holders in the lamps, their ends resting in slits cut in the tops of the holders. Between the holders the distance was varied from a quarter of an inch to half an inch, or possibly five-eight-s; this gives the lengths of the incandescent portions of the carbon; their width was various, as I should say now from a twelfth of an inch or less up to three-sixteenths, possibly a quarter of an inch; their thickness was the thicknesses of the carbon of the paper from which they were made; some of these first paper carbons, I think may have been bent flatwise, forming an arch rising above the holders, the ends of the arch resting upon the tops of the holders in a slit or slits made to receive them; or upon a ledge cut on the inner faces of the holders upon which their ends rested and held in place by the spring of the carbon. I am not positive as to any of these first carbons being used in this last way, but I think it possible they were.

X Q. 1452. As I understand you, the lengths of the carbons were
from a quarter of an inch to three-sixteenths of an inch;
1428 their width from a twelfth of an inch, or less, to half an inch,
and their thickness the thickness of the sheets from which
they were cut?

A. This is in accordance with the idea I wished, except as to length. I spoke only of the incandescent portion of the length of the carbon; to this should be added the thickness of the two holders, perhaps six-sixteenths of an inch to make their total length.

X Q. 1453. I assume these experiments were conducted with some intelligent purpose; if this be so what was your object in making conductors from the paper which you carbonized?

A. Our object was to get a good and cheap, readily made incandescent conductor and this was one step in the process.

X Q. 1454. Good in what respect?

A. Of pure carbon, and so able to withstand the intense heat of the incandescent lamp conductor.

X Q. 1455. Before carbonizing the paper you knew it could be carbonized?

A. Yes.

X Q. 1456. That if carbonized it would be substantially a pure carbon?

A. Yes, if made of the right kind of paper.

X Q. 1457. That when the sheets or mass were carbonized you could cut from them conductors of such shape as desired?

A. No, we did not know that, but we thought it probable and worth a trial, and we did not know that if we could cut the paper carbons into the size and shape which we desired for incandescent conductors, that they would then have sufficient coherency and strength to be used as such incandescent conductors, or whether they would have other properties necessary or desirable in such conductors.

X Q. 1458. By other properties, to what properties do you refer?

1429 A. Density, durability, elasticity, capability of expansion and contraction without fracture, suitable conductibility or resistance, and the like.

X Q. 1459. I am anxious to understand the object you had in view when making conductors from carbonized paper the first time. You say you knew that paper could be carbonized and that if proper paper were used, a reasonably pure carbon could be obtained, but that you did not know positively whether a conductor could be cut from a carbon sheet, or whether the carbon when cut would have requisite consistency and strength, to hold together under the effect of the current running to incandescence or to be handled and put into holders. Now please state the object you had in view in this first experiment?

A. In the first place, at that time it was extremely difficult to get any pure carbon at all suitable for an incandescent conductor. That we had obtained was difficult and expensive to work and get into shape and size; again, we thought it was not all that was desirable in many respects, such as I have mentioned above and enumerated for such conductor; we thought we might get a good conductor, as we then looked upon it, from the carbonization of paper. I do not think we went into any refinements in regard to it, such as would be considered in the present day, or such as we afterwards came to consider in the manufacture of incandescent conductors. In using the word good conductors I used it only in the sense in which we looked upon it at that time, without going into the particulars or details of the matter, and without pretending that our ideas at that time were definite or fixed as to the best conductor. We knew some properties and some things which we thought desirable, and if it fell in with those we would think it a good conductor, if it proved in our use practical.

X Q. 1460. Had you any preference at that time for a low or high resistance in the carbons, assuming the carbons to be of the same size and shape?

1430 A. I do not know what you mean by a low or high resistance; if you mean relative resistance, I can answer the question.

X Q. 1461. What I wish to know is whether at the time you carbonized this paper first, you had any preference for a low or high resistance in the carbon, due to its character or construction and not dependent on its size or shape?

Question objected to as being one which is impossible for the witness to answer; the question of high and low resistance being purely comparative and undetermined; impossible for the witness to know what is meant by the question and by the expression high and low resistance.

A. I cannot answer that question unless you state to me what you consider in the question a high and what a low resistance. If you ask the question substituting the words lower for low and higher for high, I will answer it.

Adjourned till Nov. 10th, at 1 p. m.

NEW YORK, *Nov. 10th*, 1887.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. MAX continued as follows:

X Q. 1462. Is it not true that carbons of the same dimensions differ in their electrical resistance due to the difference in structure or character of the carbons?

A. It is.

X Q. 1463. At the time you made this first experiment, had you any preference for a carbon having a higher resistance over a carbon having a lower resistance?

A. Within certain limits I had. Mr. Sawyer had a decided preference for the higher resistance kinds of carbon, perhaps I should
say that it was his opinion at the time that the higher resist-
1431 ance carbons within practical limits of resistance were, or
would prove the best carbons for the incandescent conductor
of an electric lamp. My own opinion upon the subject at the time was not fully formed, and I may say that it was a tentative opinion, that greater conduct*a*bility or less resistance in the carbon would be desirable for the incandescent conductor of an electric lamp, than Mr. Sawyer thought.

X Q. 1464. Do I understand, then, that you and Mr. Sawyer differed then, as to the desirability of a higher or lower resistance in carbons of the same size and shape?

A. Yes; I think we were not agreed.

X Q. 1465. In trying this first experiment in carbonization of paper, had you present in your mind the getting a higher resistance in the carbon due to the character and construction of the carbon?

A. I do not think we had, as a separate thing.

X Q. 1466. Then the object of this experiment was to ascertain if you could get a pure carbon, which would hold together under the effect of the current, which was strong enough to be put into the lamps, and which would last well with the current you were then using, and which could readily be made of any desired shape or size?

A. Yes; I do not recollect now any other purpose we had in mind at the time, but I do not mean to say that other things may not have been thought of by us, but I do not recollect any others.

X Q. 1467. You say from the first paper carbonized, you succeeded in cutting from twelve to twenty pieces, which you tried as incandescent conductors; did you cut the pieces to correspond in shape and size to other conductors you had used?

A. Some of them substantially so, others not at all so; I refer to those that were bent flatwise in the shape of arches, rising above the tops of the holders; we had used none of this kind before and they all differed in the manner of their connection with the holders.

1432 X Q. 1468. Had you ever before tried to run to incandescence a conductor as thin as a conductor made from a single sheet of paper carbonized?

A. I do not remember any, except the paper filled with plumbago.

X Q. 1469. Do you refer to the experiment concerning which you have previously testified?

A. Yes. It may be, however, that some of the carbons made from sheet French carbon and worked down, may have been as thin as the single-sheet paper carbon.

X Q. 1470. Did you succeed in running any of the carbons cut from the sheets of paper carbonized in your first experiment, to incandescence?

A. Yes.

X Q. 1471. All of them, or only some?

A. Only some of them; some of them were of too high a resistance for the current from our dynamo; they were cut too narrow.

X Q. 1472. Which of the carbons could you run to incandescence?

A. Those of least resistance.

X Q. 1473. And which were they?

A. Those of the largest cross-section, those that were thickest or widest, or both.

X Q. 1474. Did you find that the larger the carbon the more brilliant its incandescence?

A. Yes, within certain limits.

X Q. 1475. You say some of these carbons were of approximately the same dimensions as those you had previously used; which were they, those cut from the sheets of blotting paper glued together?

A. Some of them were, and some of them from the single sheet of drawing, or blotter, or card.

1433 X Q. 1476. Did you notice any difference between the incandescence of those carbons, corresponding in size and shape, to carbons of other materials previously used, and such carbons so previously used?

A. I do not remember.

X Q. 1477. What machine were you using at this time?

A. That I don't remember.

X Q. 1478. Did you know at that time, other things being equal, that the incandescence of the carbon would depend upon the resistance of the carbon and the quantity of current conveyed to it?

A. No, I don't think that is an accurate statement; but as the quantity of current was interdependent with the electro-motor force and the resistance in the circuit and also that the work done in the lamp with a given current was dependent upon its resistance, relatively to other resistances in the circuit, it does not seem to me that your statement, to which you wish me to assent, is accurate. We knew that the current remaining the same, the incandescence of the lamp would be increased as its resistance was increased, relatively to the total resistance in the circuit; in other words, that the work would be done where the resistance existed.

X Q. 1479. You say that you do not remember the machine that you were using at this time; can you give me any idea of its electromotive force, or the quantity of current generated by it?

A. No, only that it was sufficient to light up our lamps.

X Q. 1480. Would it light up equally well any and all carbons, irrespective of their size or character?

A. No.

X Q. 1481. Which would it light up the best?

A. Those that we adapted in size and resistance to the current produced.

X Q. 1482. What was the size and resistance best adapted to this current?

A. That I don't know.

1434 X Q. 1483. Can you not give me any idea?

A. I have already given that in the size and shape of the carbons we used. I will add that it frequently happened that we could light up with our current as we adapted the carbon only one, two or three lamps at a time; some of the carbons were such that if we undertook to place a number of lamps in multiple arc, the quantity of current was not sufficient to light them all up; again some of them were of so high resistance that the electro-motive force was not sufficient to pass the current through more than one, two or three of them, when placed in series. Of course the carbons were different at different times and in different lamps.

X Q. 1484. Now, with a given machine you could only produce given results. You don't remember the machine you had this time, and you can tell me neither its volts nor ampere capacity; if you are intelligently conducting your experiments, you must have made your lamps with some reference to your machine and arranged them, if several were used with reference to it. If the resistance of your carbon was a hundred ohms and the electro-motive force of your machine ten volts, the carbon would not become incandescent. On the other hand, if the resistance of the carbon was a fraction of an ohm and the electric force of the machine two hundred volts, and no resistance in the circuit, the carbon would be destroyed. Again, the durability of the carbon and of the whole lamp, of necessity depends upon the relation the lamp bears to the current which is conveyed to it. Can you not tell me, therefore, what work this machine would do in the way of running carbons to incandescence?

A. You forget in criticising our work, which is all the point I see in the question, that the appliances of that day were not those of to-day. You leave out of consideration the fact that we had not

then perfected a system of incandescent lighting and were
1435 working to that end. I have no other answer to make to your question, other than that we did such work as was necessary to run the carbons in the lamp to incandescence, and ascertain what we wanted to know, which was, to know if such carbons could be used. I cannot give electro-motive force, ampere resistance nor volts with any degree of accuracy and can only say that they varied at different times.

X Q. 1485. I take it, you must have known what this machine would do, and what it would not do, and that fact I am anxious to ascertain; now, if it was of such capacity as to run a lamp of a fraction of an ohms' resistance to incandescence, a lamp of a hundred ohms' resistance would not be adapted to this machine; again, if several lamps of the same resistance were *and* arranged in series, and could be run to incandescence, these lamps could not be placed in multiple arc, without a different result. Can you not tell me, therefore, what this machine would do and how you adapted your lamp to it?

Question objected to upon the ground that it is mere repetition, the witness having already stated repeatedly that he does not recollect or know the volts or amperes of the machine and that they had simply a machine or machines to which they adapted their lamps in their resistance, to enable them to determine the practicability of an incandescent conductor made of carbonized paper of an electric lamp.

Question is further objected to, on the ground that it is false in its inferences, in that it assumes that the experiments were not intelligent.

A. I answer, I do not know now, if I ever did know, the capacity of the machines we used. I agree with you, that we did not do impossible things. We did do what I have said we did.

X Q. 1486. Would this machine light up lamps equally well, of low or high resistance, and whether arranged in series or multiple arc?

1436 Question objected to, on the ground that there is no issue of high or low resistance in this case, nor is there any question as to whether the lamps are in series or in multiple arc. If, as a matter of fact, the dynamo was sufficient to prove that a good practical incandescent conductor could be made from carbonized paper, it is sufficient upon the issues of this case. Question being wholly immaterial for the reason stated.

A. All I can say in regard to that is, that we did light up lamps with the machines we used and our other appliances both in series and in multiple arc as well.

X Q. 1487. I am speaking of the machine you had when you first tried to run the paper carbons to incandescence. Was that machine equally adapted to run to incandescence high and low resistance lamps whether in series or multiple arc?

A. I do not remember the machine we had in use with these first experiments of paper carbons. If you wish to say that a machine must be adapted and run to the work required of it, or the work required of it adapted to the machine, I agree with you.

X Q. 1488. I am desirous of getting the facts with regard to these experiments. If you used one machine you must have found that with different arrangements of lamps and different resistances of conductors, different results would follow; this is true, is it not?

A. Yes; and different results would follow, according to the velocity at which the machine was run, the manner of excitation of its field magnet, the extent of that excitation, and the differing resistances in the circuit.

X Q. 1489. Very well. Could you have used a machine for any time without ascertaining what results it would produce?

A. We probably did know at the time the limits in work
1437 of the machines used at the time, and their capacity for different kinds of work, that is, work done by greater or less electro-motive force.

X Q. 1490. You must have known these things if you were working intelligently, must you not?

A. Within certain limits, I think so.

X Q. 1491. Now, if a machine were adapted to run to incandescence a conductor of one ohm's resistance, there being no other resistance in the circuit, you could not take that lamp out of circuit and put in a lamp of a hundred ohms and run it to incandescence, leaving everything else unchanged, could you?

A. Not without changing the velocity of the machine, or increasing its electro-motive force in some way.

X Q. 1492. Then, with a given machine, if you experiment with lamps having carbons of different resistance, you must have known what effect the machine would produce, would you not?

A. Within the limits of variability of the machine we must have known either in electric units of measurement, or in practical manifestation of work.

X Q. 1493. Now you don't remember electrical units, do you remember manifestation of work as to the machine you had when you first tried these paper carbons?

A. Only to the extent I have stated, in the general fact that it heated up the carbons to incandescence; how many, whether one or more, and when more, how arranged, or what resistances were in circuit, I cannot remember.

X Q. 1494. Do you appreciate that, if I could ascertain, either in electrical units, the capacity of this machine, or by a clear statement from you of the work that it would do under given conditions, I would be able then to demonstrate just what could or could not be done by this machine; or, in other words, I would be in a position to verify or demonstrate the incorrectness of your statement?

1438 A. I would be glad to give you every detail, if it were in
my power to do so, knowing that it would demonstrate the truth of my statements. Had I then appreciated, as fully as I now do the value of what we were doing, and the consequent value of

perfect, complete and accurate record of every experiment, I should not be placed in the position of not being able to give details; further than this, it is proper to say that such peculiar, unusual and persistent efforts as have been made in this case to overthrow, deny and belittle the work done by us was not anticipated by myself or my coworker.

X Q. 1495. Do you intend to answer yes to my previous question?

A. No, I do not think it would make any change whatever in this matter, or that you would be able or rather willing to admit the demonstration, if adverse to your preconceived ideas or those of your clients. I admit that if all the details, complete, of our work, were in the hands of parties unbiased and impartial, and sufficiently intelligent, it would enable them to demonstrate the truth of what I have stated.

X Q. 1496. It seems to me that while you testify very positively as to what results you accomplished, your memory is remarkably defective as to the means by which they were accomplished. You were one of the inventors, your coinventor is dead; if I could ascertain from you the facts upon which the general results as to which you testify depend, I would either greatly strengthen your case, or be in a position to show that the general results of which you speak could not have been accomplished with the means at your command. Now I have interrogated you as to a necessary factor in the experiments you performed on carbons, to wit: The dynamo machine used by you in running the first paper carbon to incandescence; if, with this machine, you tried to run to incandescence carbons varying in size and in resistance, due to this variance, or varying
1439 in resistance by reason of different size and difference in the character of the carbon, and if, of these carbons, or any of them, more than one was placed in circuit, or their arrangement varied, it would seem to me incomprehensible that you could not give me some idea of the work this machine would do. Do you wish to occupy this position before the court, that you remember distinctly making lamps containing carbons of different sizes and of different character, and running them to incandescence by this machine; that they were arranged in series and multiple arc; that few or many lamps were placed in circuit; that under all conditions the current was adapted to the lamps; but that you have absolutely no recollection as to what condition of resistance or arrangement the machine was best adapted to?

A. No, I do not want to occupy any position before the court hypothetically suggested by you in your question, containing, as it does, statements, omissions, and interferences not warranted by anything I have said. I wish to occupy before the court just that position which is shown by my testimony and no other. It is not strange that I cannot remember details, and that results best remain in my mind.

Adjourned till November 11, at 1 p. m.

1440 NEW YORK, *Nov.* 11*th*, 1887.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. MAN was continued as follows:

Witness here desires to add to his last answer the following:

There is another reason, perhaps, why I do not remember more in regard to electrical details, units and capacities. Mr. Sawyer took principal charge of the running of the dynamos, their arrangement, the arrangement of the lamps, the switches, shunts and resistances, and he made the electrical measurements that were made. If he were alive, he might be able to give the details, which I, knowing them probably at the time, but not personally working them out, cannot remember.

X Q. 1497. I have tried to get from you the capacity of the dynamo machine, in order that I may identify the machine you used as closely as possible, having interrogated you previously as to the various machines you used at different times. Please tell me, as near as you can recollect, when paper carbons were first run to incandescence?

A. I have already answered that question, that I did not know; but the nearest approximation I could give, was about two or three weeks after we went to 43 Centre street. It might have been earlier or later.

X Q. 1498. Have you any recollection or impression as to which dynamo machine you were then using?

A. I have not.

X Q. 1499. Does nothing in the experiments enable you to remember?

A. No, I don't remember anything now.

1441 X Q. 1500. You had tried to run to incandescence before trying these paper carbons, carbons varying in size and resistance, had you not?

A. Yes.

X Q. 1501. Had you found in trying such carbons, so varying, that with the same current, different results would be produced upon the different carbons?

A. We did not need to try it to know that.

X Q. 1502. I am anxious to know the fact, so please tell me what you found in practice.

A. That some carbons were of too high a resistance and some carbons of too low a resistance, according to their arrangement, and the current attempted to be used upon them at the time, to be properly lighted up. In explanation of this answer I will add: The currents from the same machines were very variable at different times, on different days and on the same day, due to our want of control of the motive power, and to the variable work going on in the factory, of which ours constituted a very small part.

X Q. 1503. You say that some carbons were of too high a resistance and some of two low a resistance, according to their arrangement and the current attempted to be used upon them. Can you give me no idea whatever as to what carbons were too high and what too low, and what the arrangement was to which you refer—I am speaking of the time you first tried these paper carbons and of the prior period?

A. The same carbons when arranged in series would be or constitute too high a resistance at one time, for us to get a current through them to heat them up—illuminate them; placed in a multiple arc or multiple arc series, they would perhaps be lighted up. Again, when placed in multiple arc, the same number of carbons would make too small a resistance and not be properly illuminated, due to the variance of the current, when a less number of carbons placed in series would be. Now, to distinguish at this time what carbons were used would be impossible for me. Again, we 1442 attempted to use single carbons in a single lamp, which alone constituted too high a resistance for us to get sufficient current through them to heat them up, at one time; when at another time the same carbons would be beautifully lighted up. At another time a single carbon of too large size would not be lighted up by the machine, being too small in resistance, or the current being too small. At another time the carbon would be lighted up. I cannot at this time distinguish what particular carbons these were. Again, we used different qualities of carbon for the conductors, some of higher resistance than we could ordinarily light up, but we sometimes could light up. If you will specify any particular carbon, and will call my attention to it, and I have any recollection of it, I will try to answer more fully.

X Q. 1504. Were you then so ignorant of the capacity of the machine while conducting these experiments, that you could form no idea beforehand when putting a lamp in circuit, what the effect would be, and were dependent upon the trial to ascertain?

A. I have already explained the cause of this variance, in the varying force we were using. Could we know the velocity beforehand at which our machine would run or continue to run? I think we knew enough at the time of the capacity of the different machines we used to adjust the lamps to the current that would be produced, but it is true that I myself personally, at the time, knew very little about dynamo machines. Mr. Sawyer was very much better informed than I was in regard to the matter. We were, I think, at this time, as every one else was, dependent upon the trial of machines to ascertain their capacity.

X Q. 1505. You don't answer my question. I am speaking of a time which your best recollection fixes as two or three weeks after you went to Centre St., and I want to know if you were so ignorant of the capacity of the machines you used as to be able to form 1443 no idea as to the effect it would have on a given carbon when placed in circuit, and were dependent upon actual experiment to ascertain?

A. To this I answer, no. We could and did form an idea of the matter and usually correct ideas, as demonstrated by trial, but we made a great many mistakes.

X Q. 1506. That being so, do you now remember what your use had taught you as to the capacity of the machine?

A. No, not to relate the whole or any considerable portion of what we had learned.

X Q. 1507. I would be satisfied with a very slight idea; so if you can tell me anything in regard to the capacity of the machine I should like it.

A. I cannot undertake to state at this length of time and confining it to that period, or to any particular machine.

X Q. 1508. Could you have ascertained anything of value regarding the value of any carbons used in your experiments with a machine which would at different times produce entirely different results?

A. Yes, I think so. No machine was necessary to learn very much about the qualities of carbons.

X Q. 1509. The effect produced on the carbons is dependent upon the quantity and character of the current conveyed to it. That is true, is it not?

A. Yes.

X Q. 1510. A carbon of too high resistance for the electro-motive force of the machines would not be heated up?

A. No.

X Q. 1511. A carbon of too low a resistance for the electro-motive force would be so brilliantly lighted up as to be destroyed, would it not?

A. Not necessarily. A carbon of too low a resistance for the quantity of current furnished would not be heated up.

1444 X Q. 1512. Assuming no other resistance than the lamp in circuit, the carbon if of low resistance and the current of high electro-motive force, the carbon would be so brilliantly lighted up that it would be destroyed, would it not?

A. Assuming the power used to be sufficient, yes.

X Q. 1513. You, therefore, have to have a carbon, which in its resistance has relation to the current conveyed to it, for the intelligent conduct of any experiments looking toward ascertaining the quality of the carbon, have you not, as an incandescent conductor?

A. No; experiments outside of the use of any dynamo current might be intelligently conducted for determining the quality, character and resistance of a carbon and its suitability for an incandescent conductor for a lamp and without knowing the exact relations of the current used to the resistance of the carbon; intelligent experiment might be conducted with the use of a current by observation of the effect upon the carbon of certain temperatures higher or less high.

X Q. 1514. If you only had a current of five volts electro-motive force could you conduct experiments on lamps having conductors of a hundred ohms resistance?

A. No, you would have to have sufficient electro-motive force to pass sufficient current through the incandescent conductor to heat it up.

No. 286.
C.E. Light Co.
v.
McK. Light Co. } p. 1446

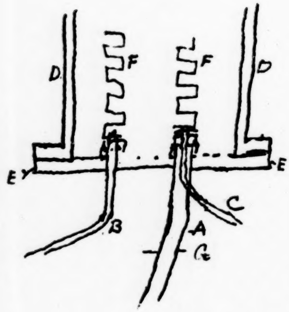


Fig 1

A. Glass tube fused in base
B Metal Conductor fused in base screw threaded at top.
C Metal conductor fused in glass tube A. screw threaded at top
D walls of Lamp Chamber
E glass base fused to flange of bottom. of Lamp chamber
F Exterior connectors -

Glass tube A. shown open was fused together at point G after Lamp was charged

Cross examination
Defendants exhibit
Man drawing
Dec 9 1887
J. G. Exr

X Q. 1515. If you had a current of a hundred volts electro-motive force and lamps of a fraction of an ohm's resistance, could you conduct experiments with but one such lamp in circuit, no other resistance outside the machine being in the circuit but the lamp?

A. No, not practically. You would probably burn up the machine or burst up your lamp, if the power were sufficient. Of course, the experiment could be tried and so much would be learned from it.

X Q. 1516. A person then while using the same machine, but trying carbons of varying size and resistance would of ne-
1445 cessity learn, if not in electrical units, in effects produced,
the capacity of that machine, would he not?

A. If he did not destroy his machine or his lamp he might get some idea of it, and probably would.

X Q. 1517. From a given machine in a given condition with an armature revolving at a given speed, and with a circuit of definite resistance, a current of definite quantity and electro-motive force results?

A. Yes.

Adjourned till Friday, the 18th inst., at 10 a. m.

FRIDAY, *Nov.* 25, 1887.

Met pursuant to agreement of counsel.

Present: Counsel as before, and the cross-examination of Mr. MAX was continued as follows:

X Q. 1518. When trying these first experiments on paper carbons did you burn up your dynamo machine?

A. Whether with these carbons or others I cannot recollect; we did destroy the insulation of the dynamo machine or injure it so that it had to be rewound or repaired.

X Q. 1519. What insulation do you refer to?

A. The insulation of the wires with which it was wound, I suppose the armature. I did not look to it personally, and I think it occurred several times.

X Q. 1520. To what did you attribute, at the time, this injury to the machine?

A. Substantially short-circuiting it; too little resistance outside of the machine.

(Here follows diagram marked p. 1446.)

Complainant's counsel instructs the witness to state, in case he had nothing personally to do with the management and manipulation of the dynamo in the experiments about which he is testifying, to say so upon the record, in answer to any future question of coun-
sel, the object of counsel being to ascertain whether the wit-
1447 ness has or had personal knowledge of the manipulation and
management of the dynamo, or whether he is testifying to
his recollection merely of what Mr. Sawyer told him about it.

Defendant's counsel objects to the instruction above given as improper.

X Q. 1521. Can you remember which machine it was that was injured in this way?

A. I think it was more than one, perhaps more than two or three, but I cannot remember to distinguish; I did not have personal charge of the running of the dynamos, but Mr. Sawyer had and usually run them, and had charge of the running and manipulation of the dynamos and circuits.

X Q. 1522. Was the arc-light machine one of these that was burned out?

A. I have no recollection in regard to that machine being burned out.

X Q. 1523. Your best recollection is that it was some of the machines that you had in your room?

A. That is my impression.

X Q. 1524. From the time you ceased using the arc-light machine in the basement and until you got the specially wound machine, I understand the machines you used were those you borrowed from Arnoux and Hochausen; was it these machines, thus borrowed, that you burned out?

A. We had, while we were at 43 Centre street, whether at this time or later I cannot recollect, other machines, among which was one or more of Weston's; I should think, however, that the machines that were injured were those of Arnoux and Hochausen; my best recollection would be that one or more of them was a borrowed machine, and that also the one we bought of them was injured.

X Q. 1525. Do you remember whether the first machine you had in your room at Centre street was burned out in this way?

1448 A. No; I remember only that it was out of order, or got so.

X Q. 1526. So that it could no longer be used?

A. No; I think we did make some use of it, but it was ineffective or crippled or diminished in efficiency.

X Q. 1527. Was it so inefficient that you had to get another machine?

A. We did get another machine, I don't know whether for this cause—possibly it was, but I do not recollect.

X Q. 1528. Was the second machine of the same make and general capacity as the first?

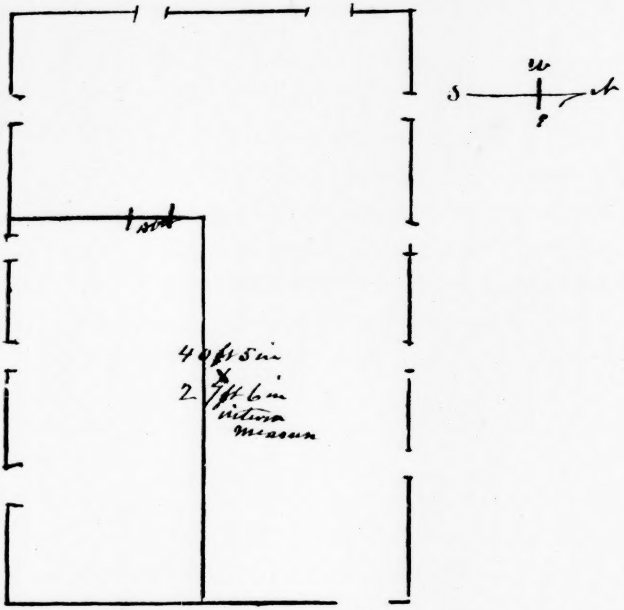
A. It was of the same general type, whether of exactly the same make I don't know, nor do I know its capacity.

X Q. 1529. After you got the specially wound machine, was it, or any of the machines you had at Centre street, after its delivery, burned out?

A. I have already answered that question as far as I can. I repeat: My impression is that both it and other machines were injured and had to be repaired.

X Q. 1530. Do you remember whether your getting different machines was caused solely by the destruction of the machines you had been using, or was prompted by other reasons?

No. 286.
C.E. Light Co.
v.
McK Light Co. } p. 1449


W
S
N
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40 ft 5 in
x
27 ft 6 in
interior
measure

over

Cons E L Co
vs
McKeesport L Co

Complainants Exhibit
Main diagram Centre
Sheet Shop March
27 1889
W.F.
S.E.

A. I think it was prompted also by other reasons.

X Q. 1531. Do you know?

A. I believe it was, and am confident as far as one could be at such a length of time, that such was the fact—I think we were trying different machines as to their capacity and suitability for our use.

X Q. 1532. But do you not now remember what capacity you desired, or in what "suitability for your use" consisted?

(Here follows diagram marked p. 1449.)

1450 A. I do not, as these matters were in charge of Mr. Sawyer, and he ran the machines and tested them; I doubtless knew at the time, but do not recollect.

X Q. 1533. You say in answer to question 1516 that a person while using the same machine, but trying carbons of varying size and resistance, if he did not destroy his machine or his lamp, might, and probably would, get some idea of the capacity of his machine. This being so, have you no recollection of the capacity of the machine you used when first trying these paper carbons?

A. I have no recollection of the electrical units, if I knew them. In effects we succeed in passing current through paper carbons and heating them up to incandescence. Some paper carbons that we tried were of so high resistance that we could not get a current through in sufficient quantity to heat them up; in others we did. I am speaking of the first batch of paper carbons.

X Q. 1534. Do you remember whether the machine which applied the current to this first batch was in your room or not?

A. I have stated already that I do not.

X Q. 1535. You do not remember the machine you used in heating up these first carbons; do you remember whether you ever afterwards regarded it as unsuited to carbons made from paper or fibrous material?

A. Not recollecting the machine I could not do so one way or the other. I remember subsequently, and after we cut the carbons to shape before carbonization, having difficulty in getting a current through the carbons in the first instance with the current at our disposal, and I remember rapidly making and breaking connection between the poles of the machine with a file, and with a saw, and with a notched piece of iron, to force the current through these carbons in the first instance.

X Q. 1536. Do you remember whether the machine to which you last refer was the same machine as you used in your experiments on the first paper carbons?

1451 A. I do not.

X Q. 1537. I understand you to remember distinctly two things concerning the trial of these first paper carbons: First, that through some you did not get current in sufficient quantity to heat them up; that others you could heat up—am I right?

A. Yes.

X Q. 1538. Do you remember whether, in the case where the paper carbon did not become incandescent there was any other resistance in circuit outside the machine than the single lamp containing the carbon?

A. I only remember that we had adjustable resistances in the circuits as we ordinarily used our lamps and experimented. These resistances could be diminished to little or nothing or increased to a great many ohms. I cannot recollect the arrangement in our experiments with the first paper carbons. I assume, however, that we had little or no resistance except a single carbon in circuit when the current was first passed through the paper carbons.

X Q. 1539. In those cases where the paper carbon was heated up was there any resistance in the circuit other than the paper carbon?

A. I repeat my last answer. Probably not at first.

X Q. 1540. We then have this fact, as I understand, that whatever machine you used at this time its capacity was not sufficient to run to incandescence some of these paper carbons, or in other words, some of these paper carbons were of too high a resistance for this machine?

A. No, that is not necessarily so; because it assumes that we tried only one machine upon these paper carbons. If we tried more it would be true when the current was not passed through the carbon that the machine then used in that experiment did not have sufficient el-tro-motive force to pass sufficient current through that carbon to heat it up to incandescence.

X Q. 1541. I speak of the machine you used in running the first batch of carbons to incandescence; I have understood you to
1452 say that that machine would run some of the carbons to incandescence, but not others. Have I understood you?

A. You have. I have simply stated that with some of the paper carbons first made we succeeded in heating them up to incandescence with the current we were using at the time without reference to dynamo machines, for I do not recollect them, and that at other times, with some of those paper carbons we did not get sufficient current through them to heat them up. I have not stated, and do not intend to state, and do not know whether we used more than one dynamo machine with these carbons. Furthermore I have stated that with the same machines we got at different times different electro-motive force, for reasons which I have fully explained. Nevertheless it is true, and that is the impression I wish to convey, that some of these paper carbons we thought were of too high resistance for practical use with the current we had.

X Q. 1542. Well, which were these paper carbons?

A. They were the smallest and longest ones; those of highest resistance.

X Q. 1543. Please tell me as near as you can the length and cross-section of the carbons to which you refer?

A. I have already given them as near as I can recollect. Do you mean those of highest resistance?

X Q. 1544. I mean those which you "thought were of too high resistance with the current that we (you) had"?

A. They were less than a thirty-second of an inch in diameter in one direction, of the thickness of carbonized blotting paper, of a cross-section at right angles to this, approximating one-sixteenth of an inch, perhaps less than that, and of a length of an inch or more. These dimensions cannot be accurate, and I speak from examination of a gauge and these carbons, in my mind's eye, after nearly eight years; I give you simply my judgment of the matter at the present time.

X Q. 1545. Did you ever do any further carbonizing at your house than the single instance you have mentioned?

1453 A. Yes.

X Q. 1546. How long after this time was it?

A. Right away, within a day or two.

X Q. 1547. Did you use the same iron box as previously?

A. Yes, and others.

X Q. 1548. Do you mean you used two boxes in the second carbonization?

A. I cannot tell whether I used two boxes in the second carbonization or in subsequent carbonizations; I used more than one in the fire at the same time, and made a good many carbonizations within a week or ten days.

X Q. 1549. What did you carbonize in the second carbonization?

A. After the first carbonization we cut paper of different thicknesses, some of them cemented together, into shapes for incandescent conductors, of different shapes and sizes and lengths, and I think we cut slips of wood—my impression is, first, of willow into shapes, sizes and lengths for incandescent conductors, and I think, in the second carbonization, the box or boxes contained the wood and paper in the same box.

X Q. 1550. Had the paper or wood been treated in any way?

A. No further than where the paper was cemented together, to give it greater thickness; some carbonaceous material was used as a cement, and that the paper was pressed and consolidated.

X Q. 1551. Do I understand that in this second carbonization, which was done at your house, the material to be carbonized was cut to the desired shape and size of the conductor?

A. Yes, to the desired shape and size to make a conductor.

X Q. 1552. Did you then prefer any special shape or size, or any general shape or size?

1454 A. We preferred a shape that, when the conductor was placed in the holders it would rise above them, but, as to size, we made the blanks of various sizes and various lengths for trial, and we did not make them all of the curved form to rise above the holders, but many were straight; our opinion perhaps was tentative as to what would prove best at this time.

X Q. 1553. What kinds of paper did you carbonize at this second trial?

A. Only white blotting paper; it may have been that some card or drawing paper was used at this second trial.

X Q. 1554. Do you remember what your reason was for using only blotting paper at this second carbonization?

A. Yes; we thought that the white blotting paper, not having been treated in its manufacture with any other substances, and being pure cellulose, would make a purer carbon.

X Q. 1555. Describe the willow you carbonized this second time, what kind of willow it was, and how it was cut, and what your object was in carbonizing it?

A. The willow was ordinary willow, such as used by basket-makers; was cut out in straight pencils; the object was to make an incandescent burner of willow charcoal.

X Q. 1556. Had you any theory on the subject of what the qualities of such substance would be?

A. I had an idea that willow charcoal was most free from impurities; that was the reason for my selecting willow.

X Q. 1557. Your recollection is, as I understand, that this second carbonization was within a day or two after the first; did you carbonize again at your house, and, if so, how soon was the next carbonization?

A. I followed up these carbonizations with a good many more at my house; I think they were all done at my house, but some may possibly have been done in the furnace at 43 Centre street.

1455 X Q. 1558. You don't tell me how soon the third carbonization was after the second.

A. I don't recollect.

X Q. 1559. Well, about how long?

A. In my second carbonization, or in one of those made very soon after the first, I burned up one of the boxes and spoiled the carbons, and I very soon spoiled the first box that I used; I should think the third carbonization, from recollection, was within a week or ten days of the first.

X Q. 1560. What did you carbonize the third time?

A. I should think only white blotting paper and willow wood, but I cannot undertake to remember the minute details of this work.

X Q. 1561. Was the material carbonized treated in any way?

A. No, except where cemented together and pressed.

X Q. 1562. Was the material cut to the desired shape and size of the conductor before carbonization?

A. Yes.

X Q. 1563. Had you at this third carbonization determined on any general size or shape?

A. I don't think further than I have before stated.

X Q. 1564. On how many separate occasions did you carbonize at your house while the laboratory was at 43 Centre street?

A. I cannot recollect; a good many; I burned up several boxes, I got some wrought-iron boxes and covered them with clay and finally used crucibles, luting their covers down with clay and making a small vent for the escape of gases?

X Q. 1565. What would be your best recollection as to the number of times you carbonized at your house?

A. I won't undertake to state; I should think twenty-five or thirty times and probably more, but I cannot undertake to recollect at this length of time.

X Q. 1566. Was it your habit to pack the boxes at 43
1456 Centre street, take them to your house, carbonize them and
then take them back to Centre street?

A. With the metal boxes I think that was done, but not altogether with the crucibles.

X Q. 1567. What material, if any, other than paper and willow wood did you carbonize at your house?

A. I carbonized a variety of woods, every kind that I could get hold of; I also carbonized strings of different kinds and different materials; I think, broom-corn; woods cut into strips and bent; different shapes of paper; some woods in the form of veneers worked down extremely thin and cemented together with the fibres running in different directions; excelsior, I think; manilla; I don't now recollect all the things that I carbonized; I also recarbonized after this different things after saturating them with pure white sugar after the first carbonization.

X Q. 1568. What object had you in view in carbonizing these different substances?

A. We wanted to get pure carbon that would be sufficiently elastic and strong and not liable to break, and that would endure the strain put upon the incandescent conductor of an electric lamp. Perhaps it would be summed up in calling it a structural carbon, that is, one in which the material to be carbonized had been formed by nature, and in which the natural form was being preserved after carbonization, we thought some advantages might be derived. To give an illustration of the subject-matter of our thoughts, we had procured and we made carbons for the incandescent conductor of an electric lamp made of pulverulent materials in which, when pressed into form, the arrangement was heterogeneous. These carbons we found, or thought we did, were liable to fracture and disintegration by the current, and we were trying to get a carbon that would stand "the racket," as Sawyer said. A further illustration:
The mineral carbons and other made-up carbons were so far
1457 rigid that by the least flexture or bending they were broken,
while the vegetable carbons and those made especially of paper could be bent to a considerable extent without breaking, showing their greater flexibility and elasticity; the mineral carbons and those made-up carbons were amorphous in their structure while the others were fibrous.

X Q. 1569. You say you carbonized all these substances at your house in your cooking range in the hope of getting a pure carbon which would be elastic and strong, and not liable to break; of the different materials you carbonized did you regard them all as equally good?

A. No.

X Q. 1570. Did you try them all in your lamps?

A. I think that we tried all that I have mentioned, more or less.

X Q. 1571. Did you try all the different shapes and sizes?

A. No, I don't think so; of the different materials, I think, on reflection, that we did not try in the lamps the carbons made from wood veneers; I think they showed themselves defective without trying; I do not know that while at 43 Centre street, we tried the manilla fibres, pure and simple; my impression is that they were too fine, and I cannot be certain that we tried all the carbons made from different kinds of wood in the lamps but most of them we did.

X Q. 1572. Which of these various materials did you consider you got the best of carbon from?

A. They were three kinds at this time; my recollection is indistinct in regard to one of them, whether the trial of this one was preferably satisfactory to us when at 43 Centre street, or afterwards in the fall of 1878; the three from which we met the greatest success and which were preferred by us, in the order of preference at the
time, were willow-wood carbons, paper carbons, and carbons
1458 from broom-corn, if our preference was established for that
while at 43 Centre street, of which I am in doubt.

X Q. 1573. Now of paper carbons, which paper did you consider made the best carbons?

A. White blotting paper we had the most success with.

X Q. 1574. Did you ever treat the material in any way before carbonization?

A. Yes, we soaked the paper sometimes in sugar solution and we always compressed it. I think we also soaked different woods in sugar. I am not confident in regard to it, but I think we also impregnated the materials with different carbonaceous substances, such as oils, glues, etc., to reduce the resistance of the carbons after they were carbonized. This was not done till after the first few carbonizations at my house.

X Q. 1575. You say you treated the materials before carbonization to reduce their resistance. Had you found the carbons of too high resistance?

A. We so treated some of them, and we had found that some of our carbons were of too high a resistance for our currents, and we also treated some of them in this manner for another purpose, that is, to make them more rigid; that is, where they were to be used as straight pencils.

X Q. 1576. And you found that straight pencils of fibrous material were not sufficiently rigid for conductors?

A. That is perhaps too broad a statement. They were not sufficiently rigid to use in some of our lamps.

X Q. 1577. Were the only materials that were thus treated before carbonization these which would be of too high a resistance, or straight pencils whose rigidity you desired to increase?

A. No, I should think not. At first we crushed the ends of some
— the paper carbons between the clamps in which they were
1459 held. To make the carbons harder and less easily crushed
we soaked them in sugar, some of them before carbonization.

X Q. 1578. Did you ever adopt this treatment before carbonization as a general practice?

A. No, I don't think we did.

X Q. 1579. Did you consider it an *an* advantageous thing to do?

A. Not more so than the treatment after carbonization.

X Q. 1580. Question repeated.

A. For the purpose that we sought to attain, that I have mentioned, it was advantageous.

Adjourned till Monday, the 28th inst., at 10½ a. m.

MONDAY, *Nov.* 28, 1887.

Adjourned till Tuesday the 29th inst., at request of defendant's counsel.

TUESDAY, *29th Nov.*, 1887.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. MAN was continued as follows:

X Q. 1581. I understand that where you wished to reduce the resistance, you treated material to be carbonized in the manner described, and also where you desired to use the materials as straight carbons, and you desired greater rigidity it was so treated; what other material was treated in this way?

A. Your statement needs correction. I simply said that we sometimes did this for the purpose stated, not that we did it always when we wanted to attain those ends, as your statement implies. I
do not recollect what other substances we treated in this way;
1460 we frequently did it, but I cannot bear in mind what particular substances were used, further than I have stated.

X Q. 1582. Is it then the fact that you sometimes treated the material before carbonization, and at other times did not?

A. Yes, and I will add to save further question, that we sometimes treated them in a similar manner after carbonization, and recarbonized after treatment and sometimes did not.

X Q. 1583. What I want to get at is, in what cases and for what reason you treated before carbonization, and in what cases and for what reason you did not treat before carbonization?

A. No further than I have already stated.

X Q. 1584. Did you ever form an opinion as to whether it was a good thing to do?

A. We formed an opinion that it accomplished the results we desired in practicing it—of making the carbon more dense, harder, and of less resistance, and that it was a good thing to do when we wanted to accomplish these things.

X Q. 1585. Question repeated.

A. I have no further answer to it; I don't think we had any further opinion in regard to it than I have stated.

X Q. 1586. You never adopted this as a practice, I understand?

A. We certainly did practice it, if that is what you mean.

X Q. 1587. You had not at this time, as I understand you, decided upon any desirable resistance for a conductor of any given shape and size?

A. No, I do not think we had, except in connection with the particular system and other things with which it was to be used.

1461 X Q. 1588. Do I understand that you had decided this question with reference to the system that was to be used?

A. Most assuredly we had decided that the resistance must be a practical one for the current available, but I do not think we had decided in regard to the electro-motive force as a usual thing, which would be most suitable in a general system for use of incandescent lighting, and upon that, as a general proposition, would depend the resistance of the conductors to be used, taken in connection with the arrangement of the lamps.

X Q. 1589. Had you determined anything more then, than that the resistance of the lamp must have relation to the current conveyed to the lamp?

A. In regard to what do you ask the question? Specify; do you mean in regard to the resistance of the conductor alone?

X Q. 1590. Question repeated.

A. I don't know what you mean by "more," what do you mean by "more" in regard to what?

X Q. 1591. I am trying to ascertain the object and extent of your treatment of paper or fibrous material before carbonization, and what, if any, decision you had come to in regard to the advisability of doing so; you say in some cases you did treat them, in others you did not; you practiced it but did not adopt it as a practice; that it had the effect of reducing the resistance of the material, but that you had not determined upon any desirable resistance for a conductor of given shape or size; if I understand your answers, it would seem that you have no opinion whatever on the subject of its value, but that you only used it as an expedient in certain cases; is this correct?

A. If you will consent to take my testimony in the words in which I give it, instead of going on to state what I say, in your own fashion, and coupling great numbers of things together without accurately stating what I say, and ask me whether it is correct or
1462 not, we will get along better and faster; you state that you are
trying to ascertain, first, the object of the treatment of paper or fibrous material before carbonization; second, the extent of that treatment; third, what, if any, decision we had come to in regard to the advisability of doing so; I have fully answered in regard to the first and third things you say you are trying to ascertain; if you now ask me in regard to the extent of our practicing that thing as a fact, I can answer it; if I answer the question you put to me, I shall have to go back and correct your statement of my testimony.

Answer objected to as irresponsive.

X Q. 1592. Was this treatment before carbonization, used only as an expedient in those cases where you desired to make the resistance of the conductor less than it would be if the material were not treated?

A. No; it was used also for another purpose.

X Q. 1593. What other?

A. To make the carbon more dense and harder and better able to endure the clamps of the holders and other manipulation of the conductor.

X Q. 1594. Any other object?

A. I do not remember any other now.

X Q. 1595. Would you, then, in those cases where you desired to obtain these objects treat the material, and in other cases not treat it?

A. Yes.

X Q. 1596. Did you ever reach any conclusion as to whether it was desirable to, in some way, increase the density and hardness and decrease the resistance of a carbon made from paper or fibrous material from what it would be if the material were simply carbonized and used without any treatment?

A. Not as an abstract question in and of and by itself; we did not reach a positive conclusion or opinion that our electrical treatment of carbons, which did reduce resistance and increase
1463 the density and hardness and decrease the resistance of a
carbon made from paper was desirable, and we also had an opinion that it was a convenient way and useful, in making certain carbons, to treat them before or after carbonization in carbonaceous solutions or liquids, and this did reduce resistance, and increase hardness and density.

X Q. 1597. To what extent did you treat material to be carbonized before carbonization, in your experiments?

A. I cannot at this length of time remember with accuracy, to state the extent of the treatment before carbonization, as distinguished from the treatment after carbonization. We sometimes did one and sometimes the other and sometimes both. (I am referring to the time at 43 Centre street to which I understand you to refer), and taken together we treated, I think, more considerably than we left untreated. I think, a large majority of our carbons were so treated; almost all I should think, while at 43 Centre street, but not all.

X Q. 1598. Almost all then were treated either before or after carbonization?

A. I think so; either by the treatment of the suguar or carbonaceous solution, or by electrical treatment, in a hydrocarbon atmosphere, liquid or gaseous, both.

X Q. 1599. This latter was according to the process of the Sawyer and Man patent, to which we have referred?

A. Yes, and we frequently treated the same carbons in both ways.

X Q. 1600. Who assisted in this treatment either before or after carbonization?

A. The electrical treatment was almost always done by Mr. Wm. E. Sawyer. The other treatment I frequently performed, and I think I frequently had the assistance of all three of the Sawyers, Mr. Wm. E. Sawyer superintending it when I was absent.

X Q. 1601. Were you usually present when the electrical treatment was done?

A. I was sometimes present and sometimes not. The 1464 bulk of the time I was not at Centre street, and the work went on whether I was present or not.

X Q. 1602. Did anybody assist you in the carbonization at your house?

A. Yes; the servant usually assisted me, and once or twice I think Mr. Wm. E. Sawyer was over there. Sometimes I had no assistance.

X Q. 1603. Who was the servant to whom you refer?

A. I really couldn't tell. She is not with me now; she simply built up the fire for me and handed me things, and so on.

X Q. 1604. You say you preferred, of the various materials you carbonized, first, willow carbon and second, paper carbon. What were the qualities in willow carbon that made you prefer it to carbons made from other fibrous materials?

A. I do not know anything except that we were more successful in the use of it in our lamps while at 43 Centre street, and could easily get it into the shapes and sizes we wanted.

X Q. 1605. What properties did you find in paper carbon that made you prefer it to other carbonized, fibrous material, with the exception of willow?

A. We thought that the arrangement of the fibres in the paper carbon was an advantage, and we also thought that it being already of the size, or sizes, in one direction, which we desired, being in flat, thin sheets, or easily made or selected of the dimensions in one direction, which were required for the incandescent conductor, and easily put in shape or cut in shape for the conductor before carbonization, and both the willow and paper carbons being pure carbons, or substantially so, that these were most advantageous, and they proved the most successful of the carbons in use in our lamps. We also thought that their fibrous structure, retained after carbonization, was an advantage. We also found that these substances were best carbonized without fracture, except some fibres and 1465 strings of which we made little use at this time, except by way of experiment.

X Q. 1606. What was the arrangement of the fibres in the paper carbon, to which you refer in your last answer as an advantage?

A. They were all laid in one plane.

X Q. 1607. Is this true of all papers, or only of certain kinds?

A. It is generally true of all; not absolutely true of any, but approximately.

X Q. 1608. What was the advantage which you attributed to this arrangement of fibres?

A. That they, the fibres were less easily broken in the direction of their length than in the direction of their cross-section, more of the fibres of paper carbon would lie in the direction of the length of the incandescent conductor than would be the case in a substance not reduced to sheets, and therefore they would not be so easily broken or so fragile.

X Q. 1609. Aside from any ease of cutting or shaping to the desired size, what were the properties possessed by carbon made from willow as a material which you considered advantageous?

A. Simply that the fibres run in the direction of the length of the conductor, and that it was a pure material, made a pure carbon, that is, aside from the convenience of getting it into shape.

X Q. 1610. Would not the fact whether the fibres of the material ran in the direction of the length of the conductor depend on how the willow was cut?

A. Yes; but we cut them to make them run in that direction; the same is true to some extent with paper; the fibres mainly run in one direction, and we cut them to avail ourselves of this fact.

X Q. 1611. You speak in your 1605th answer of an advantage due to the retention of the fibrous structure after car- 1466 bonization. In what did the advantage referred to consist?

A. Strength and resistance to fracture in the directions of the length of the fibre, and possibly in the directions at right angles, or other directions, possibly also elasticity or flexibility, or both.

X Q. 1612. How long had you been experimenting with paper or willow carbon before you concluded that they were preferable to other carbon?

A. I cannot tell. I know that when we left 43 Centre street we thought they were preferable to all we had tried of fibrous carbons.

X Q. 1613. How long was it before you made up your mind that the fibrous was superior to the non-fibrous carbon?

A. I don't know that as carbon I ever made up my mind to that effect.

X Q. 1614. As the carbon for an incandescent conductor?

A. I have already testified very fully in regard to this subject-matter, and I do not wish to be misunderstood in regard to it; I only stated, in substance, that the incandescent conductor made from fibrous or textile material, taking everything into account, including purity, practicability, cheapness and ease of manufacture, of proper size and length, was, on the whole, the best that I had known of.

X Q. 1615. Of the carbons tried in Centre street the great majority were not fibrous carbons?

A. I think not.

X Q. 1616. They were French carbons, were they not?

A. They were mineral carbons, so called, and deposit carbons.

1467 X Q. 1617. At the time of leaving Centre street had you any preference for fibrous carbons over non-fibrous carbons?

A. At the time of leaving Centre street I had an idea that in the end the fibrous carbons would prove the best to use for the incandescent conductor of an electric lamp, but my mind on that subject-matter I do not think was fully made up; that is, I had not demonstrated to my satisfaction that such was the fact.

X Q. 1618. What were Mr. Sawyer's views?

Objected to as incompetent.

A. I do not think that at that time there was any difference of opinion between us about the subject-matter; perhaps I was strongest in my views about it.

X Q. 1619. Do you mean that Sawyer thought that fibrous material would prove the best?

Objected to as incompetent.

A. I mean to say that I think Sawyer thought that our incandescent conductor made from fibrous material would prove a good conductor; whether he thought as I did, that it would or might prove the best, I cannot say.

Adjourned till Wednesday, the 30th inst., at 1 p. m.

1468 NEW YORK, *Nov.* 30, 1887.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. MAN continued as follows:

X Q. 1620. Referring to the treatment before carbonization, please to state what the general nature of the carbonaceous solution with which you soaked the paper was, what your method of thus treating it was, what effect the treatment had, and what materials you thus treated. You have spoken also of pressing and consolidating the material before carbonization; will you please explain how this pressure was effected, and what the effect of such pressure was on the material thus pressed?

A. The material with which we usually treated the fibrous substances to be carbonized before carbonization was a solution of refined white sugar—we may have used, and I think we did, isinglass or glue and oils; whether the oils were at 43 Centre street I can't recollect; we soaked the fibrous substances in these solutions, dried them, resoaked them, until we thought we had got them fully saturated with the sugar or other carbonaceous material or sufficiently filled with it for the purpose we intended; the effect was to fill the pores of the substance more or less with the carbonaceous material as we desired; after thus filling the pores, and while the material was in a condition to do so, we pressed it between smooth plates in a screw press or vice to consolidate it; we carefully afterwards dried it, sometimes in a muffle, to drive off the water, carrying the heat in the drying process as far as we could without charring the material; the substances we thus treated were paper and strings of different kinds and wood, except that we did not press the wood, and we did not treat before carbonization with the carbonaceous solution, but a small part, comparatively very few;
1469
usually when treated in this way at all, they were treated after the first carbonization, but we usually pressed or consolidated the fibrous materials, paper and other kinds, except woods, before carbonizing them or hammered them for the same purpose on a smooth anvil with a strong hammer; I think also we stiffened

some of the strings that we carbonized with starch instead of sugar and the effect was to render the carbon formed from the material more dense and for the same size of higher conductability or less resistance; it was also harder and better suited for handling and manipulation without breakage as we thought.

X Q. 1621. In some instances, as I understand you, the material was resoaked and recarbonized several times?

A. It was.

X Q. 1622. Now, as I understand, the material was treated after carbonization either by the electrical treatment, solution or both, the electrical treatment being your patented treatment?

A. Yes.

X Q. 1623. When did you begin this electrical treatment with reference to your experiments on paper?

A. With our first carbonizations of paper we put them in a bath of hydrocarbon gas or in a lamp containing hydrocarbon gas to try them; before then we had discovered the electro deposit of carbon upon an incandescent conductor heated up in an atmosphere of hydrocarbon gas, but I do not think that we put the first paper carbons into this atmosphere in the first instance with the intention to treat them, but because it was the most convenient way of trying the carbons, the atmosphere of the lamp or vessel in which they were tried being readily supplied, resupplied and kept up from the gas pipes; we knew then that their resistance would be reduced rapidly by this treatment or use.

1470 X Q. 1624. Am I correct in understanding that all the carbons, irrespective of the kind of fibrous or textile material from which they were made, were treated by this patented electrical process?

A. No, not all; but it was our practice usually to treat them and we treated nearly all of them and thought them improved by treatment, but we also treated them sometimes and frequently in order to get conductors of the same electrical resistance.

X Q. 1625. As a *a* rule this electrical treatment was done by Sawyer?

A. Yes, sir.

X Q. 1626. In treating these fibrous carbons by this electrical process, to what extent was this treatment carried on; I do not refer to the number of fibrous carbons treated, but to the extent of the treatment of such as were treated?

A. In some cases the treatment was very slight, hardly perceptible except under the glass; in other cases the treatment was carried on and repeated until sufficient deposit of carbon had been made to serve as a conductor after the removal of the original carbon and the deposit-carbon conductor thus formed was sometimes by us split or cut into two or three conductors lengthwise and retreated to make them of the size and resistance required; the treatment which we gave to the carbon was all the way from the extremely slight treatment I have first mentioned to the extremely extensive treatment I have last mentioned; I do not remember carbons made from any other fibrous substances than paper and wood with this extremely large treatment and most of those so largely treated were of wood carbon, some few of paper carbon cut in the form of arches.

X Q. 1627. In some cases I understand you treated to such an extent only as would make several carbons of uniform resistance and in other cases would treat for the purpose of improving the carbon irrespective of the question of resistance?

1471 A. Yes, and in some cases to manufacture conductors of pure-deposit carbon.

X Q. 1628. Where you desired simply to improve the carbon, the question of resistance being not involved, what was the extent of the treatment?

A. We tried all kinds and extents of treatment for the purpose of improving the conductors from the slightest to the highest.

X Q. 1629. Was there any extent of treatment which was deemed best while you were at 43 Centre street?

A. Yes, I think there was; we had found while we were at 43 Centre street, I think, that the deposit carbon had a tendency to fly to pieces or break like glass when suddenly heated up; we had found that carbons largely treated with deposit carbon were liable also to fly to pieces in the same manner, when suddenly heated up; or if the current was not turned on to them gradually, but that fibrous carbons less treated were not liable to do so; for this reason we thought it best not to treat the carbons too much, but I do not think I could describe, at the present time, the extent of treatment that we thought best; the extent of the treatment that we thought best simply gave a silvery or lustrous appearance to the carbon, instead of being black, as it was before treatment.

X Q. 1630. Was the resistance of the carbon reduced in proportion to the extent of the treatment?

A. Yes.

X Q. 1631. I quote from the testimony of Mr. Sawyer, in the interference between Edison and Sawyer-Man, cross-question and answer 42:

"X Q. 42. As a matter of fact, about how much was the resistance reduced?

"A. Mr. Man's idea and mine upon that question of resistance began to differ. That is to say, my theory that the most perfect electric lamp would be one in which the incandescent con-
1472 ductor had the highest resistance and the least transverse mass was gradually abandoned by myself, while largely retained by Mr. Man; my present theory being that the most perfect electric lamp is one in which the incandescent conductor has not only the least transverse mass, but the least resistance; I soon began to reduce the resistance of my carbons to as low as an ohm; at present I make them only ¼ ohm, therefore I would treat the carbons so as to obtain a heavy deposit; judging from the difficulty in getting the current through some of Mr. Man's carbons, treated according to his ideas, they must have had as high as 100 ohms resistance, but I don't recollect whether we made measurements of any particular ones; answering the question directly, I should say that Mr. Man reduced the resistance in his carbons from fifty to

seventy-five per cent. by the treatment referred to; this is an estimate, and not the result of measurements."

Is it your recollection that Mr. Sawyer's statement in the above testimony is correct?

A. I have no means of ascertaining or judging; I assume that Mr. Sawyer's statement, in regard to the reduction of resistance, has reference to an average or usual thing; if it is taken in that sense, I could not say that Mr. Sawyer's statement is not correct, but I would judge, and I think I know, that in many cases the resistance of conductors treated was not reduced either fifty or seventy-five per cent., nor even three or five per cent., but I do not understand that Mr. Sawyer was speaking of anything but average practice.

X Q. 1632. Sawyer, as I understand, actually did the treatment; do you know the extent to which he usually treated where the desire was to improve the carbon?

A. Mr. Sawyer usually did the treatment, but I think not always—almost always; he frequently treated carbons while I was present, and under my suggestion as to the extent of treatment; as I said before, I have no means of judging of the extent of average treatment, or at least nothing occurs to me now by 1473 which I can satisfactorily to myself make such judgment; I do not mean to criticise Mr. Sawyer's statement of what he thought it was at the time when he gave that testimony, and assume that he gave it as nearly as he could correctly from his then recollection, and the matters called to his attention by questioning; I, therefore, would acquiesce in Mr. Sawyer's statement of his average treatment, but I could not say what actual treatment Mr. Sawyer gave at different times, for the purpose of improving the conductor, as any treatment would, as we then considered, be an improvement.

X Q. 1633. Was there no point at which you considered the treatment had shown the most beneficial effect?

Adjourned till Monday, the 5th day of December next at 10½ a. m.

MONDAY, *December* 5, 1887.

Adjourned till Tuesday, the 6th inst., at 10½ a. m.

NEW YORK, *December 6th*, 1887.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. MAN continued as follows:

Witness answers the last question of the previous session:

A. There was a point at which we considered the treatment most beneficial; as I have stated, the treatment could be carried to the extent of making the conductors substantially of pure-deposit carbon or like one of pure-deposit carbon; now we considered that the deposit carbon as carbon was the purest and best carbon, but conductors made of such carbon were in practice liable to objection, principally for the reason that the carbon being amorphous and dense like glass or possibly crystalline in structure was liable to fly 1474 to pieces and break as glass does when suddenly heated up, especially if the carbon was of any considerable cross-section and of less or very small cross-section was liable to fracture in handling and manipulation as well as in use in the lamp; for that reason, as I have stated and for the other reasons I have stated, among others ease and practicability of manufacture and cheapness, we preferred in practice a fibrous carbon which was not liable to fly to pieces or break when suddenly heated up; the point then which we considered most advantageous in treatment of the fibrous carbons was that extent of treatment, which, while driving out the occluded gases and purifying the fibrous carbon in the treatment, would not interfere with or destroy the fibrous structure of the carbon, but would leave it still a fibrous or structural carbon with nothing but pure carbon added to it and that not to an extent to interfere with the advantages of the fibrous or structural character of the conductor, nor to render it liable to the disadvantages of the deposit carbon, of which I have spoken; this condition being observed there was another point in the treatment having reference to the resistance of the conductor; first, to treat to a sufficient extent to render the resistance of the conductor uniform throughout its length, and secondly, to conform the resistance of different conductors to the same standard so that they would be equal or substantially so in resistance.

X Q. 1634. What were the advantages of the fibrous or structural character of the carbon which you desired to preserve?

A. I think I have pointed out these advantages fully before; they were mainly as I conceived them, flexibility, elasticity and strength, due to the fibrous arrangement, possibly to the structure of the material of which the carbon was made, being produced by a process of nature and some arrangement of molecules or atoms in such process.

1475 X Q. 1635. Was the treatment carried on to an extent sufficient to fill up the pores of the carbon or coat its surface?

A. Yes, to some extent, but that extent in the use of our fibrous carbons, as fibrous carbon conductors, was not carried so far as to completely or considerably fill up the pores, and after treatment the appearance of the carbon as to size, dimensions and fibrous character, remained apparently the same as before treatment, but the carbon was rendered more dense and harder; and had under the glass a lustrous or silvery appearance; in cases where we desired to render the carbon more of the character of the deposit-carbon conductor, the treatment was carried further, the pores were more filled up; in some cases as fully as we could do so, and the conductor was increased in size; these we considered substantially deposit-carbon conductors, and they were to some extent liable to the objections of which I have spoken of deposit-carbon conductors, but not as liable to those objections as conductors made solely and entirely of deposit carbon.

X Q. 1636. In this treatment were the pores filled up before the surface of the carbon became coated?

A. In the treatment the first and most rapid action was at that point of the conductor in its length having the highest resistance; the coating on the conductor went on evidently upon the individual fibres, whether within the body of the conductor or lying upon the outside of the conductor; if the treatment was properly conducted, when the treatment was carried so far as to bridge over the spaces between the fibres, or substantially bridge over such spaces, the coating or deposit of carbon went on only upon the outside of the conductor, and if the treatment were not properly conducted, or was conducted for that purpose, the coating would bridge over between the outer fibres of the conductor almost immediately, and the pores or spaces between the fibres would not be filled up.

X Q. 1637. Then, as I understand you, the treatment 1476 would fill up the pores and coat the outside, or coat the outside and not fill up the pores according as the treatment was conducted?

A. Yes, except that in any treatment there must have been some filling up of pores, but the process as a whole would be as I say.

X Q. 1638. Which did you do in practice?

A. We did both.

X Q. 1639. Which was the proper way of treating?

A. Both were proper, but for different purposes. For the purpose of producing or improving the fibrous conductor, the first method of treatment was the proper one, carried only to the extent I have mentioned, as the best for the production of fibrous carbon. For the purpose of producing a conductor of pure-deposit carbon, the process by which the deposit went on mainly on the outside of the conductor was the proper one, and for the purpose of producing a carbon, having mainly the character of a pure-deposit carbon, but with a core of fibrous carbon left in it, the second process, by which the deposit went on mainly on the outside of the conductor, was the proper one.

X Q. 1640. As I understand then, by the use of this treatment you obtained three characters of carbon: first, a fibrous carbon treated as you describe; second, a fibrous carbon treated to such an extent that the original carbon simply acted as a core for a shell of deposit carbon; and thirdly, a deposit carbon pure and simple, from which the fibrous carbon was removed?

A. Yes.

X Q. 1641. Was the second carbon liable to fracture or fly to pieces?

A. More liable than the first and not as liable as the last.

X Q. 1642. As between the first and second, which did you consider the best carbon, eliminating the question of liability to fracture from consideration?

1477 A. In some forms of our lamps we preferred the first and in some forms the second, simply for mechanical reasons. As a whole we preferred for the incandescent conductor of the lamp, as I have stated very fully heretofore, the conductor of fibrous carbon, which is the first.

X Q. 1643. I call your attention to the following question and answer of yourself in the interference proceeding:

"Q. Then as I understand you, there was no objections to the burner made of the paper carbon?

"A. Yes; there were objection at first; it was too fragile; it was not good enough conductor for the electro-dynamo machine which we used. The burner had too high resistance. When carbonized with a current, it was liable to crack and to break from contraction. But it had advantages at the same time which we were trying to secure and were working for. When made of pure cellulose, it was a pure carbon, which we were trying in every way to obtain. That is why we kept working at it and finally succeeded in overcoming all its objections."

From this testimony it would seem that you considered a paper carbon, pure and simple, as being too fragile and as having a too high resistance but that you considered it a pure carbon and so kept working with it until you had finally overcome all its objections. Is such the fact, and if so, how were the objections overcome by the treatment to which you have been referring?

Objected to as incompetent; it being a mere fragment of the deposition referred to and as immaterial, having no bearing upon the issue in controversy.

A. Your statement is not a fair statement or conclusion from the testimony you have quoted; you generalized from a particular statement and ask me to adopt your generalization in answering. I do not desire to change the answer you have quoted, and if your question relates solely to the particulars of that answer I will reply,
but I cannot adopt your generalization; I speak in that an-
1478 swer of the difficulties of using the paper carbon with us at
first only; if you ask how we overcame those difficulties, I can tell you some of the things which we did, perhaps not all.

X Q. 1644. In your first use of paper did you find that it was too fragile?

A. As the conductors were made by us, at first, yes.

X Q. 1645. How did you obviate that defect, if at all?

A. In part by cutting the conductors to shape and size before carbonization; in part, by better carbonization of the conductors so cut to shape and size and in part by modifying our lamps; in part we rendered the conductors sometimes and usually, but not always, less fragile by an electrical treatment.

X Q. 1546. Did the electrical treatment make the conductors less fragile?

A. Yes, harder and denser.

X Q. 1647. I quote from the testimony of Wm. E. Sawyer in the interference.

"Q. 15. Referring now to the paper carbons, some of which are represented in the sketch Sawyer Exhibit No. 6, state whether or not you put them in a sealed lamp and tested their practicability.

"A. Yes, sir, we did.

"Q. 16. Did you try any of the carbons illustrated by the drawing Sawyer Exhibit No. 6, and if so, which of them?

"A. The carbons shown in Figs. 1, 2 and 3 and the half circle, were positively used; were sealed up and run; the great trouble with them was when we raised the temperature till we could get a bright light they would break; for this reason I preferred the harder carbons; we finally made them hard enough by treating them in hydrocarbon gas by the Sawyer-Man process."

It is true that in the early use of carbons made from paper
1479 "the great trouble with them was when we (you) raised the
temperature till we (you) could get a bright light they would
break?"

A. In the early use of the paper carbons I remember trouble with their breaking; we attempted to run them up, I think now, to too high incandescence, and our lamps and holders were not all adapted to their *use*.

X Q. 1648. Sawyer in this testimony says: "For this reason I preferred the harder carbons; we finally made them hard enough by treating them in hydrocarbon gas by the Sawyer-Man process." Is that your recollection of the fact?

A. My recollection is that we did treat them with this object in view, and that those so treated were successful in use, but it is also my recollection that some, not treated, were also successful in use; I understand Mr. Sawyer to be speaking in a general way of the subject-matter there, and in such a way, his testimony is correct.

X Q. 1649. Did you in your early experiments find that the paper carbon, pure and simple, was not a good enough conductor for your dynamo machine; that such a burner had too high a resistance?

A. Yes; we found that the paper carbons we made in our early experiments were of too high a resistance for the current of the dynamo we were using, and we had to get increased electro-motive force to pass sufficient current through them to heat them up to incandescence.

X Q. 1650. You remember that fact distinctly, do you?

A. Yes, sir.

X Q. 1651. Which did you do, increase your electro-motive force or decrease the resistance of your conductors?

A. We did both.

X Q. 1652. How did you increase your electro-motive force by get-ing another machine?

A. We increased our electro-motive force, in some instances,
1480 by rapidly making and breaking connection in a short circuit
shunt between the poles of the machine, and in some instances we charged the field magnet of one machine by a current from another; we varied the velocity of the armature, getting higher velocity than we could usually attain by waiting until after the other machinery in the building where we were was stopped, and then using the increased velocity of the pulleys in the building with which the machine was connected; we used sometimes, I think, with these paper carbons at first the current from the arc-lighting machine of Arnoux and Hochausen in the basement.

X Q. 1653. Would the expedients you mentioned in your last answer serve for the conduct of any experiments that would give you any valuable information in regard to the conductors?

A. Yes.

X Q. 1654. Could you run a conductor to incandescence for any length of time by the use of these expedients?

A. Yes, by some of them.

X Q. 1655. By which?

A. By the coupling up of two or more machines—by increased velocity of the armature, or by the use of the arc-lighting machine having a higher electro-motive force than the others.

X Q. 1656. How much could you increase the electro-motive force by coupling up the machine or increasing the velocity of the armature?

A. I don't know—enough, so that we passed the current through the paper carbons and heated them up.

X Q. 1657. Did you continue to resort to these expedients, and thus continue these experiments on these high-resistance carbons, or did you abandon experiments on them and work with carbons suited to your machine?

A. We reduced their resistance by treatment, and by making them larger, until they would serve as conductors with the currents we had available, but we frequently had not sufficient current, and had to wait until the other machinery was stopped before we could run our lamps. 1481

X Q. 1658. Do you mean to be understood that you gave up the use of carbons of such resistance as to be beyond the normal capacity of your machines?

A. Of course we used carbons mainly that were suited to the capacity of our machines; I do not think that we gave up experiments in making carbons while we were there at 43 Centre street.

X Q. 1659. What you did do, then, as I understand, was to bring the resistance of the carbon down to the capacity of the machine?

A. Yes; that, and to arrange and run the machines to the carbons, chiefly reducing the resistance of the carbons to the normal capacity of the machines.

X Q. 1660. If you had designed conducting experiments to any extent on carbons whose resistance was beyond the normal capacity of the machines, the proper thing to have done would have been to have got a machine of greater electro-motive force?

A. It would be the proper thing to do to get a machine of greater electro-motive force for the conduct of experiments on carbons of very high resistance, but it would not indicate that we did not design to conduct such experiments that we failed to get such a machine; it will be borne in mind that we were at work upon other things than the carbon conductors of our lamps.

X Q. 1661. You have said that in your early experiments you found the resistance of the paper-carbon conductors too high, and reduced the resistance. How did you reduce the resistance?

A. We made them larger and shorter, and we treated them

1482 by the electrical treatment and by soaking them in sugar, etc., and recarbonizing them or soaking them, as I have explained.

X Q. 1662. Which of these methods did you generally or finally adopt?

A. We almost always treated them by the electrical process, but not always by any process, and I think all the processes were practiced more or less up to March, 1879, not, however, after we left 43 Centre street, ordinarily with a view to reduce the resistance, but to improve the conductor.

X Q. 1663. In view of the fact that you found your first carbons of too high resistance, and reduced the resistance as you have stated, can you tell me the dimensions of the carbons whose resistance were too high, and what size you had to make them, and to what extent you had to treat them to bring them within the normal capacity of your machine? I am referring to the time you were at 43 Centre street.

Objected to as mere repetition, as this subject-matter has been all gone over in this examination once, if not twice.

A. Our carbons were usually made of a resistance equal to a well-made deposit carbon, of deposit carbon pure and simple, or conductor, of a length of from half an inch to three-quarters of an inch, and a twentieth of an inch in diameter; some of them that we made were of a great many times this resistance—how many I can't say—and some of them were many times less this resistance, and we prepared the fibrous carbons giving to them all these kinds of resistance, but we usually used them of about the same resistance I have stated of the deposit carbon of the length and size stated.

X Q. 1664. Which did you find in practice the more durable carbon—the fibrous carbon treated by your electrical process or the carbon not treated?

1483 A. I think all the carbons were improved by the electrical treatment and rendered more durable, and I think they are to-day so improved by such treatment.

X Q. 1665. It appears, by the record in the Sawyer-Man-Edison interference, that Mr. Broadnax asked Mr. Sawyer the following question, and received the following answer, referring to the use of paper carbon:

"Q. How long did they last in the lamp?

"A. Untreated by the Sawyer-Man process would last from one second to ten minutes, if run up to give a good bright light; if run at a low temperature, they would run anywhere from one hour to a hundred hours; it depends entirely upon the temperature."

Is it your recollection that while at 43 Centre street paper carbons, which had not been treated by the Sawyer-Man process, would last if run up to give a good bright light from one second to ten minutes?

A. It is my recollection that while at 43 Centre street, and indeed up to March, 1879, we usually ran our carbons up to very high incandescence—much higher than the incandescent lamps of to-day are run, so high that a single lamp would illuminate a large, dark room, with rough walls and ceilings, of about twenty by forty feet in size and about ten or eleven feet high, which was the character of our room at 43 Centre street, and I take it that that is what Mr. Sawyer means by a good bright light; if such interpretation were put upon his testimony I fully agree with him; I know that many of our paper carbons untreated were destroyed, as Mr. Sawyer states, but many others untreated run at low incandescence, giving a fair light, lasted the longer times, he states.

X Q 1666. Was this high incandescence at which you usually run them the degree of incandescence which you then considered proper or desirable?

A. Yes; I think we had some idea of competing with arc lamps.

1484 X Q. 1667. Is it the fact then that the life of these untreated paper carbons when run to the degree of incandescence which you then thought proper or desirable was from one second to ten minutes?

A. Yes, usually.

X Q. 1668. On cross-examination the following question was asked and the following answer was made by Mr. Sawyer:

"X Q. 49. Referring now to your 17 answer, could a lamp as described there which would burn from one second to ten minutes be used in competition with gas or other commercial lights?

"A. It could not; and at that — the invention was not so perfected in all respects, including the inclosing globe and mechanism as to make the lamp suitable for any practical purpose; by mechanism I mean the general construction of the lamp, method of sealing conductors, &c.; 'that is, all the attachments of the lamp and the general mechanical construction of the lamp.'"

Do you agree in the opinion of Mr. Sawyer and is the statement of facts made in the answer true according to your recollection?

A. I would agree to the statement until the latter part of the time we were at 43 Centre street; my opinion is that some of the lamps we had when we left 43 Centre street, were supplied with fibrous carbon and were good commercial lamps considering the then state of the art of incandescent electric lighting.

X Q. 1669. The following question was asked and the following answer made by Mr. Sawyer in the interference referred to:

"X Q. 18. State as near as you can recollect how long the best of the paper carbons you made at 43 Centre street would last in the lamp when raised to a temperature high enough to give a good bright light, after having been treated by the Sawyer-Man process?

1485 "A. Run at a power of about 25 candles they would last from five to 100 hours; once in awhile we would get a lamp so perfect in every respect that it would seem to undergo no changafter a long use, but generally they would fracture in 5 to 20 hours run at that temperature; the difference in the duration of the burners was due to both imperfection in the lamp and in the carbon; where the fracture alone occurs it must be due either to imperfection in the carbon or the effect of unequal expansions; when consumption occurs it is due to the imperfect charging of the lamp."

Is it your recollection that the treated paper carbons when run at about twenty-five candles, would generally last from five to twenty hours?

A. I can only say that my present recollection of it is not sufficient for me to state, but I have no reason to criticize Mr. Sawyer's statements taken as a whole, and think it is probably as nearly accurate as he could give it.

X Q. 1670. On cross-examination in the interference referred to, the following question was asked of Mr. Sawyer and answer given:

"X Q. 50. Referring now to your 18 answer, could a lamp as described there which would burn from five to one hundred hours be used in competition with gas or other commercial lights?

"A. I think not."

Is such your opinion?

A. No; there are situations and places where such a lamp would drive out the use of gas in my opinion, and it would depend upon the facilities at hand or available for restoring such lamps, as is the case with the arc light, whether it could compete with gas or not, commercially; in some places it could, in others it could not so compete, in my opinion.

Adjourned till Thursday, the 8th inst., at 10½ a. m.

1486 THURSDAY, *Dec.* 8, 1887.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. MAN was continued as follows:

X Q. 1671. Referring to the specimens of excelsior, manilla and broom-corn offered in evidence, did you ever make a lamp in which the carbon was made of manilla fibre?

A. I do not know; we tried such carbons in our lamps, but I don't know whether we made a successful lamp with it or not.

X Q. 1672. Why do you not know?

A. Simply because I do not recollect.

X Q. 1673. Do you recollect of running any of such carbons to incandescence?

A. Yes, I recollect of carbonizing them and trying it.

X Q. 1674. Did you get a current through?

A. Yes, I think through the single fibres of short lengths; I know we did through the twisted fibres or strings of the same; I mean the manilla.

X Q. 1675. How short were these single fibres?

A. I don't think more than a quarter of an inch long between the holders; they may have been longer, but I judge not.

X Q. 1676. How did you support these single fibres in the holders?

A. The ends were placed in clamps at the tops of the holders.

X Q. 1677. What sort of an atmosphere did you use in the lamps where these were tried?

A. Hydrocarbon gas, hydrogen and nitrogen were the gases that we were using and all our trials were made in one or more of these gases or in a vacua of those gases.

1487 X Q. 1678. How long did you get any one of these single manilla fibres to remain incandescent?

A. I don't recollect.

X Q. 1679. Can you give no idea?

A. No, I cannot.

X Q. 1680. Did you have a machine which would, when worked to its normal capacity, render them incandescent?

A. Of short lengths.

X Q. 1681. Were they delicate carbons to handle and place in the lamps?

A. Yes.

X Q. 1682. How did they compare in your estimation with the larger and harder carbons?

A. I do not recollect; the carbon of manilla fibre was a hard carbon comparatively.

X Q. 1683. Did you ever make a lamp in which the conductor was made of manilla fibre?

A. I do not recollect that we made any lamps in which the carbon was of single manilla fibre, though we tried it by way of experiment; we did make some in which the carbon was of twisted manilla fibre in the form of loops; they did not last any better, if as well, as the paper and wood carbons; they wore more difficult to make and use and we did not continue to make them, preferring the others.

X Q. 1684. Is what you have said of manilla equally true of jute?

A. It is, except that we did not like the jute as well as the manilla.

X Q. 1685. What were the endogenous woods you carbonized?

A. I don't know, and I don't know whether I knew at the time; we got them to carbonize by reason of our thinking that their interlacing fibres might be an advantage?

X Q. 1686. What endogenous woods have interlacing fibres?

1488 A. I don't know; I think the palms and the other larger growths of endogenous woods.

X Q. 1687. Did you ever make a lamp in which the carbon was made of *odengneous* wood?

A. Yes, we simply did it, though, by way of experiment.

X Q. 1688. Did you ever*y* try excelsior in a lamp?

A. Yes.

X Q. 1689. With what success?

A. The excelsior carbons were mostly too fine and high resistance for our current, and we did not make much use of them; we carbonized them and tried them in the arch form, but had to make the arches too flat of it to satisfy us; its use was experimental.

X Q. 1690. Did you ever try the broom-corn in a lamp?

A. Yes; either while at 43 Centre street or at the corner of Walker and Elm streets, I can't recollect which.

X Q. 1691. With what success?

A. We bent and carbonized broom-corn in the form of loops, for conductors, but I do not think we saw any advantage in it, and I remember it only as a thing we tried experimentally.

X Q. 1692. The patent in suit mentions the use of a vacuum, and you have, throughout your deposition, mentioned the use of a vacuum in your lamps, or the use of an attenuated atmosphere of some non-combustion supporting gas; what means had you, at 43 Centre street, for supporting a vacuum?

A. We had an air pump, worked by hand, and we also used an exhausting apparatus with mercury.

X Q. 1693. Where did you get the hand pump?

A. We borrowed it, or Sawyer did; I don't recollect where, if I knew, nor from whom.

X Q. 1694. About how long after you had been to Centre street was it borrowed?

1489 A. I cannot recollect, but I should judge a week or so, or two weeks; it may have been sooner.

X Q. 1695. Did you have the continuous use of this pump while you were at Centre street?

A. I don't know; we had the use of a pump, this or others, while there; I do not recollect about it, because I did not personally get or borrow the pumps or pump.

X Q. 1696. You speak of "pumps," were more than one borrowed?

A. I don't know whether the same pump remained there all the time after we borrowed it, or whether it was borrowed more than once, or whether other pumps were borrowed.

X Q. 1697. Do you remember whether you had the continuous use of a hand pump?

A. No; I only remember using it when we wanted to.

X Q. 1698. Do you remember whether you always had it there to use when you wanted to?

A. I do not remember whether we always had it there or not.

X Q. 1699. What was the exhausting apparatus used with mercury?

A. It was of the character of a Geissler pump, used by displacement of air by mercury.

X Q. 1700. Where did you get this apparatus?

A. We rigged it up ourselves.

X Q. 1701. By "ourselves" who do you mean?

A. Mr. Sawyer and I.

X Q. 1702. Where did you get the parts which you thus rigged up?

A. I forget; I think though that I got the reservoir either from Haggerty Brothers, in Platt street, or from the glass house in Brook-

lyn; it was the one lying south of the South Seventh-street ferry; a continuation of the street running north and south by that
1490 ferry and several blocks south of the ferry, or to the right hand as you cross the ferry from New York.

X Q. 1703. Where did you get the glass tubing and stop-cocks?

A. I don't know; we bought such at a variety of places, among others from Frasse, in Chatham and Fulton streets, New York; from Hahn, in North William street; from the glass factory I have mentioned, and perhaps at other places, and I had some at my house which I brought over and used.

X Q. 1704. Did you have any glass-blower assist you in putting the apparatus up?

A. No; we put it up ourselves.

X Q. 1705. Did you individually possess sufficient skill to put the apparatus up?

A. Yes; it required no great skill.

X Q. 1706. Please describe in detail this apparatus, and state when it was put up and where in the room?

A. The apparatus I cannot describe in its minute details; generally it was a glass reservoir with three outlets, one to the open air on top with a stop-cock in it, two at or near the bottom of the reservoir with stop-cocks, one connecting to the lamp chamber through glass and rubber tubing, the other to a bottle having two outlets, one at the top and the other near the bottom; the last bottle was larger than the reservoir I first spoke of; it was used in different places in the room; the apparatus was put up soon after the purchase of the mercury shown by ——; that purchase as appears by my check book was paid for to Charles P. Pfizer & Co., April 6, 1878; the stop-cocks were of glass and bought of Mr. Hahn in North William street; the usual place of working this apparatus was on a bench in a little room partitioned off from the main room by a canvas partition.

X Q. 1707. Did you use this apparatus to any extent for obtaining a vacuum?

A. Yes; we used it frequently, not always.

1491 X Q. 1708. Could you get a vacuum with it?

A. Yes; very good.

X Q. 1709. Better than with the hand pump?

A. Yes; much better.

X Q. 1710. Were you troubled with mercury vapor?

A. I don't know; I don't recollect.

X Q. 1711. You remember no trouble of that kind?

A. I don't remember observing any.

X Q. 1712. Did you have any trouble with it?

A. I don't recollect any trouble with it except in keeping the joints tight and in bursting a rubber tube connecting between the two reservoirs and bottle.

X Q. 1713. How did you keep the joints tight?

A. We covered them with rubber tubing and tied them over with strings.

X Q. 1714. Did Sawyer ever complain of this apparatus as creating a mercury vapor?

A. I don't remember; we might have had trouble of that kind and Sawyer may have complained of it, but I do not recollect that he did.

X Q. 1715. Do you remember taking any precautions to avoid the creation of a mercury vapor?

A. I do not.

X Q. 1716. Had you ever tried such an exhausting apparatus before?

A. Yes.

X Q. 1717. Where?

A. I don't know.

X Q. 1718. Do you know whether Sawyer ever had?

A. I don't know, I only know it was not new to me and I don't think it was to Sawyer.

X Q. 1719. Is it then the fact that you put this apparatus up and that it had worked successfully from the start?

A. Yes, we put it up, had some trouble with the bursting of tubes or rubber tubing and it worked well enough for our purposes.

1492 X Q. 1720. Which did you prefer, a vacuum or an inert gas at atmospheric pressure for your lamps?

A. We were most successful with an atmosphere of inert gas at atmospheric pressure, as compared with the vacua that we obtained without the gas, but I think we preferred a vacuum or partial vacuum of inert gas to either.

X Q. 1721. Don't you know which you preferred?

A. I do not remember exercising ourselves in regard to it; I think clearly that we preferred the inert gas at atmospheric pressure to an atmospheric vacuum such as we obtained. By "atmospheric" I mean such a vacuum as contained no inert gas or remnants thereof, but only a remnant of atmospheric air.

X Q. 1722. As between an inert atmosphere at atmospheric pressure or a vacuum where the residual atmosphere was an inert gas, which did you prefer?

A. We very rarely had, if ever, an atmosphere in our lamps when they were finally closed up at atmospheric pressure, but somewhat less than that. I do not remember that while we were at 43 Centre street we had formed any decided preference as to the degree of pressure or attenuation of the atmosphere of our lamps; it was only, as I think now, after we went to the corner of Walker and Elm streets that we began to think that it was a possible advantage to reduce the amount of gas in the lamps. Still, I may be mistaken in this, but I think not.

X Q. 1723. Did you ever form a preference for either?

A. Yes, I think while at the corner of Walker and Elm streets, in the fall of 1878; at all events we practiced extensively the exhaustion of the air of our lamps.

X Q. 1724. You say you "think;" do you mean that you are in doubt as to whether you did?

A. No, I don't think I am in doubt in regard to it; I think we preferred clearly and distinctly the exhausted chamber, but there were other questions connected with the matter that complicate the matter in my mind.

1493 X Q. 1725. I do not understand whether you are clear as to whether you preferred one over the other or are merely conjecturing in regard to it. Did you have a distinct preference at any time?

A. Yes; we did have a theoretically distinct preference in regard to the matter is what I mean to say.

X Q. 1726. What do you mean by "theoretically"?

A. We recognized the fact that any atmosphere with which we could fill the lamp could not be a perfectly inert atmosphere. We also recognized the fact that a perfect vacuum would be. The complication- of which I have spoken have reference to our practical difficulties in getting even an approximation to such a vacuum and then sealing up our lamps and having the vacuum preserved in them.

X Q. 1727. You say you recognized these difficulties. Now, as a practical question, did you ever reach any preference?

A. Yes.

X Q. 1728. Which was it for?

A. It was for an attenuated atmosphere in an inert gas.

X Q. 1729. Attenuated to what extent?

A. We tried all extents from slightly below atmospheric pressure, perhaps a third of the pressure removed, up to the highest that we could get; we had difficulty in preserving while sealing up the higher attenuation, and we adopted ordinarily in practice therefore a less attenuation than the highest that we could get, as an ordinary thing.

X Q. 1730. Can you give me any idea as to the degree of attenuation which you preferred?

A. No, I don't recollect. I don't think we could know what the degree of attenuation was, but only the pressure of the atmosphere in the lamp which was always hot when sealing it up; my idea would be now that we ordinarily reduced the pressure perhaps a half, perhaps more, perhaps not so much, perhaps only a

1494 third, from a third to two-thirds, and it was still further reduced when the lamp was cooled off; this was only in lamps in which we were endeavoring to have a vacuum or partial vacuum; in much the greater number of our lamps we used the pumps only as a method of exhausting the air and for filling the lamps with the inert gases; so that they were more nearly at atmospheric pressure than the others.

Adjourned till Friday, the 9th inst., at 10½ a. m.

FRIDAY, *December* 9, 1887.

Met. Present, counsel as before, and the cross-examination of Mr. MAN was continued as follows:

X Q. 1731. Aside from the fact that no inert atmosphere is absolutely inert toward carbon when incandescent, were you of the opinion that it was disadvantageous in any other respect?

A. There are certain degrees of vacua in which the current seems to be transmitted, whether conducted I cannot say, in the manner of the Geissler tube, and certain degrees of exhaustion in which the electric arc seems to be more readily established than in a plenum at ordinary atmospheric pressure or in a high vacuum; a higher exhaustion and a less exhaustion do not have the same results in these particulars; again, the higher the exhaustion the less the conduction of heat by the atmosphere of the lamp; again, the higher the exhaustion the less the wearing away of the conductor by the impingement of the atoms of the air or atmosphere against the conductors, sometimes called the bombardment of atoms, referred to in the kinetic theory of gases.

X Q. 1732. Did you recognize these facts at the time of your experiments?

1495 A. We did.

X Q. 1733. What effect had the conduction of heat on the candle power of the lamp?

A. Of course to the extent that heat was conducted away from the incandescent portion, the candle power of the lamp was diminished; I do not mean by this that the loss in candle power was an exact fixed ratio to the loss of heat from the conductors; the ratio would increase as the loss of heat increased.

X Q. 1734. Would *now* current then be required to bring the lamp up to incandescence?

A. It would.

X Q. 1735. You recognized that then, a high vacuum, if it could be first obtained and when maintained, would be preferable to an inert atmosphere?

A. Yes, unless the vacuum was one of inert atmosphere; that is preferable to any other atmosphere.

X Q. 1736. Why then did you not employ a high vacuum of either atmospheric air or an inert gas?

A. We did so employ it, but it was not our ordinary method or practice.

X Q. 1737. Why did you not adopt it as your ordinary method or practice if you knew it to be superior?

A. Because of the difficulty of securing such a vacuum, the long time consumed with our apparatus in getting it and the difficulty of maintaining it when obtained and because we were hurrying to get lamps to exhibit and put in use, and because that our lamps with a very moderate exhaustion and little below the normal pressure of the atmosphere seemed to us good enough for practical use.

X Q. 1738. The patent in suit in its 4th claim, as one of the elements of the combination thereof, speaks of "an illuminating chamber made wholly of glass, hermetically sealed." The specification of the patent speaks of a "lamp chamber" composed
1496 wholly of glass as described in the patent 205,144; did you

and do you consider the lamp chamber of patent 205,144 as made wholly of glass?

A. Yes.

X Q. 1739. Referring to your answer to questions 50, 51, 52, 53, 54, 55, 56, 57 and 58 of your direct examination do you know of your own knowledge that lamps were made as there described?

A. Yes; I saw them at the place, 94 Walker street.

X Q. 1740. Did you see them made?

A. No.

X Q. 1741. You say but a few were made, about how many?

A. I don't know; three, four or five of them came under my observation at the shop in Walker street. I had not known of their being made until I saw them in the shop. I then asked Mr. Sawyer in regard to them, or first his father and then him; his father's time was being taken up with these lamps when he had other work assigned to him; he told me that his son had got them made and directed him to do the work; I asked Mr. Sawyer then in regard to them and he told me he had got them blown at the glass-blower's right opposite our shop, or nearly opposite, in Walker street, where we had had some small amount of glass-blowing done; the lamps were put up by Mr. Sawyer and he called my attention to them again several times; I don't think I ever saw but one of them at a time lighted up, whether the same lamp or different ones I do not recollect, but I believe different ones.

Defendant's counsel objects to what Sawyer stated to witness as incompetent.

X Q. 1742. Then you were not consulted and did not know as to the making of these lamps?

A. No, not at first; Mr. Sawyer was at the time in charge of the shop and gave directions for the work to be done, usually consulting with me in regard to it beforehand, but in this case he did not.

1497 X Q. 1743. Then you do not know of your own knowledge how these lamps were made except as you inferred from the completed structure or as Sawyer told you?

A. The completed structure showed how they were made and Sawyer also told me.

X Q. 1744. Is your recollection of these lamps clear?

A. Yes, *a* lamps all used together and not in separate parts.

X Q. 1745. What kind of carbon did they have?

A. The same carbons as our other lamps; I can't recollect whether circular or straight; I think circular.

X Q. 1746. Did they have hollow conductors?

A. Yes, one hollow conductor, not two; I think one of the lamps had a glass tube instead of a metal one, and the conductor in that lamp in the tube was solid, making both conductors solid.

X Q. 1747. Is your recollection clear as to there being such a lamp?

A. Yes, my recollection is clear in regard to it.

X Q. 1748. Please illustrate by a sketch each of these lamps.

A. Figure 2 of patent 317,676 will show the general appearance

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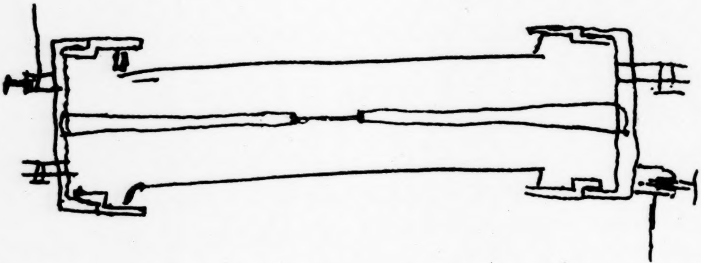


Defendant's exhibit
Chan Slatch no 2
Oct 11 1887

No. 286.
C. E. Light Co.
v.
McK. Light Co.
p. 1498

of one lamp when set up; Fig. 5, of the same patent, shows the construction of the bottom of the lamp, the only difference being that the flange *x* of the globe and the base piece *y* were fused together after the interior works of the lamp were set up; the base, *y*, was thinner than as represented in figure 5 of the patent referred to.

Witness makes a sketch.

(Witness continues:) I have made a drawing, illustrative of a base of one of the lamps that I saw; there were other constructions which I saw, but I cannot remember them with sufficent accuracy to make drawings of them; in one, I know there were two glass tubes fused in the base into which conductors were fused.

(Here follows diagram marked p. 1498.)

1499 Drawing offered in evidence, and the same is marked "Defendant's Exhibit Man Drawing Dec. 9th, 1887."

X Q. 1749. Referring to the drawing, did the metal conductor C pass out through a hole in the tube A?

A. Yes, through a hole in which it was fused.

X Q. 1750. Did the glass tube A have an open outlet into the interior of the lamp?

A. It did.

X Q. 1751. Was the conductor C sufficiently loose in the tube A to admit of exhausting or charging the lamp by means of this tube?

A. Yes.

X Q. 1752. What was the material and size of the metal conductor B?

A. I think it was a brass wire; both the conductors B and C at first, I think, were brass wires.

X Q. 1753. Why did you say "at first"?

A. Because they afterwards changed it, using an iron wire.

X Q. 1754. In other respects the lamp conformed to the general style, shown in the patent in suit?

A. Yes; one, however, was different, but I cannot recollect it with sufficient accuracy to describe it.

X Q. 1755. The order in which these parts were made or put together you do not know of your own knowledge?

A. Only as I could judge what it was from what I knew of glassblowing.

X Q. 1756. Have you now testified in answer to my questions, as to all that you remember on this subject?

A. All that occurs to me now.

X Q. 1757. If there was any invention in the doing of what you have just described it was the sole invention of Sawyer, was it not?

A. Neither Mr. Sawyer nor I thought there was any invention in it; if there was, I did not claim any part of it; if there was any invention, it was his alone, but it belonged to the Electro Dynamic Light Co., under his agreement with that company. 1500

X Q. 1758. Was the character of construction followed up in any way?

A. No more than those few lamps, so far as I know.

X Q. 1759. You say in your 49th answer that Exhibit No. 29 was blown directly from the pot in your presence; was it blown in a mould?

A. No.

X Q. 1760. Was any commercial use made of the lamps you have described previous to my last question, I mean those having the glass bottom plate fused unto the globe?

A. The only use that was made of them was to set them up in our shops and run them for lighting up the place and show them to people who came in, so far as I know.

X Q. 1761. Your usual method was to clamp the parts and not fuse them?

A. It was.

X Q. 1762. You preferred the clamping?

A. I think we did; we preferred to fit them together so that we could take them apart and renew the carbons, and recharge them or exhaust them.

Adjourned till Monday, 12th inst., at 10½ a. m.

1501 MONDAY, *December* 12, 1887.

Met pursuant to adjournment.

Present, counsel as before, and the cross-examination of Mr. MAX was continued as follows:

X Q. 1763. In answer to your 87th question, referring to the use of the soapstone disc, —:

"We subsequently ascertained that it was not necessary, and ultimately left it out."

When, in point of time, did you ascertain that it was not necessary?

A. We came to the conclusion while we were at 94 Walker street, in the fall of 1878, that the disc of conducting or insulated material, to which you refer, for the purpose for which it was first introduced, viz., to prevent the radiation of heat, was not necessary, but for the purposes secondly introduced, the serving as a base or support for the conductors or holders and the incandescent conductor, that it was useful. So long as Mr. Sawyer and I were together, until March or April, 1879, we continued its use for this latter purpose, modifying it in form and shape and materials used.

X Q. 1764. If you considered the disc unnecessary for preventing heat in the fall of 1878, why did you, in the patent applied for on November 5, describe its use for this purpose and claim it?

A. I think our conclusion that the disc was not a necessity for preventing radiation had not been reached at that time, and possibly not till the winter of 1879. Whether it was or not, I do not think, so long as Mr. Sawyer and I worked together, that we were convinced that the disc referred to might not be of some use in preventing the radiation of heat to the base of the lamp.

1502 X Q. 1765. I understand the fact to be that you and Sawyer always retained it, as a part of the construction of your lamps, irrespective of the purpose which it served.

A. We did, I think, so long as we worked together, up to and into March, 1879, but not of a size to fill the globe of the lamp and prevent radiation, but only as a base for setting up the holders and incandescent conductor.

X Q. 1766. In your 87th answer, referring to this disc, you say that ultimately it was left out; what do you mean by that statement?

A. I mean that the Eastern Electric Manufacturing Co. and the Consolidated Electric Light Co. left it out as a feature of the lamp, to prevent radiation, and its only remnant in the lamps of the latter company consists in the glass base projected inward into the lamp upon which the holders and incandescent conductors are set up, and which glass base is fused to the walls of the lamp chamber. It appears in Complainant's Exhibit No. 21, in this remnant form.

X Q. 1767. Was not the lamp that you considered you had perfected, when you left Centre street, and the lamp which you designed at that time to introduce commercially, a lamp of large carbon and lower resistance?

A. Yes; I think so.

X Q. 1768. With the exception of such experimental lamps as you made after that period, were not your efforts directed mainly to the improvement of that type of lamp?

A. I think we gave more attention to the making of a lamp of moderate resistance than to attempt to realize the advantages of a lamp of high resistance, for the reason which I have heretofore stated.

X Q. 1769. Is it not true that, so far as there was any difference between the smaller and larger carbons, you preferred, for the reasons that you have stated, the larger carbons?

A. It is hardly fair to express it in that way. It was not 1503 a question of larger carbons or smaller carbons—a question of high or low resistance, but a question of what we could do with the means at our command; and we made mostly the larger carbons, with low resistance, because we could run them—a lot of them together—while we could only run one, or at most two, of the finer carbons with the current at our command. It was a question, therefore, of making a good lamp, and the question of high resistance or low resistance, as a matter of preference in my mind, I do not think existed. We considered, I believe, that having made good lamps of any suitable resistance for giving proper light, we could make lamps of higher or lower resistance than those we had made, within the limits of practicability and suitable to currents, available for use, of higher or less electro-motive force.

X Q. 1770. But the fact is, is it not, that the ordinary lamp you built was one that had a comparatively large carbon and low resistance?

A. Yes, in comparison with most of the incandescent electric lamps of the present day. Some of the electric lamps of to-day have carbons of larger cross-section than those we ordinarily used, but I think they are longer and of higher resistance than our carbons usually were.

X Q. 1771. While you were at 43 Centre street, how long, of your own knowledge, did a carbon remain at continuous incandescence. I mean to inquire as to what you yourself know, independent of any statements made to you by others, in regard to the incandescence of the carbon?

A. I saw the same carbons, in the same lamps, without intermission run for hours at a time, three, four or five hours or longer, all an evening and all an afternoon, at several different times.

X Q. 1772. It was not your custom to be at Centre street as long as three or four or five hours at a time, was it?

A. No, sir.

X Q. 1773. These, then, were special occasions?

1504 A. Yes, sir.

X Q. 1774. The engine in the building on which you were dependent did not run at night, did it, except by special order?

A. No, sir.

X Q. 1775. On the evenings to which you referred, did you make special arrangements for the running of the engine?

A. We did.

X Q. 1776. Who made these arrangements, and with whom were they made?

A. The engineer. I forget whether by myself or by Mr. Sawyer at any particular time. Sometimes one of us and sometimes the other; usually Mr. Sawyer.

X Q. 1777. What was the occasion of the running at night?

A. To exhibit our lamps and to run them continuously a longer time than could be done while the engine was usually running.

X Q. 1778. Who were present at these exhibitions at night to which you refer?

A. I do not remember. A large number of people at different times. I remember Mr. Lawrence Myers being there; Mr. William Hays; Mr. Jacob Hays; Mr. Classon; Mr. Hugh McCulloch, I don't know whether at night or in the daytime; other gentlemen invited there by Mr. Sawyer, whose names I do not recollect, if I knew them; other gentlemen invited there by myself, whose names I cannot recall.

X Q. 1779. Can you mention any gentlemen now present who you know were present at one or all of these exhibitions at night?

A. I think all of the gentlemen I have mentioned, with the possible exception of Mr. McCulloch, saw the lamps running at evening. I do not think any of them remained during all the time that
1505 the lamps were lighted up. Mr. William H. Church was also present, and saw them running at evening.

X Q. 1780. What I desire to know is, if you are certain, so certain that you do not think, but know, that some gentlemen now living that were present at any or all of these evening exhibitions. If there is any person or persons whom you know were so present, please mention their names.

A. I have given you the best of my recollection upon this subject. It is ten years, or nearly so, ago. I feel the greatest confidence, and think I know that all of the gentlemen that I have named, except possibly Mr. McCulloch, were present, and saw the lamps running at evening at 43 Centre street, but I do not claim to be infallible in my recollection. I only say that such is my recollection, and I think I know it.

X Q. 1781. Are you as confident that these gentlemen saw these lamps running at 43 Centre street as you are of any other fact concerning which you have testified?

A. No; some one or more of these gentlemen might have seen it in the daytime and not at evening, and I might be mistaken as to one or more of them, but I think not.

X Q. 1782. As I understand, these were exhibitions to show the lamps running?

A. Some of them were and some of them were not. Some of them were for trial of the lamps.

X Q. 1783. And about how many occasions did you run these lamps at night?

A. I cannot tell; perhaps a dozen times?

X Q. 1784. On each occasion you were dependent upon the power in the building, and had to depend on the engine in the building being run after hours?

A. Yes, but sometimes other people in the shops wanted
1506 to work at night, and the engineer would advise us that he
was going to run after hours and we could avail ourselves of the opportunity thus furnished.

X Q. 1785. What was the usual time that the power in the building shut down?

A. Six o'clock, I think; it was frequently after dark.

X Q. 1786. How late do you remember running at night?

A. I should think nine or ten o'clock, but not usually later than eight or from eight to nine.

X Q 1787. Now, these exhibitions that were made in the evening were exhibitions of completed and running lamps, as I understand?

A. Yes; so far as they were exhibitions.

X Q. 1788. About when did the first of these exhibitions take place?

A. Very soon after we went there to 43 Centre street, within a week or so; Mr. Sawyer invited a number of gentlemen to see the lamps lighted up after candle light, or they remained after candle light, I don't know which.

X Q. 1789. Do you remember any of the gentlemen who were present at that exhibition?

A. No, I do not.

X Q. 1790. Were you present?

A. During only a part of the time; I left before the rest.

X Q. 1791. The apparatus at this exhibition was, I suppose, comparatively crude?

A. Yes.

X Q. 1792. When was the first exhibition in the evening at 43 Centre street, in which you showed a well constructed and finished lamp?

A. I think in April, 1878.

X Q. 1793. What was the construction of the lamp exhibited?

A. I can't recollect, because we had various constructions.

1507 X Q. 1794. You mean you exhibited several different constructions of lamps?

A. Yes; mostly lamps with straight pencils or low, flat arches.

X Q. 1795. Were they of the same general construction, differing only in detail, or of radically different construction?

A. They were of the same general construction, except as to the holders and incandescent carbons and leading-in conductors; the shapes of the globes were different in differe-t lamps; some of them were straight and some of them had bulbs.

X Q. 1796. How many lamps did you run at a time at this first exhibition in April?

A. From two to four, probably; at different times we ran different numbers of lamps, sometimes only one and sometimes as many as eight.

X Q. 1797. Were these lamps shown at this first exhibition of the construction shown in patent 205,144?

A. I cannot distinguish any exhibition in my recollection in the month of April as the first; the lamps shown in our exhibitions were generally similar, but not like it, the respect that the part G shown in the drawing of that patent was usually omitted and a spring was substituted for the weight of the part F usually; again, many of the lamps which we exhibited had the carbons running crosswise between the holders, some of them rising in arches above the holders, instead of standing vertically or upright as shown in the drawing of this patent; there is a type shown in figure 8 of the drawings of this patent which is more nearly like the lamps we usually exhibited.

X Q. 1798. In these lamps that you exhibited, what were the incandescent conductors made of?

A. Referring generally to the lamps shown to different people at different times while we were at 43 Centre street, the incan-
1508 descent conductors were generally made of mineral carbon or deposit carbon, treated according to our electrical process; some, however, were of fibrous carbon, wood or paper, treated according to our electrical process.

X Q. 1799. To whom were the lamps containing fibrous or paper-carbon conductors treated as described, exhibited?

A. I do not know; they were simply shown with our other lamps; Mr. Church and old Mr. Sawyer and his son George were the only persons that I think at that time knew of the fibrous carbons being used; others may have known it, but I do not know that others did.

X Q. 1800. Were any lamps containing fibrous paper carbon untreated, exhibited while you were at 43 Centre street?

A. I do not know of any, and I do not know that they were not;

I think and am confident that Mr. Wm. H. Church saw them used and knew what they were, and also Mr. Wm. Sawyer and George Sawyer; of course Mr. Wm. E. Sawyer saw them.

X Q. 1801. Did these gentlemen that you think saw these lamps run, watch them running for any considerable period?

A. I don't know that they timed them; I think Mr. William H. Church watched their operation, but am not sure.

X Q. 1802. Was the construction of the lamp and the character of the carbon explained to them?

A. They saw the work going on and knew more or less of what we were doing. Of course in doing the work, more or less explanation, how much I cannot tell now, was necessarily given to Mr. Wm. Sawyer who worked on the lamps and in setting them up, and assisted generally. Mr. George Sawyer was employed principally as a messenger in sending in for different things and sometimes as an assistant merely, to his brother and father or to me.
How much explanation was given to him I do not know or
1509 recollect; he was a boy about 17 or 18 years old or less.
The construction of the lamps and the preparation of the carbons was, I think, explained to Mr. Church more or less by Mr. Sawyer or by me, mostly by Mr. Sawyer. I think he was pretty well advised as to what was going on.

X Q. 1803. On the occasion on which you saw the same carbon run at continual incandescence, for a period of three or four hours, were you present for the purpose of watching the continued burning of the carbon?

A. Sometimes, yes; when we were testing them. Sometimes no, when I was simply at the shop working or assisting or advising and consulting with Mr. Sawyer and the lamps were being run. Sometimes no, when I had invited people to see the lamps and simply went there and remained because they were there.

X Q. 1804. While at 43 Centre street, what is the longest period that you were told of a lamp being run at continued incandescence?

A. All day, from early morning until evening.

X Q. 1805. As to whether such was the fact depended upon the truth of the statements of the Sawyers?

A. In part yes; but in part confirmed by my own observation in seeing the lamps started or running, and afterward returning and finding them so, at midday and at evening.

X Q. 1806. But whether they had been running in your absence you do not know?

A. No, not further than I was told by the Sawyers, and I think Church.

X Q. 1807. How many hours of actual incandescence do you, of your own knowledge, know of any one carbon continually burning at 43 Centre street?

A. I cannot give the number of hours. We did not keep track of them. I saw the same lamps with the same carbons in them run
day after day at high incandescence, I should judge from 25
1510 to 50 candle pow*d*er, or higher sometimes, from some time

in April until we left 43 Centre street, the last of May or first of June. They were good then and the carbons seemed not to be affected by their use.

X Q. 1808. How do you know that the carbons had not been changed in your absence?

A. Because of the manner of setting up the lamps, and the appearance of the carbons themselves, and of the lamps. If they had been changed I should have observed it.

X Q. 1809. You had no reason to suspect that anything of the kind had been done or would be done, had you?

A. No, I knew of the carbons being changed in lamps very frequently, and observed the changes that were made, and observed those that were not changed, and was closely watching the lamps and the effect of their use upon the carbons.

X Q. 1811. You had no reason to suspect, at the time, that the Sawyers had or would deceive you, in regard to the life of these carbons, or to suspect that the carbons had been changed in lamps, which you were led to suppose had not been touched?

A. No.

X Q. 1812. You were not looking for deception on their part?

A. No, but I was looking to see that I was not deceiving myself. I do not remember ever asking them in regard to the changing of the carbon, for I observed the changes myself, and I was observing the carbons in the lamps, and the lamps, and how they were affected by use; watching them continually while I was there and they were running, or examining them if they were not running.

X Q. 1813. Your habit was to run these lamps until they gave out?

A. Yes, until the carbon gave out, or something happened
1511 to the lamps or until seeing, as we thought, a change for im-
provement in the lamp, we took it down, made the supposed
improvement and set it up again, sometimes with the same carbon,
sometimes with a different one.

X Q. 1814. Did you try running different carbons under the same conditions, to ascertain their respective life?

A. Yes, as nearly as we could.

X Q. 1815. I understand that the conclusion of your experiments in March, 1879, or rather prior to that time, while you were still at 94 Walker street, the Electro-Dynamic Light Co., considered your lamps so far perfected, as to order several hundred to be made. Is that the fact, and that a great many lamps were made in conformity to such order?

A. Yes.

X Q. 1816. About how many lamps were made in conformity to that order?

A. I do not know that I ever knew how many.

X Q. 1817. At this time had you decided on a type of lamp as being the one that you intended to introduce?

A. We had decided upon several which we thought were suitable for introduction.

X Q. 1818. Any one that you preferred?

A. There were two forms which we preferred; possible three; one was a straight pencil carbon; the other was the loop or arch form carbon; another was a carbon held straight across the tops of the holders with adjustable tension between the holders.

X Q. 1819. Now, these lamps that were made by you in conformity with the large order of the company—what kind of carbons did they have, and what was their form?

A. The carbons were straight pencils or strips of pure-deposit carbon, some hollow and some solid arched carbons of pure-deposit carbon; some of the same of both shapes with a core of wood or other fibrous carbon inside; some of both shapes of wood or other fibrous carbon treated according to our electrical process to 1512 all extents, from a treatment barely sufficient to drive out occluded gases, purify the carbon, render its resistance uniform throughout its length and regulate the resistance to conform to other carbons of the same kind, up to a treatment making a substantial deposit of appreciable thickness upon the fibrous core; some of these carbons of both shapes were substantially round in their cross-section, some of them were flat and thin and some of them were square, or nearly so, in cross-section.

X Q. 1820. This order was the first commercial order that was given for Sawyer-Man lamps, and the lamps to which you have referred were made in response to it?

A. I think so; that is, it was the first direction given by the company to make lamps for commercial use.

X Q. 1821. How did it happen that there was such a variety and difference in the shape and substance and treatment of the carbon and such difference in the construction of the lamps as must have been necessitated thereby?

A. I do not think that there was anything strange about it when it is considered that the superintendent of the work was an inventor and desired to make the lamps in a variety of forms rather than one.

X Q. 1822. What do you mean, that it was left to you and Sawyer to make such lamps only as you saw fit, the number only being ordered?

A. I mean just what I say; that these different forms of lamp having been made before that time or projected and the different forms and characters of carbon having been tried; the order of the company was given to make the lamps, and the character of the lamps to be made was not specified; I will add that there was another reason for this, I mean the not settling down to one particular form of lamp and carbon—a thing that I personally greatly desired to accomplish.

X Q. 1823. Then the order of the company left it to you 1513 and Sawyer to decide upon the kind of lamp that should be made and the shape and character of the carbon to be used?

A. Yes.

X Q. 1824. Why then did you make lamps containing the differences you have mentioned?

A. I suppose to try upon a large scale which was the best.

X Q. 1825. You say "suppose," don't you know?

A. I know that that was all the reason I had for doing so, or consenting to its being done.

X Q. 1826. Then at this late day, you had not determined which was the best form for the carbon or the best material?

A. Yes, I think I had.

X Q. —. You say you "think," don't you know?

A. Yes, I believe I had.

Adjourned till Tuesday, the 13th inst., at $10\frac{1}{2}$ a. m.

1514 NEW YORK, *Dec.* 13, 1887.

Met. Present: Counsel as before, and the cross-examination of Mr. MAN was continued as follows:

X Q. 1828. If you were satisfied at this time of the superiority of one kind of carbon over the others, what is your explanation of making lamps of those carbons that you knew to be inferior, the lamps having been intended, as you say, for commercial use?

Objected to as immaterial and not cross-examination.

A. Prior to the giving of the order or direction by the company for making a large number of lamps for commercial purposes we had made a number of lamps of each of the kinds of carbons that I have described, all of which were good and satisfactory lamps; I had my own ideas and preferences in regard to the carbons in these different lamps: I endeavored to have them carried out after these orders were given; my own time was greatly absorbed by my business in charge of trust estates and property, where I was handling hundreds of thousands of dollars and had charge of millions of dollars' worth of property, real and personal; and I was worn out with the work of that and in the workshops of the Electric Dynamic Light Company, so that I could not give as much attention to the work there as I had previously done; and in December, 1878, was obliged to substantially give up work in the shop and get through the company Mr. Lawrence Myers to go to the shop and stay there continuously, and try to keep Mr. Sawyer sober; Mr. Sawyer's habits of inebriation grew on him to such an extent as to seriously interfere with his duties and work as superintendent of the work of the company; I did not succeed in having my ideas carried out, and Mr. Sawyer's condition was such that 1515 systematic and continued work upon what, previous to that time, had been considered the best carbons was not uniformly continued by him; it was due, *I as* think, to Mr. Sawyer's habits and the result of those habits in bad workmanship and carelessness in work where the utmost particularity and care was required, as it is to-day, in the manufacture of incandescent lamps, that the work was not as systematic as it should have been and as I desired it to be, and that the best, or what we considered the best, carbons were not made and put into use more extensively in the lamps we built.

Answer objected to as irresponsive and as containing many matters that are immaterial, as to which the testimony is incompetent and others in respect to which he has not been interrogated.

X Q. 1829. I want you to tell me how it happened that in filling this large order for lamps intended to be used commercially, carbons of different materials were used, some of which you believed so be inferior to others?

Objected to as having been already answered.

A. I have already fully answered that question, that it was due to Mr. Sawyer's being drunk, neglecting his work and making bad work, &c., being capricious, unmanageable and incompetent to exercise good judgment, and to my inability to be present at the workshops, as I had been before.

X Q. 1830. What had these facts to do with making the carbons of different material? I can understand how his intoxication could have interfered with his workmanship or prevented the work from being of the best kind; but how does it account for the making the carbons of these lamps intended for commercial purposes of such different materials which I should suppose would require a greater amount of work than if they were all made of one?

A. Mr. Sawyer was the superintendent; he gave directions
1516 to the work; his bad workmanship and judgment when drunk
and his carelessness while in that condition, resulted in the failure of many lamps, obscured what had previously been well settled and ascertained in our joint judgment; and led him to make first one thing and then another to remedy the defects which caused his failures, and so it was that he continued to put all kinds of carbons that we had made in the lamps, first one and then the other, and I was not there, and could not be, to control, if I could have done it, if I had been there.

X Q. 1831. You did not then participate in the making of these lamps?

A. Yes, to some extent; but not to a great extent, or as great an extent as I had before.

X Q. 1832. You did not approve of the use of these different carbons in the lamp, then?

A. Yes; sometimes I did and sometimes I did not.

X Q. 1833. You understand I am speaking of the filling of this order?

A. Yes; it would be more proper to say that I acquiesced in it, because I could not help it.

X Q. 1834. You were cognizant, then, of how the order was being filled as it progressed?

A. Yes, I think I was as fully as I was able to keep myself informed, but I could not keep myself fully informed of the work that was going on in all its stages.

X Q. 1835. You say that sometimes you approved of putting different carbons in these lamps and sometimes not; please explain what you mean?

A. I mean that we had made good lamps with all these carbons, and that when Mr. Sawyer told me of his failures of some of the lamps made with any of the kinds of carbons, or I observed those failures myself, and Sawyer told me that he was making lamps with different carbons, and believed that he would not make so many failures with the other kinds of carbon, I acquiesced in his
1517 going on with it, sometimes, and sometimes I protested and tried to keep the work uniform.

X Q. 1836. What fact or circumstance would influence you in acquiescing or protesting?

A. I don't recollect what particular facts or circumstances did at any particular time or instance; I only recollect that I was anxious to get a large number of lamps that were good and satisfactory, completed—more desirous of this than of testing or exploiting any particular carbon in the lamps.

X Q. 1837. So you practically let Mr. Sawyer go ahead as he saw fit?

A. Yes, if he would make good lamps.

X Q. 1838. Leaving to him to determine how good lamps should be made?

A. No, we had made good lamps in large numbers before, and the patterns were before him and in use.

X Q. 1839. But the fact is he went ahead, making lamps having carbons of different shapes and different materials, some of which were better than others?

A. Yes, I thought so.

X Q. 1840. But you allowed him to go ahead and make the inferior carbons and shapes as well as the superior?

A. So long as he would make good lamps we urged him on to do it, irrespective of the kinds of carbons or their shapes.

X Q. 1841. Now, had Sawyer, at this time, a decided preference for one shape or kind of carbon?

A. I don't know; I don't think he was capable during a great part of the time of exercising intelligent judgment in the matter.

X Q. 1842. What I want to know is whether he had formed a judgment?

A. He had before this time formed a judgment, and expressed it to me.

1518 X Q. 1843. Is it your believe that at this time he had a preference?

Ans. I don't know.

X Q. 1844. Do you mean to say that at a time when you claimed the experimental stage of your work was over, that you were ready to manufacture lamps for commercial use, and an order had been given by the company for the manufacture of a large number of the lamps, and you and Sawyer were manufacturing them, that you don't know whether your coworker and co-inventor had a preference for one kind or shape of carbon over another kind or shape?

A. I mean to say that at this time, while the manufacture of these lamps was going on, that had been directed to be made by the company, that my coworker, Mr. Sawyer, was not usually or ordinarily in a condition to exercise intelligent judgment upon the matter, and that he expressed himself in such various and contradictory ways to me—one thing to-day and another to-morrow—that I could form no opinion as to his having preference one way or the other, except temporary, and not reasonable and permanent.

X Q. 1845. If such were his conditions, why did you entrust the manufacture of these lamps to him?

A. We could not help ourselves; no one else except I was educated in the work; he made many good lamps, and we wanted to get lamps made, as I have stated before.

X Q. 1846. Then, is this the fact, that Sawyer was not so drunk or so unintelligent that he was not capable of making or superintending the making of good lamps—lamps which you intended to sell and use commercially; but that he was so drunk and so unintelligent as to be incapable of selecting the best kind and shapes of carbons, that having been a matter upon which you and he had already decided?

A. If I permit you to testify for me, I should convey very
1519 curious ideas, it seems to me. I have stated that Mr. Sawyer's inebriate habits interfered with his work in the making of the lamps, and caused him to make failures in their making; that while he made good lamps he also made bad ones; that his failures obscured in his mind what we thought had been previously made clear; the preference for carbons which we had been agreed upon in opinion; that his mind was rendered vacillating, as any drunken man's is: that I could form no intelligent opinion in regard to his then preferences, by reason of such vacillating.

X Q. 1847. If you could have had your way, would the lamps all have had one shape and one character of carbon?

A. Yes; unless that shape and that character had proved unsuccessful in use.

X Q. 1848. Had your experiments reached such a point that you had a decided preference for one shape and material?

A. Yes; one general shape, and of one material treated.

X Q. 1849. And if you could have had your way these lamps would have all been of that shape and material?

A. Yes, if the first had proved successful lamps.

X Q. 1850. What do you mean by saying "if the first had proved successful lamps"? Was not your mind sufficiently made up at that time?

A. My mind was made up. I mean by "first" the first lamps set up and run of those made under that order.

X Q. 1851. Was it sufficiently made up to have made all the lamps after one model, and having one kind and shape of carbon?

A. It was.

X Q. 1852. But yet, if the first instalment of lamps made up under this order had not been good, would you have changed the shape and material of the carbon?

1520 A. Yes, one or both unless the failure should have been due to some cause outside of the carbon. If we had deemed the failure due to the shape or material of the carbon, the shape or material would have been changed.

X Q. 1853. Had you then learned so little from all your experiments, that you would at this time, have changed the shape and material of the carbon, if the first instalment of lamps had been a failure which you attributed to the shape of material?

A. I will answer this by saying that I had no fear of failure by reason of the shape or material of the carbon, but that at any time we would have adopted a better shape and a better material which we could control as would be done to-day in incandescent electric lamps.

X Q. 1854. Then you do not think it possible that you could have attributed any failure in the first instalment of lamps to the shape or material of the carbon, if they had been made of the shape and material you preferred?

A. I do not think it probable that I would have attributed the failure of the first lamps to the shape or material of the carbons if they had been properly prepared and made.

X Q. 1855. What shape and material did you prefer?

A. I preferred a carbon of fibrous material electrically treated, of a form rising above the holders, of an arch or loop shape.

X Q. 1856. What kind of fibrous material?

A. I think paper fibre or paper carbon were my preference at this time, next wood carbon of willow.

X Q. 1857. What kind of paper?

A. Paper that was pure and had not remaining in it anything but cellulose.

X Q. 1858. Please mention the name of such paper?

A. The nearest paper of that kind in ordinary use is white blotting paper, or paper similar to it, unsized paper, of clean, pure paper stock.

1521 X Q. 1859. You say you preferred fibrous material treated to what extent?

A. Treated, as I have stated, to the point where the resistance of the carbon throughout its length would be rendered uniform, and to the point where there would not be so much of the deposit carbon on it as to render it liable to fly to pieces, as pure-deposit carbon does, when suddenly heated up. This treatment in our practice simply gave the carbon a silvery or lustrous appearance, and did not apparently change its dimensions.

X Q. 1860. Some two hundred lamps were made pursuant to this order, were there not?

A. I should think so, perhaps not so many.

X Q. 1861. How many of such lamps had loop or arch-shaped carbons?

A. Few comparatively, perhaps fifty; that is my best judgment.

X Q. 1862. The others were straight carbons?

A. Yes.

X Q. 1863. How many of these two hundred lamps had conductors of fibrous material?

A. I don't know.

X Q. 1864. What is your best recollection?

A. At this date I should simply have to guess. I should think from a third to a half, perhaps not so many. They were not near so many as those having mineral carbons or deposit carbons.

X Q. 1865. Who made the carbons for these lamps?

A. Mr. Edward Myers did the carbonizing mostly. Mr. Sawyer did the treating.

X Q. 1866. Edward Myers is dead, is he not?

A. He is.

X Q. 1867. Where was the carbonizing done?

A. In the furnace of the steam engine at 94 Walker street; our own furnace in our own room.

1522 X Q. 1868. Who did the mechanical work on these two hundred lamps?

A. It was done all over town in different places.

X Q. 1869. Tell me the places.

A. That I don't know; the metal spinning was done at three or four places in Centre street; the glass-work was done at the factory in Brooklyn near South 7th-street ferry; the carbon-work other than the incandescent carbons was done at two or three different places; the soapstone discs were done by a soapstone man down in the vicinity of Water street, and I think Peck slip, in that neighborhood; the metal-work was part of it done by H. L. Judd & Co., in Brooklyn; part of it was done by different mechanics in Centre street, one was a firm, I do not recollect their names, in the top story of the building at the corner of Howard and Centre street-; the setting up was done at our shop, 94 Walker street.

X Q. 1870. What persons or mechanics assisted in the assembling of these lamps at 94 Walker street?

A. Mr. Wm. Sawyer, who is now dead; Mr. George Sawyer, Mr. Wm. Sharp, Mr. Edward Myers and Mr. Wm. E. Sawyer.

X Q. 1871. The only persons living are Geo. Sawyer and Mr. Sharp?

A. I think so.

X Q. 1872. They ought to know then the mechanical character of these lamps, and whether they had straight or circular carbons?

A. I don't know whether they would or not.

X Q. 1873. If they put the work together they ought to?

A. I don't think they ever put the carbons in the lamps.

X Q. 1874. Could they not tell from the holders whether the carbons were to be upright and straight or horizontal or curved?

1523 A. They could tell whether the carbons were to be set upright or horizontal, not whether they were to be curved or straight.

X Q. 1875. Were the various parts of these lamps made from drawings or models?

A. I think they were made from drawings and samples both.

X Q. 1876. Did you give any of the instructions to the mechanics, or furnish them with the drawings or samples?

A. Yes, I think so, but it was mostly done by Mr. Sawyer.

X Q. 1877. Give me the names of any persons whom you thus gave information to or instructed?

A. H. L. Judd & Co., the glassmen in Brooklyn, I don't know their names, and the soapstone man whose name I do not remember; I probably gave directions to others, but I do not at present recollect their names. I remember one, one other to whom I gave instructions and models for castings in brass, but I don't remember his name; his location was a brass foundry near the Five Points, New York; I remember also being at two or three metal-spinners' with reference to the work; I do not remember their names.

X Q. 1878. What kind of fibrous material was it that was used in these lamps?

A. Mainly paper and wood.

X Q. 1879. To what extent was it treated?

A. Some of them were treated with a view of the removal of the fibrous carbon to leave pure-deposit carbon for the incandescent conductor of the lamp; some of them were treated so as to make a visible coating of appreciable thickness upon the conductors; most of them were treated to the extent I have specified or approximating that as in accordance with preference as stated to-day.

X Q. 1880. What was the extent of that treatment; I
1524 mean, was it sufficient to fill up the pores of the material
and coat it.

A. No, it left the material still porous, its ultimate fibres were, of course, coated, but the coating was infinitely thin except where points of higher resistance were regulated in the process to make the conductor uniform in resistance throughout its length.

X Q. 1881. How many of these two hundred lamps had conductors of carbonized paper or wood treated to this slight extent?

A. That I do not recollect.

X Q. 1882. About how many?

A. I did not do the work and I do not know.

X Q. 1883. Have you no idea?

A. No, not to express it in numbers; I can guess, I should think more than half of the fibrous carbons were treated, or intended to be, in that way.

X Q. 1884. What is your best recollection as to how many of these two hundred lamps had fibrous carbons treated to this slight extent?

A. I have no recollection which would enable me to fix the number; I can guess.

X Q. 1885. Well, guess, if that is the best you can do.

A. I should think thirty or forty lamps, maybe more, rather more than less.

X Q. 1886. I understand that some of the straight carbons were fibrous and some not, and some of the loop-shaped carbons were fibrous and some not?

A. Yes.

X Q. 1887. Who now living knew that some of these two hundred lamps contained these fibrous carbons treated to this slight extent?

A. I think that Mr. George Sawyer and Mr. Lawrence Myers

knew of it at the time, and that the other gentlemen, the two Messrs.
Hays and Mr. Classon were told of it; I think Mr. Amos
1525 Broadnax knew of it, and I knew of it; how much the
others can recollect of it at this time I do not know.

X Q. 1888. What has become of these two hundred lamps?

A. Part of them I have, one or two; a part of them Mr. Sawyer took when we left Walker street; part of them were put up, packed in barrels, and left with me at the time when we left 94 Walker street; part of them Mr. Sawyer subsequently got from me for making exhibitions and never returned; part of them were used up in our workshop in lighting them, the shops, up; part of these were used up in running them in exhibitions, experiments and testings at our place, 94 Walker street; part of them were taken down and modified by Mr. Sawyer.

X Q. 1889. Do you know whether there is now in existence one or more of these lamps containing a fibrous carbon conductor treated to this slight extent?

A. I do not; I think there is.

X Q. 1890. Where?

A. I don't know where.

X Q. 1891. Were these two hundred lamps paid for by the Electro Dynamic Light Co.?

A. They were, all the work.

X Q. 1892. Are there no books or papers in existence that would show who was paid for the work and who did it?

A. There were books and papers and bills which would show who was paid for part of it, not all.

X Q. 1893. Where are they, and in whose possession?

A. I don't know; the last I saw of them they were in the possession of the company.

X Q. 1894. What person had the custody of them?

A. I think the last time I saw them they were in the custody of Mr. Lawrence Myers or Mr. Jacob Hays.

X Q. 1895. Were these two hundred lamps delivered to the company, and were they its property?

1526 A. They were in the company's shops and were its property; there was no formal delivery of them.

X Q. 1896. Why did you in no way in the interference case mention or refer to this large number of lamps which you now say were made, and which had conductors of fibrous material and were made for commercial use?

A. I don't know whether I did or did not so refer to them.

X Q. 1897. The fact would have been important, would it not?

A. I do not know; it is proper to say that I have not stated here that these lamps were put to any use, except that of the company, or use made of them by Mr. Sawyer after March, 1879. This reminds me that I think some of these lamps were taken by Mr. Sawyer to Ansonia, Conn., to Mr. Wallace's place; I don't know whether those taken there had fibrous carbons in them or not.

X Q. 1898. Why was not one of these lamps containing a fibrous cabon put in evidence in that interference?

A. That I don't know.

X Q. 1899. Why were not the people whom you say knew of them interrogated concerning them in that interference?

A. I really cannot tell why anything was not done.

Mr. Broadnax, of counsel for complainant, says, that "you" (witness) might say that there was enough before the Commissioner to satisfy him (Commissioner) that Sawyer and Man were the first inventors, and that that is a good reason why there was nothing more put in.

X Q. 1900. These two hundred lamps having been made for commercial purposes, what generator of electricity did you intend to use with them?

A. We intended, when we should introduce the lamps into uses other than our own, to have dynamos built to run them.

1527 X Q. 1901. These two hundred lamps, under what conditions of current and electro-motive force were they constructed to be used?

A. I do not know, for they were of very variable resistance.

X Q. 1902. Were they not approximately of one resistance?

A. No.

X Q. 1903. Were they not adapted for use approximately under the same conditions?

A. Not in the same numbers, nor in the same arrangements.

X Q. 1904. Were they intended to be run in series?

A. Yes, some of them, a series of from eight to twelve lamps.

X Q. 1905. Were they not constructed in reference to some definite system or arrangement?

A. No, they were not, except in the limited numbers of from four to twelve, and some of them for use as single lamps.

X Q. 1906. Between what limits did the resistance of these two hundred lamps vary?

A. That I cannot tell in regard to any of our lamps; I know that some of them were less than an ohm and some of them, I think, were from thirty to fifty ohms, and perhaps higher.

X Q. 1907. Why was there so great variance in the resistance of these two hundred lamps?

A. It was an eminent illustration (these lamps two hundred, more or less) of the want of systematic work due to the condition of Mr. Sawyer, as I judged at the time, and of his inability by reason of inebriation to discriminate and judge and plan and adopt and adhere to system and regularity, and of the combination by Mr. Sawyer of work more in the character of experiments than for one particular purpose and in one particular plan.

1528 X Q. 1908. Was this wide difference in resistance due to accident or design?

A. I think it was due to design.

X Q. 1909. Your design?

A. No, design on Mr. Sawyer's part.

X Q. 1910. Had you any desire or preference as to what the resistance of these lamps should approximately be?

A. I will answer that question by saying that I have never determined in my own mind what the most advantageous resistance in an incandescent electric lamp is or should be.

X Q. 1911. Please answer my question by telling me whether you had any desire or preference as to what the resistance of these two hundred lamps should be.

A. Not any fixed resistance, that is, I had determined no such resistance in my mind.

X Q. 1912. Had you any preference or wish as to what about the resistance should be?

A. I have answered that question as fully as I can.

X Q. 1913. Do you mean that you were indifferent as to whether they were a tenth of an ohm or a hundred ohms?

A. No; I do not mean that.

X Q. 1914. Were you indifferent as to what their resistance should be?

A. No, I wanted them of suitable resistances.

X Q. 1915. What did you then consider suitable resistances?

A. Very various, as I do to-day.

X Q. 1916. Did you want these lamps then to very in resistance?

A. Yes, a little.

X Q. 1917. Did you then think Sawyer had done well in making them of different resistances?

A. No, not as they were made.

1529 X Q. 1918. Do you mean that you approved of the variance in resistance, but did not approve of the means by which it was obtained?

A. No, I do not mean that generally.

X Q. 1919. What was the resistance of the great majority of these lamps, about?

A. I do not know; I should judge from one to five ohms.

X Q. 1920. Had Sawyer any opinion at this time as to what about was the most desirable resistance in an incandescent lamp?

A. I do not know or recollect.

X Q. 1921. Had Sawyer and Man as joint inventors?

A. At that time when these lamps were built I do not *that think* we had or agreed upon anything as a fixed desirable resistance.

X Q. 1922. Had you agreed upon anything approximately?

A. At this time I do not think we consulted together in regard to it.

X Q. 1923. Now these lamps you say were made for commercial use; that being so, had you no idea of the character of the dynamo they were to be used in connection with?

A. Excuse me; I did not say they were made for commercial use; I said they were ordered to be made with the intent to have them used commercially. The lamps which we did make could all of them be run with the dynamos and other appliances we had.

X Q. 1924. Were the lamps made for commercial use or were they not?

A. We made them with a view of having lamps for commercial use. They were many of them lamps suitable to be used commercially in various positions and in various arrangements.

X Q. 1925. You did not make them then with reference
1530 to any approximate condition of current or electro-motive
force?

A. We made them for use with various currents and various electro-motive force, as I have stated.

X Q. 1926. Were any of these lamps ever sold for use commercialiy?

A. I don't know of any unless it was the lamps that were taken to Ansonia. I think they were paid for by Wallace.

X Q. 1927. What do you mean by saying they were paid for by Wallace, that he took them as part of your experimental plant?

A. No, Mr. Wallace did not take our experimental plant, except a dynamo, as I recollect. That belonged to me and I lent it to him.

X Q. 1928. Did the Electro-Dynamic Light Co. ever order any lamps to be manufactured other than these two hundred and subsequent thereto?

A. My recollection in regard — that matter is, that two or three directions were given by the board for the manufacture of specific lamps. They were some of them, I think, made and set up, but they would be included in my estimate or guess of two hundred lamps made.

X Q. 1929. With the exception then of this lot of two hundred lamps more or less of which we have been speaking, your recollection is that no other lamps were made than the few specific lamps referred to in your last answer?

A. No, that is not my recollection. The few specific lamps are included in my estimate of two hundred lamps made after the first direction given by the company. Before any specific direction was given by the company we had made, as I stated before, a considerable number of lamps of all the different varieties I stated. This is not included in my estimate of the number of lamps made after the direction of the company to make a specified number.

1531 X Q. 1930. Did the making of these two hundred lamps,
more or less, in *the* pursuance of the order of the company,
practically complete the work of Sawyer and Man?

A. Yes, practically, the making of the lamps which I have estimated at about two hundred, after the direction of the company to go on with the manufacture practically, completed the work of Sawyer and Man together.

Adjourned till Wednesday, the 14th, inst., at 10½ a. m.

NEW YORK, *Dec. 14th*, 1887.

Met pursuant to adjournment. Present, counsel as before, and the cross-examination of Mr. MAN was continued as follows:

X Q. 1931. In your 1887th answer, you say that you have one or two of these lamps made in Walker street pursuant to the order of the company; will you produce them at the next sitting?

A. I will, if so instructed. I am unwilling to give these lamps out of my custody. I had a complete assortment of all the lamps including all the different shapes of carbons and different kinds of carbons including fibrous carbons of different kinds, and they have got them all away from me except these, among others one that I set up with my own hands at 43 Centre street and which was used as an exhibit in some of the cases and they are all used up, broken and lost so far as I know; and I do not propose to give up the last remnants which I have of my work.

X Q. 1932. Will you bring such lamps as you have with you at the next sitting?

A. Yes; if so instructed.

X Q. 1933. You went to 94 Walker street the last of September, 1878, and remained till the latter part of March, 1879?

1532 A. Yes.

X Q 1934. And experiments were conducted there during that time?

A. Yes.

X Q. 1935. Was any carbonizing done there?

A. Yes.

X Q. 1936. While at 94 Walker street did you carbonize any at your house?

A. I do not remember; it is probable that I did, but the bulk of what was done was done at the shop.

X Q. 1937. Who did it usually?

A. I did some Mr. Edward Myers did—the most of it, I think Mr. Sawyer did some.

X Q. 1938. Who now living knew of its being done there?

A. I think all that I have mentioned as being at the shop, including our workmen and Mr. Church, Mr. George Sawyer, Mr. Sharp, Mr. Lawrence Myers, Mr. Amos Broadnax and myself, and Mr. Wm. H. Church. There are probably, a large number of other persons that saw it, but I don't know.

X Q. 1939. Who assisted in the work at 94 Walker street?

A. Mr. William E. Sawyer, George Sawyer, George W. Sawyer, Sharp and men who were employed by the day, but who they were I don't remember.

X Q. 1940. So far as experiments on the lamps were concerned at 94 Walker street, what direction did these experiments take?

A. Before going to 94 Walker street we had ordered and got delivered in part glass globes and bases of different sizes and shapes, and the leading-in conductors with their apparatus, spun caps for covering the base of the lamps of different sizes, the convoluted or folded conductors beneath the diaphragm, their connections through the base of the lamp, diaphragms, screws and carbons, and an
1533 assortment of a metal of different sizes and shapes for making
holders and parts above the diaphragms of the lamps; we had given orders for the making of a dynamo, and generally had prepared more thoroughly than before for the commencement of work on our lamps, switches, &c., bought and prepared electrical apparatus, resistances and measuring instruments; our first work was directed to the manufacture of the several different kinds of lamps I have

mentioned as manufactured or made before the direction given by the company to proceed with the manufacture of a large number of lamps, in order to get good lamps, improve their shape and appearance, and settle down upon all the different parts of lamps for different uses and of different kinds; to the preparation and testing of different kinds of carbons and their adaptability for use in different lamps as incandescent conductors; meantime the testing and trial of different dynamos went on and testing and trial of different methods of treatment and different extent of treatment of the incandescent carbon conductors; at the same time we were preparing switches, regulators, and resistances and automatic cut-outs, and doing the electrical experiments and work of testing and measuring; after we had got a sufficient number of lamps ready they were exhibited to the officers of the company—the directors, stockholders and their friends; matters having progressed so far, the direction of which I have spoken was given by the company to proceed to the manufacture of a large number of lamps, and the work of making and setting up lamps and the other work I have spoken of was continued; the materials for the large number of lamps I have spoken of as directed to be made were contracted for and procured in whole or in part from a great number of different people. I have omitted to mention the very extensive work which was carried on with reference to the atmosphere of the lamps, commenced at 43 Centre street, carried on more extensively during the last days of August and in September, until we went to 94 1534 Walker street, while we were at the corner of Howard and Centre streets; this work involved extensive chemical apparatus and materials and means of exhausting the chamber of the lamp and was carried on in part in our own shops, in part at Stevens institute, Hoboken, in part at the School of Mines in New York, and in part at a place in Broadway, down near the Battery; this is a general description of the work up to the time in November or December, 1878, when I was obliged to give up working so much and giving so much of my time to the work of the company; after this time much the same kind of work was continued under the superintendence of Mr. Sawyer, with my attention only so far as I was able to give it from time to time up to the time in March when we left 94 Walker street.

X Q. 1941. From whom were the globes, bases, leading-in conductors with their apparatus, spun caps, the convoluted or folding conductors, the diaphragms, screws and carbons mentioned in your last answer ordered and obtained?

A. I have already answered that question as completely and fully as I can.

X Q. 1942. You only remember the name of Judd & Co.?

A. Yes, none other occurs to me now.

X Q. 1943. To whom was the order for a dynamo given referred to in your last answer?

A. Arnoux & Hochausen.

X Q. 1944. Was the machine made?

A. Yes, but not before we got to 94 Walker street.

X Q. 1945. Was this the machine you principally used at 94 Walker street?

A. Yes, I think so; I do not know but that another was substituted for it of a similar kind.

X Q. 1946. What has become of this machine?

A. I think it is at Mr. Wallace's place at Ansonia, Conn.; I lent it to him.

1535 X Q. 1947. Can you tell me approximately its capacity or construction?

A. No.

X Q. 1948. Was the machine a special design, or one of Hochausen's regular make?

A. In general appearance it resembled the arc lighting machine which they were then building.

X Q. 1949. How did it compare with them in capacity—do you remember?

A. I object to further use of my time in repeating testimony already given; only that it was of less electro-motive force.

X Q. 1950. You say, in your answer to the 1939th question:

"After we had got a sufficient number of lamps ready, they were exhibited to the officers of the company, the directors, stockholders and their friends."

Did any of these lamps contain fibrous carbons but slightly treated, either straight or in the loop form?

A. Yes, some of those we exhibited contained the fibrous carbons treated in a slight way.

X Q. 1951. Were the persons to whom they were exhibited told the nature of the carbons?

A. I think the officers and directors of the company were told in regard to it, but I do not know.

X Q. 1952. Mention such persons as are now living that you think were told?

A. I think the two Messrs. Hayes, and Mr. Myers, and Mr. Church; I know Mr. Broadnax was told in regard to it, and that it was exhibited to him, and that he was applied to early in October by me to apply for patents for the fibrous carbons.

X Q. 1953. What was the material of the conductor of the great majority of the lamps made at Walker street?

1536 A. Either mineral carbon or deposit carbon, as I have said a great many times.

X Q. 1954. Had the majority of lamps made there straight or circular carbons?

A. Straight.

X Q. 1955. Were the lamps with straight carbons substantially such as shown in your patents?

A. In general appearance the same; they did not have the support G, shown in the first patent; they more nearly resembled the figure 8, shown in that patent, and were more like the lamps shown in the patent 210,809, except that some of them had straight carbons extending horizontally across between the holders; these last were of the same general construction of the lamps with looped or arched carbons, the only difference being compensation for expansion and contraction of the incandescent carbons.

X Q. 1956. About how many lamps in all should you say were made at 94 Walker street?

A. I have already stated that I do not know the number, and can only guess at it, but I should judge somewhere between two and three hundred—about two hundred and fifty or sixty would be the minimum idea in my mind of the number, and it may have been very much more than three hundred.

X Q. 1957. What is your explanation of the fact that the majority of the lamps made in Walker street had straight carbons, if, as I understand the fact to be, you had made lamps with circular carbons, which was a better and cheaper construction?

A. There are several things which occur to me in this connection; one was that we had not applied or got the application made for the fibrous carbons and the loop shape, which we then considered belonged to us, and were in doubt, under the advice given by counsel, whether the invention was patentable; another was that,
after we commenced the manufacture of lamps, Mr. Sawyer's
1537 condition was such, from inebriation, that he was not capable of exercising good judgment in regard to the matter, and
Mr. Sawyer was the superintendent in charge of the work.

X Q. 1958. What is your explanation of the fact that the majority of lamps made at Walker street had conductors made of hard or deposited carbon, if it be true, as I understand you to say, that fibrous carbon was the better carbon and the easier to make?

A. Before going on to the making of our largest number of lamps, as I have stated, I think Mr. Sawyer and I were agreed in opinion as to the fibrous carbon and the loop form being the preferable one; when the larger number of lamps were being set up by Mr. Sawyer and tested, he set up a considerable number of lamps of this form with this carbon and tested them, and many of them failed, perhaps a majority, through, as I believe, no defect in the carbon or their shape, but to unskillful manipulation in the setting up of the lamps. He was not in a condition to exercise good judgment in regard to them, and discriminate in regard to the causes of his failures. This rendered him vacillating and changing. He then went on to set up lamps with straight carbons with much the same result. He changed the forms and interior works of the lamps from what we had settled upon. I think as a whole, he preferred the straight carbon lamps at that time, and built them mostly, although not entirely, and I think that he preferred on the whole the deposit carbons for conductors, and used them mostly, but not entirely. I could not give directions to the work nor have it carried on, nor control it as I wanted to. As I said, Mr. Sawyer's opinion was one thing to-day and another to-morrow. I was, as I have said before, and the company was, more anxious to get good lamps built in large numbers, than to work out and determine the absolutely best form of lamps, and in order to do so we let Mr. Sawyer do as he pleased in a large measure. And to this answer I desire to add as a reason, the whole of my last previous answer.

1538 X Q. 1959. An arrangement has been referred to that was made with Wallace of Ansonia; will you please state what that arrangement was and what was done in regard to it?

A. In the spring of 1879, the Electro Dynamic Light Co. granted an exclusive license to the Wallaces of Ansonia, for the manufacture and sale of all our patented appliances and inventions up to that time, coupled with an agreement on the part of Mr. Sawyer to go to Ansonia and instruct the workmen and superintend the building of lamps and other apparatus, and putting them in operation, for which Mr. Sawyer received payment from the company or its stockholders, and Mr. Thomas Wallace became president of the Electro Dynamic Light Co., and Mr. Edward Myers, who *who* been in the employ of the company up to that time, from, I think early in September, 1878, was employed by the Messrs. Wallace to assist in the work. The Wallaces were to pay royalty to the company for every lamp put out, and to build and put out a large number of the lamps. The Wallaces went on and commenced to work, and got ready the parts for a large number of the lamps, but Mr. Sawyer's conduct was such, and his habits so bad, as I understand from him and Mr. Wallace, that they could not get along with him, and finally turned him out, and went on with the work with Mr. Myers in charge. Mr. Myers was taken sick some time in the fall of 1879, lingered along, expecting to return to the work which was held in waiting for him, and finally died without returning, at his father's house in Plattsburgh, New York. There was no person educated to the work and who could go on with it as Messrs. Wallace claimed, whom they could get. The matter lingered along and no work was done by, or under the Electro-Dynamic Light Co. until finally a consolidation was made with the Eastern Electric Manufacturing Co. and the patents and inventions were assigned to that company and the Messrs. Wallace surrendered their license.

Adjourned till Thursday, the 15th inst., at 1 p. m.

1539 THURSDAY, *December* 15, 1887.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. MAN was continued as follows:

X Q. 1960. Did Wallace ever make any lamps?

A. I don't know whether he ever completed any or not; I was not there.

X Q. 1961. What was the general model of lamps that was to be made by Wallace?

A. I don't know; I suppose all the different kinds.

X Q. 1962. What carbons were they to have?

A. I do not know; all the different kinds of carbons that the Electro-Dynamic Light Co. owned, I suppose.

X Q. 1963. Of what shapes were the carbons to be?

A. I don't know.

X Q. 1964. Who was to decide on all these matters?

A. The Messrs. Wallace.

X Q. 1965. Did the Wallaces know the preferences of the inventors, and what constructions they considered best?

A. I think Mr. Thomas Wallace knew what had been done. I am not certain of that. The lamps were exhibited to him and his representatives by Mr. Sawyer, at No. 94 Walker street. I was not present and don't know what Mr. Sawyer told him. I remember before the arrangement was completed of only one conversation with Mr. Wallace. I do not remember expressing any preferences to him in regard to the carbons or their material. I do remember having expressed a preference for the incandescent lamps, over the semi-incandescent or feeder lamps.

X Q. 1966. Did you ever inform the Wallaces, or did the company ever inform them, as far as you know, that you preferred a conductor of fibrous material slightly treated?

1540 A. I don't remember ever having expressed myself to that effect to Mr. Wallace, and think it very unlikely that I would do so at the time, nor do I think that any such preference was stated to him by the company.

X Q. 1967. Did you ever inform the Wallaces, or were they ever informed by the company, so far as you know, that you preferred a loop or arch-shaped carbon, to a straight carbon?

A. I do not remember. I think it probable that I may have done so to Mr. Thomas Wallace, but I do not recollect that I did.

X Q. 1968. What had the Wallaces then to guide them in the manufacture of these lamps, that they were to undertake?

A. Mr. Sawyer's experience and that of Mr. Myers, and sample lamps, I think. It is proper to say that the Messrs. Wallace were largely engaged in electrical work, and as I understood, had done a large amount of experimenting and other work in electric lighting, and their own judgment in such matters I suppose would guide them.

X Q. 1969. By Sawyer's experience do you mean his statements in regard to his experience, or such as he chose to give them?

A. I mean just what I say: Mr. Sawyer was hired to go up there and aid them in the work.

X Q. —. Hired by the Electro Dynamic Light Co.?

A. Hired under the agreement made with Mr. Wallace, the compensation for his services coming from contributions made by the company and its stockholders.

X Q. 1971. The Wallaces personally did not know what his experience had been, but depended on him for information; am I right?

A. I have stated all I know about that matter.

X Q. 1972. Were you one of the stockholders that contributed for the payment of Sawyer's expenses?

A. Yes.

1541 X Q. 1973. Did you inform the Wallaces or did the company, so far as you know, of Sawyer's habits of intoxication and of your experience at 94 Walker street, in the manufacture of the two hundred lamps, as to which you say he was incapable of exercising good judgment, and was changing about from day to day?

A. I do not think I had any opportunity to do so before the arrangement with them was completed, and therefore think I could not have done so, nor do I think the company did or had any opportunity to do so.

X Q. 1974. In your 1967th answer you speak of sample lamps that you think Wallace had to go by. Are you quite confident that he had sample lamps?

A. I only know that sample lamps were furnished by the company to Mr. Sawyer for use at the Wallaces'; and I know in the fall following that a claim was made upon Mr. Wallace by Mr. Sawyer for lamps which he claimed the company had given to him, and which I think Mr. Wallace settled with him, rather than to have a fuss. Of this I am not confident; whether he settled with him, or paid him, or not; I think he did.

X Q. 1975. Did any of those sample lamps have conductors of fibrous carbon slightly treated?

A. I do not know. Mr. Sawyer himself selected them from a barrel of lamps which was stored in the upper story of the building, No. 3 Mercer street, where I had my office.

X Q. 1976. Did any of them have looped or arch-shaped carbons?

A. I made the same answer.

X Q. 1977. Did the company ratify or approve Sawyer's selection?

A. No further action was taken on it.

X Q. 1978. Did you, or the company, know at the time what lamps he selected?

A. No, I don't think any of us did, except Mr. Sawyer.
1542 Mr. Sawyer also was permitted by the company to take for
his own use a considerable number of the lamps at the time
when we broke up at 94 Walker street.

X Q. 1979. Was the arrangement made by the Electro-Dynamic Light Co. with the Wallaces in writing?

A. The arrangement with the Wallaces was made by Mr. Sawyer alone, afterwards ratified by the company, and a license to them was reduced to writing, and I think executed by the company and Mr. Wallace, which was afterwards surrendered and cancelled, and lost or destroyed, at least I made a diligent search for it and could not find it.

X Q. 1980. Did that agreement ever get into the possession of the complainant so far as you know?

A. I do not know. I do not believe it did.

X Q. 1981. Did that license include the invention of the patent in suit in its terms, so far as you know?

A. I think it did, but I do not know. If it was covered it was under a general heading, covering all inventions owned by the Electro-Dynamic Light Company having reference to electric lighting and distribution of current of electricity, &c., &c., and not by specific reference.

X Q. 1982. Did the Electro-Dynamic Light Company or did you so far as you know, ever inform the Wallaces of the invention of the patent in suit?

A. I do not remember.

X Q. 1983. Who was president of the Electro-Dynamic Light Company at this time?

A. I was president during the negotiations and Mr. Thomas Wallace became president through the negotiations and entered upon his duties as such, and I became vice-president, and I remember that by a resolution of the company, I was directed to execute the license, by reason of Mr. Wallace being president and interested as one of the licensees.

X Q. 1984. I understand that after the arrangement with
1543 the Wallaces fell through and the license was cancelled, the
Eastern Electric Manufacturing Company which had been previously formed by Sawyer as a hostile company, acquired all the patents and inventions of the Electro-Dynamic Light Company, and after they had been so acquired, manufactured some lamps. Am I correct?

A. That is substantially correct. The license to the Messrs. Wallaces was surrendered by them through negotiations with the Electro-Dynamic Light Company just previous to and in contemplation of the sale of the patents to the Eastern Electric Manufacturing Company. That company made some lamps with which they made exhibits in Philadelphia, St. Louis, Chicago and Boston. I never saw them and don't know what they were or how many there were of them. I saw some lamps of their make in their new place in Fulton street. I think all this was done under the superintendence of Mr. Sawyer.

X Q. 1985. The patents afterwards became the property of the complainant?

A. Yes.

X Q. 1986. And the complainant has manufactured and sold incandescent lamps?

A. Yes, in large numbers.

Adjourned till Friday, 16th, 1887, at 10½ a. m.

1544 FRIDAY, *December* 16, 1887.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. MAN proceeded:

X Q. 1897. Your agreement with Mr. Sawyer of May 11th refers to certain patents of his in which one James Flanagan is stated to have an interest. Please state whether, when you first went to work with Sawyer, you knew what his relations with Mr. Flanagan were or had been concerning his inventions, whether you ever learned of any agreement made between Sawyer and Flanagan and one Smith, and when you first saw that agreement.

Objected to as not cross-examination, incompetent, irrelevant and immaterial, and notice of motion is given to strike it out at the hearing, together with any answer the witness may make to the question.

A. When I first went with Mr. Sawyer I knew nothing of any agreement on his part with Mr. Flanagan, or any obligations on his part to anybody, further than that he told me that the patents which he showed me, and which are referred to in the agreement of May 11, 1878, had been assigned in part, I think three-fifths, to Mr. Flanagan, and he claimed that he had the right to and would redeem them and have them reassigned to him and to convey me $\frac{45}{100}$ths of the same provided I would go on and furnish money for experiments; that was the condition of things until some time after we went to work, when I learned that there was a written agreement between him and Flanagan; I asked him to show the agreement, and some time in May, 1878, as I think, he showed me the agreement, or what he said was a copy of it, very soon after we went to work at 43 Centre street; Mr. Flanagan was in there at our shop, and several times, I think twice or three times, perhaps more, 1545 and saw us at work, and I invited him to unite with us in the project, to which he replied that he would think of it; I asked him if he could not get other parties to come in, and unite with us himself; the lamps were shown to him at the time, lighted; he seemed very friendly, and in the course of the conversation, I think in reply to my suggestion to his coming in and getting other parties to unite, he used these words, "I'll think of it, and all events if I don't help you, I won't hurt you." About this time I became cognizant of a quarrel or disagreement that appeared to have occurred between Sawyer and Maxim and Schuyler, who were, I understood, in some way, associated with Flanagan; Sawyer was angry with them and good friends with Flanagan; after this and before hearing of the agreement between Sawyer and Flanagan, I requested Sawyer, because Flanagan did not unite with us, to get from Flanagan an account of the expenses which he said were to be paid in order to obtain a reassignment of the patent referred to in the agreement of May 11th; such an account was rendered by Mr. Flanagan; Mr. Flanagan and Mr. Sawyer were not agreed about the account—discussed it in my presence at 43 Centre street; I think this was some time in April, 1878; when I learned of a written agreement between Sawyer and Flanagan I supposed it to be between them alone; I asked Mr. Sawyer to give it to me to look at by reason of his disagreement with Mr. Flanagan about the account Flanagan had rendered; after some time, and I think in the month of May, 1878, I got view of the agreement, or a copy of it, or what purported to be a copy; up to the time and even after the rendering of the account by Flanagan to Sawyer, they were very friendly with each other, and at the close of the interview at which I asked Mr. Flanagan to unite with us in the project, they went away together in a cab.

X Q. 1988. Did Flanagan know of your agreement of March 19, with Sawyer, by which you were to pay for his experiments and get $\frac{45}{100}$ths interest in his patents?

1546 Same objection and notice.

A. I never told Mr. Flanagan the character or contents of any agreement that I had made with Mr. Sawyer, but he knew from me from the first time I saw him at 43 Centre street, very soon after we went to work, that I was interested in the operations there and must have known that I was paying the expenses.

X Q. 1989. Did you ever tell him you were paying the expenses?

Same objection and notice.

A. I told him what was tantamount to that in asking him to come in with us.

X Q. 1990. Did he ask you if you were paying the expenses?

Same objection and notice.

A. No, not to my recollection.

X Q. 1991. In asking him to come in with you did you explain to him that you were paying the expenses and were to get an interest in any of the inventions?

Same objection and notice.

A. I do not remember to have made any detailed explanations to him.

X Q. 1992. Do you remember giving him to understand that such was the fact?

Same objection and notice.

A. Most clearly that I was interested in what was going on.

X Q. 1993. Did you tell him how, or in what way you were interested?

Same objection and notice.

A. No, I did not.

X Q. 1994. Did Sawyer tell him, so far as you know?

Same objection and notice.

A. I do not know what Mr. Sawyer told him; I know that Mr. Flanagan knew, while we were at 43 Centre street, that Mr. 1547 Sawyer and I were interested in this matter, in this way; during the latter part of the time while we were there at 43 Centre street, Mr. Flanagan's brother, as I was told from him, Mr. John R. Flanagan, went to my uncle, Mr. A. P. Man, and sent him to me to caution me about Mr. Sawyer, that he was a bad man; my uncle conveyed this message to me.

X Q. 1995. When you came to read the Flanagan agreement, or what purported to be a copy of it, did it occur to you that, under that agreement, Flanagan could claim an interest in Mr. Sawyer's invention?

Same objection and notice.

A. It did occur to me that such a thing was possible as that Mr. Flanagan might make such a claim, under that agreement; I examined the instrument with that view, and took legal counsel upon it, and came to the conclusion that he could not sustain such a claim, as also did my counsel, Mr. A. P. Man.

X Q. 1996. Did you communicate with Mr. Flanagan and ask him if he intended to make such a claim?

Same objection and notice.

A. No, sir.

X Q. 1997. Did you speak to Sawyer on the subject?

Same objection and notice.

A. I think I did.

X Q. 1098. Did you take him to task for not having told you of this agreement when you were working together?

Same objection and notice.

A. I do not remember; I remember only that Mr. Sawyer always claimed that he was under no obligation under that agreement for any inventions he might make after he ceased to be paid under the agreement a certain stipulated sum, as wages or expenses, and that those payments had ceased before he came to work with me.

X Q. 1999. Did you ever make any effort to get Flanagan to release any claim he might have had on those inventions?

1548 Same objection and notice.

A. No, I never did, and he never made any claim.

X Q. 2000. Did you ever suggest to any one, or were you ever advised, that the taking out of the inventions in your joint names would protect your interest and cut off Flanagan?

Same objection and notice.

A. Not in that way.

X Q. 2001. In what way, then?

Same objection and notice.

A. That even if Mr. Flanagan should make any claims upon Mr. Sawyer he had no claim upon the joint inventions of Mr. Sawyer and myself, and the patents would and should be taken out in our joint names; I explained the whole subject-matter of what I had done to my uncle, Mr. A. P. Man, at the time I consulted with him with regard to the Flanagan agreement, and in that consultation he agreed with me in opinion, that Sawyer's and my joint inventions were certainly and unquestionably in no way effected by the so-called Flanagan agreement; but he also told me, at the same time, that neither were Mr. Sawyer's individual inventions made after he separated from and ceased to work for Mr. Flanagan, liable in any way to claim by Flanagan, in his opinion, which was the same opinion which I had myself formed.

X Q. 2002. Was the agreement of May 11th made after this consultation with your uncle?

Same objection and notice.

A. I cannot tell whether after or before.

X Q. 2003. In the discussion preceding this agreement with Mr. Sawyer, was the Flanagan agreement referred to in any way?

Same objection and notice.

A. I have said that I think that this agreement, or the copy, had
been handed to me by Mr. Sawyer before the agreement of
1549 May 11th; of this I am not sure; if it was so handed to me
before the 11th of May by Mr. Sawyer, the discussions of the
agreements between him and me were prior to the agreement of that
date.

X Q. 2004. Do you know whether Sawyer ever stated, in substance, that the agreement of May 11th and the taking out of the patents in the joint names of Sawyer and Man, was a subterfuge to get around any possible claim that Flanagan might make or have?

Same objection and notice.

A. No.

X Q. 2005. You have never heard that Sawyer so claimed or stated?

Same objection and notice.

A. No; I do not remember to have ever heard of that statement having been made by Mr. Sawyer, but it would not surprise me, considering the other false statements that he did make of which I heard and of which he himself told me that he had made, if I should hear that he had made such statement, or statements to that effect.

X Q. 2006. Did you ever hear of such a statement or claim as having been made by anybody?

Same objection and notice.

A. Yes; I think I have as coming from our opponents in the interference cases and suits in regard to our patents.

X Q. 2007. But never as coming from Sawyer, Flanagan or Schuyler?

Same objection and notice.

A. No; I don't think I have in regard to that agreement.

X Q. 2008. You do know that Sawyer asserted that the alleged Sawyer-Man inventions were the sole inventions of himself?

Same objection and notice.

A. I heard that Mr. Sawyer had made such statements; he told
me more than once that he had done so; several times he
1550 told me so; he told me at the same times that he was sorry,
and begged my pardon for having done so, and stated that
he was drunk when he did it, and that he was influenced by other
parties to do it, and tried to make excuses for it.

Defendant's counsel offer in evidence agreement between William E. Sawyer and James Flanagan, dated January 2, 1877, and the same is marked "Defendant's Exhibit Flanagan Agreement, December 16, 1887;" also accounts of Flanagan's disbursements on behalf of Sawyer's experiments, December 16, 1887.

Exhibits objected to as incompetent, irrelevant and immaterial and not cross-examination.

X Q. 2009. What explanation have you to offer of the fact that no application for a patent covering the invention in suit was made until nearly two years after the time you say the invention was made?

A. First, that our counsel, Amos Broadnax, doubted the patentability of the invention, and although applied to in October, 1878, to make application for patents on the invention, postponed it until first he could go and see it and ascertain more about the matter, and afterwards by reason, as he told me, of press of business, until Mr. Sawyer and I quarreled, and after that I could not get him to unite in applications for patents, and because I thought we were in time to make the application at any time until I heard that other parties were liable to make application.

X Q. 2010. Now, as to the first reason given, you say that Mr. Broadnax was applied to, to prepare an application to cover the invention of the patent in suit in October, 1878, who saw Mr. Broadnax on this subject?

A. Both Mr. Sawyer and myself; I know I did.

X Q. 2011. What did you tell him the invention was?

A. A loop carbon made of paper or wood.

X Q. 2012. Did he tell you he did not consider the invention patentable?

1551 A. No; he told me he considered it doubtful, as he looked upon it; that it was simply charcoal which had been used in incandescent lighting before.

X Q. 2013. Did he advise you not to apply for a patent?

A. No; on the contrary, I saw him several times in regard to it, and at last got him to go and see it; he did not then, after seeing it, as I remember, change his mind in regard to the matter; at least, he postponed it.

X Q. 2014. Did he advise you to apply for a patent on it?

A. According to the best of my recollection, he told me that there was plenty of time, and that he had his hands full with another work; I do not remember his advising me to apply for it, but only to postpone it.

X Q. 2015. Why to postpone it; to suit his convenience?

A. Yes; to suit his convenience and to allow him to go on with other pressing work of the company.

X Q. 2016. Had you ever mentioned the invention to him before October, 1878?

A. I do not know whether I had or not; I don't remember to have done so; I think the first was shortly before the making of an assignment by Mr. Sawyer and me to the Electro-Dynamic Light Company, of carbons for electric lamps, and treatment of carbons for electric lamps, or at the time of making of that assignment;

Mr. Sawyer and I were both present at that time; I think that I had talked with Mr. Broadnax somewhat before the execution of this assignment and of our inventions and got Mr. Sawyer to go to his office with reference to making applications for the patents and assigning them to the company, but whether I had spoken to Mr. Broadnax about this particular invention before the making of that assignment I cannot remember; it was talked over at the time of the making of that assignment.

1552 X Q. 2017. Is it then the fact that the first time you remember to have spoken of this invention to Mr. Broadnax was about the time of the assignment to the Electro-Dynamic Light Co., dated the 14th of October, 1878?

A. Yes.

X Q. 2018. You say he expressed doubt as to its patentability; did you discuss the question of its patentability with him and seek to remove those doubts?

A. Yes, somewhat; I think to about the extent of saying to him that I thought it was a good thing and new in the manner in which we use it, that we ought to be able to get patents for it.

X Q. 2019. What did he say in response to this?

A. I do not recollect further than as I have said.

X Q. 2020. Were his doubts removed by what you said?

A. I don't know; I can't recollect in terms of sufficient accuracy to repeat the conversation between us. I know I urged him to go and see it.

X Q. 2021. Do you recollect the fact whether his doubts were removed as to the patentability of the invention or whether he still adhered to them?

A. I don't really know or recollect.

X Q. 2022. In your 2018th answer you say you stated to him that you thought it was new in the manner in which we used it; did you explain to him how you used it?

A. I think so.

X Q. 2023. How did you tell him that you used it?

A. That we cut it out and shaped it, and carbonized it after we cut it out, and that I thought that the loop or arch was a new form for incandescent carbons.

X Q. 2024. Did he combat that idea or agree to it?

A. I don't know; don't remember.

X Q. 2025. Did you tell him the importance you attributed to the invention, and how great you regarded its value?

A. I don't remember.

1553 X Q. 2026. Did you instruct him to apply for patents for the invention irrespective of what his opinion as to its patentability might be?

A. I asked him to do so.

X Q. 2027. Did he promise to?

A. I don't know further than that he promised to consider it and see what was best to be done about it.

X Q. 2028. Consider what, whether he would apply for a patent for it, or whether it was patentable?

A. Really I have related the substance of what took place between Mr. Broadnax and myself in regard to it. I can only give general ideas in regard to it. The impression in my mind is that he told me that he would consider how he would apply for a patent for it, what kind of a patent he could get for it, or a part of it.

X Q. 2029. Did you see him afterwards on this subject and ask him to what conclusion he had come in regard to it?

A. Yes, I saw him almost every week, and I frequently talked with him on this subject after he had been up and seen the thing at 94 Walker street. I think the general conclusion was that the invention, or some part of it, was patentable, particularly the loop form of the carbon, but that it could wait until he got other things out of hand which he was at work at for the company.

X Q. 2030. How long do you suppose it would have taken a lawyer of Mr. Broadnax's skill in these matters to have drawn up an application for a patent?

A. I don't know. I suppose it would depend upon the difficulty of the subject, and his information on the subject in regard to which he was requested to prepare the application.

X Q. 2031. Did Mr. Broadnax ever prepare an application?

A. Not to my knowledge; he assisted or advised some-
1554 what at the time when the application was finally filed by
Mr. Baldwin.

X Q. 2032. The specifications of several of your patents were drawn up by Mr. Sawyer, were they not?

A. Yes, our first patents before we left 43 Centre street.

X Q. 2033. He was familiar with the drawing up of specifications was he not, and able to draw them?

A. I don't know how familiar he was; he did draw up specifications for these patents I have mentioned.

X Q. 2034. Did he ever draw up a specification on the invention in controversy?

A. Yes, I think so.

X Q. 2035. When?

A. When the application was finally filed.

X Q. 2036. Did you ever draw up a specification on the invention in controversy?

A. Yes.

X Q. 2037. When?

A. I drew up several.

X Q. 2038. When?

A. It was in the nature of a specification; in the fall of 1878 and in the winter following.

X Q. 2039. What was your object in drawing these up, and what did you do with them?

A. My object was to clear up my own mind as to what we had a right to patent, and to get Mr. Sawyer's ideas in regard to it. I don't know what became of them.

X Q. 2040. Did you regard Mr. Broadnax as neglecting the matter of filing an application on this invention?

A. No.

X Q. 2041. If either you or Mr. Sawyer or the company had especially desired him to draw an application on this invention 1555 and instructed him to do so, have you any doubts as to whether he would have obeyed those instructions?

A. I suppose Mr. Broadnax would if he had time have obeyed any positive instructions that were given to him by me as president of the company, or by directions of the board, but we were following his counsel and did not give positive instructions, but only general ones, and this was not the only matter by a great many where patents were not taken out, in which Mr. Broadnax was advised with, and in which we desired him to obtain patents.

X Q. 2042. Had you stated to Mr. Broadnax that you considered this a very important invention, and that you wanted him to determine the question of its patentability, and apply for a patent, do you not think he would have found time to have done as you wished?

A. I do not know that he would during the limited time after he had seen the thing and before Mr. Sawyer refused to sign any more applications for patents for the company, unless he had been told that it was a matter of great haste, requiring positive and immediate attention, which he was not told in regard to this matter.

X Q. 2043. Then I understand the fact to be that in October, 1878, you mentioned to Mr. Broadnax the use of fibrous material as the incandescent conductor, and use of an arch form of incandescent conductor, and told him how you made it, that Mr. Broadnax considered that it was very doubtful whether there was anything patentable in the use of paper or fibrous material as an incandescent conductor, that several interviews afterwards were had with Mr. Broadnax on this subject, that his doubts as to the patentability of paper or fibrous material was not removed, but that he considered the form of conductor might be patentable and the method of making it, that the matter was thus postponed, and that he did nothing in the way of preparing an application except to go and see the lamp with such carbons in it?

1556 A. Yes, such was about the consideration that the subject received as I remember, and all the consideration except discussions in regard to patentability and general requests when he could, to take the subject up and see what he could do with it, to do so.

X Q. 2044. Do you understand that we have been referring to a period between October, 1878, and March, 1879?

A. Yes, so far as Mr. Broadnax is concerned and his intercourse with Sawyer.

Adjourned till Monday, the 19th inst., at 10.30 a. m.

MONDAY, *December* 19, 1887.

Met. Present counsel as before, and the cross-examination proceeded.

X Q. 2045. In your 2009 answer you give as an additional reason for the delay or neglect to apply for a patent, that after you and

Mr. Sawyer quarreled he refused to sign applications for patents for the Electro-Dynamic Light Company.

A. Yes.

X Q. 2046. When did the quarrel occur?

A. I had no personal quarrel with Mr. Sawyer, I never would quarrel with him. It perhaps might better be characterized as a disagreement and ill-feeling on his part toward me, arising and growing out of his bad habits, and culminated some time in January, 1879, when or soon after Mr. Lawrence Myers ceased to go to the shop. From this time forward, and even afterwards, with occasional intervals when he would comply with some of my requests, but not with many. At the time I have mentioned in January I told him unless he could change his habits and give better
1557 attention to the business that the work must stop, or that his supervision must cease.

X Q. 2047. What efforts were ever made so far as you know to get Mr. Sawyer to join in an application for a patent on the invention in controversy?

A. I asked him to do so before we broke up at 94 Walker street several times. I think Mr. Broadnax asked him to unite in applications, and he declined absolutely to execute any papers that would benefit the Electro-Dynamic Light Company.

X Q. 2048. Do you mean to be understood that you asked him to unite in an application for this specific invention?

A. Yes, I mean that I asked him to unite in applications for all the things that he and I had worked together upon and I talked over the things with him. I also asked him to execute applications, and assign them to the company for all that he considered his sole inventions. I do not remember specifically the different things that I spoke to him about. They were all the inventions in which I had worked with him, and I have no doubt that this was spoken of with them, but I have no distinct recollection of this as separate from any of the others.

X Q. 2049. No application for the patent was ever drawn up, and he asked to execute it, was there?

A. My recollection is that a description and provisional specification was drawn up by Mr. Sawyer and myself I should think separately; and that Mr. Sawyer's paper was handed to Mr. Broadnax for him to prepare the application. I should think too no formally prepared application for a patent was presented to Mr. Sawyer for execution, still I do not know in regard to that and several formal applications were prepared and sent to him which he refused to execute. This may have been among them, but I don't know; my impression is that it was not.

1558 X Q. 2050. When was this "provisional" specification prepared, and what do you mean by "provisional"?

A. I mean by that, simply such a description and such an indication, in regard to what claims might be made as a client would ordinarily furnish his attorney in regard to an application for a patent. If it was furnished to Mr. Broadnax, it was done prior to the 1st day of January, 1879, or during the first days of that January.

X Q. 2051. Did Mr. Broadnax, so far as you know, ever prepare a formal application for a patent on this invention?

A. I do not know that he did, until the final application in which he participat*ing* by advising me in regard to it.

X Q. 2052. Was he ever formally instructed by you or the company to prepare an application?

A. He was only formally employed by the company and requested to prepare applications generally, never as I know formally instructed to prepare applications for any particular patent, though I do not say that he was not.

X Q. 2053. Did the company ever formally request Mr. Sawyer to execute an application for the patent in controversy?

A. Through me, yes; verbally, a good many times.

X Q. 2054. Who in the company so asked you to request Mr. Sawyer?

A. I was president of the company and chairman of its executive committee, and entrusted and charged with these matters, and I did it of my own motion in the discharge of my duty, and at several of the board meetings I was requested to get Mr. Sawyer to make or unite with me in making applications for patents for all our inventions.

X Q. 2055. I am only interested in knowing concerning the invention in controversy. Do you remember ever having been requested by any person in the company, to ask Mr. Sawyer to join
you in an application for a patent: for the invention in
1559 controversy, I mean in regard to this specific invention?

A. I do not remember this as distinguished from any other.

X Q. 2056. Do you remember that this was discussed with the others, or are you only inferring in regard to it?

A. Yes, I remember this invention being talked about at the board meetings.

X Q. 2057. Who now living was present at those meetings and ought to remember of this invention being talked of?

A. I don't know who would remember; I have not talked with them about it.

X Q. 2058. Who was present at these discussions?

A. I cannot recollect only that a quorum of the board was present.

X Q. 2059. Was any formal resolutions passed or any record in the books made that would show that this invention was discussed or any action taken in regard to it?

A. I think not, but I do not recollect.

X Q. 2060. So far as you know, prior to the appearance of Mr. Cheever on the scene, were Mr. Broadnax's doubts as to the patentability of fibrous material ever removed?

A. I do not know.

X Q. 2061. Did you ever inform any person in the company of the value you attributed to fibrous material, so that a determined effort might be made to get Mr. Sawyer to file an application or get one prepared?

A. I do not remember.

X Q. 2062. Now, between January, 1879, and January, 1880, Sawyer did execute assignments of patents to the company?

A. Yes; of things or inventions already patented, or for which applications had been filed, but not, I think, of any others.

1560 X Q. 2063. Did he not also sign applications for patents?

A. I don't recollect; he may have done so.

X Q. 2064. During the year 1879 was not Sawyer in the pay of the Electro-Dynamic Light Co.?

A. Part of the time.

X Q. 2065. Do you include the period he was with Wallace, in your answer?

A. Mr. Sawyer was paid for the service with Wallace in advance, in the manner I have stated, at the time he made the arrangement with Mr. Wallace in the spring of 1879; he was not under the control or properly an employee of the company, except to render service at Wallace's place for which he had been paid.

X Q. 2066. How was Sawyer induced to sign the assignments and papers in 1879?

A. I do not recollect the circumstances fully in regard to the thing; I only recollect that after a great deal of work I got him to sign in February—I think it was 1879—a kind of confirmation assignment, if my recollection serves me right; it was upon an understanding that if Sawyer could get parties to pay the Electro-Dynamic Light Co. for all the patents and inventions they would be assigned to the parties he should designate.

X Q. 2067. There appears to have been three assignments made by Mr. Sawyer to the Electro-Dynamic Light Co. in 1879, one dated July 31, 1879, on a patent allowed upon an application of his, filed April 23, 1879, for an improvement in electric lamps—two; an assignment, dated February 3, 1879, of letters patent to Wm. E. Sawyer, No. 210,151, for an electric meter; letters patent 210,152 for switch; letters patent 210,809 for an electric lamp; letters patent 211,262, for carbon; three, a general release, dated May 21, 1879, to the company of all claims, in consid*sid*eration of forty-nine thousand, alleged to have been paid; four, an assignment, dated
1561 July 30, 1879, an application for letters patent, filed April 23, 1879; it thus appears that in July, February and May, 1879, Sawyer executed two assignments and one general release to the company. How did the company secure the execution of these papers?

A. I have already explained in regard to the assignment in February, which I got as a confirmation assignment of patents already then issued, and application already then filed, not of any new applications or inventions for which applications had not been made; that it was done, according to the best of my recollection, by Sawyer after a great deal of quibbling and bother and hesitation, and striking out of everything but those matters, upon a kind of understanding that if Sawyer could find parties to pay the Electro-Dynamic Light Co. for all the patents and inventions what that company owned, they would be assigned to such parties by the company, it was under such an understanding, modified to conform to the agreement made with Wallace, that that agreement was negotiated by Sawyer; the release executed by Sawyer to the company was required by the company as part of the arrangement in closing with Wallace; the assignment of July, 1879, was an assignment of a feeder lamp, the invention of Sawyer, as he claimed, which was made part of or to come under the license to the Wallaces, and Mr. Broadnax took charge of the application and obtained the final assignment in July from Sawyer, in confirmation of previous assignments, and the understanding at the time of the agreement with Wallace.

X Q. 2068. When the application for the patent in suit was filed, its preparation seems to have been the subject of some discussion; why was no mention made of what the advantages of fibrous carbon or paper were?

Objected to as utterly immaterial, and as it is of no sort of importance whether the specification states the advantages of the invention or not.

A. If such is the fact I do not know or recollect.

1562 X Q. 2069. If you had found fibrous or paper carbon superior to non-fibrous carbon, and if, as you say, preferred it to the incandescent conductor of an electric lamp, why did you not state that in the specification?

Same objection, and further that it was a common practice among the examiners of the Patent Office, to insist that everything in the specification going to show the advantages of the invention should be omitted.

A. I don't know or recollect further than I have stated the circumstances under which the application was made, and I don't know whether they had anything to do with it or not.

X Q. 2070. You have said that to get the best conductor from fibrous material, a certain arrangement of fibres was advantageous: why was not that fact mentioned?

A. I do not know why it was not mentioned or why it should be mentioned.

X Q. 2071. You have stated that it was easier and better to cut the material to size and shape, and carbonize it afterwards, rather than to cut it from a block of the material after carbonization; why was that not mentioned in the specification?

A. I do not know that it was not mentioned in the application as sent to Mr. Sawyer for execution, and I do not know that it is not included in the application as filed, and if not included I do not know why it was omitted.

X Q. 2072. You do not remember why the application as filed did not state the advantages of fibrous material over a mineral carbon. Can you tell me why the patent as issued stated the advantages?

A. I suppose from the desire of the solicitor or myself, or both, if it does so state.

X Q. 2073. Please do "not suppose," but tell me what the fact is, if you know?

A. I only know that Mr. Broadnax, the solicitor, and I
1563 consulted together and made the application for the patent
when it was made, and Mr. Sawyer, I think consulted with Mr. Broadnax in regard to it, and that the patent was allowed and issued as it was issued; that is all I know about it.

X Q. 2074. Do you remember consulting and advising with Mr. Broadnax as to whether the specification should be made to state the advantages of fibrous over non-fibrous material?

Objected to as being a misstatement of facts leading to the inference that the specifications does not state the superiority of the invention over other carbons for incandescent lighting.

A. No, I do not remember anything but the fact of the consultation with Mr. Broadnax at this moment; if any particular consultation or conversation, of which there were a number, were called to my attention, I might be able to remember some of the details of these consultations, but I do not now.

X Q. 2075. You do not then remember having discussed with Mr. Broadnax whether the specification should be made to state the advantages of fibrous over non-fibrous material?

A. I do not.

X Q. 2076. You have been unable to state why the original specification did not state that the material was to be cut to size before carbonization; can you tell me why it is that the patent as issued states that it is to be done?

Objected to as a repetition; the question has been already asked and answered.

A. I have not intended to state that I knew that the application as prepared before modification by Mr. Sawyer, or as finally filed, does not or did not contain or imply that the carbon was cut to size or shape before carbonization, only that it did not contain or imply that; I did not know or recollect why; I now say that if the patent as issued contains that statement I suppose it contains
1564 it in accordance with the ideas of Mr. Sawyer and myself
and Mr. Broadnax, as the right thing to be there, and in accordance with the facts of the invention; I know no other reasons, or at least, no others occur to me.

X Q. 2077. Please do not "suppose," but tell me if you know why the patent as issued was made to contain this statement?

A. I have stated all that I know. I was not the attorney or solicitor. I assume that if anything was not put in the patents or applications, it was because the solicitor thought there was enough there, or from some exigencies arising in the Patent Office during the interference, and that *that* everything — was put in the specifications and patents was put there in accordance with the facts given to the solicitor and proved in the interference. I don't know personally further than I can know by the correspondence of the specifications and the patents with the facts given by the inventors.

All that the witness has assumed is moved to be stricken out.

X Q. 2078. Were you aware at the time that the 1st, 2d and 4th claims of your patent as filed were rejected as not containing patentable matter?

A. I don't know.

X Q. 2079. Were you aware that when the interference was declared with Edison's application that the 1st, 2d and 3d claims of your application as filed were rejected?

A. I don't think I knew it; I don't know.

X Q. 2080. After the decision of the interference did you read the various amendments that were filed prior to their being filed?

A. I don't know; I don't think I did; I read some proposed amendments at some time, but what they were I don't know; I think the proposed amendments were to claims only; they may have been to the specification also.

1565 X Q. 2081. It appears from the file-wrapper of the application for the patent in suit that the 4th claim of the application as originally filed

"An incandescent arc made of carbonized fibrous or textile material"

was on the 9th day of January, 1880, rejected by the office—that a new specification was filed May 17, 1880, in which the first claim was

"An incandescent arc for an electric lamp of carbonized fibrous or textile material and of arch or horseshoe shape, substantially as hereinbefore set forth."

That on May 20th that claim was rejected, that on December 4th, 1884, Mr. Broadnax amended the application by inserting the issue of the interference as a claim, and requested that the 1st, 2d and 3d amended claims filed May 17th

"Having been once rejected by the primary examiner, are now respectfully submitted for reconsideration."

The official letter of the examiner in reply and under date of February 19th, 1885, holds that claims 2 and 3 are fully anticipated, but makes no mention of claim 1 which at that time stood rejected. On February 19th, Mr. Broadnax amended the application of May, 1880, substituting in the first claim for the word "arc" the word "conductor" and asking that the second and third claims be stricken out. Were you aware of these proceedings in the office?

Objected to as immaterial, incompetent, and not cross-examination.

A. I do not know and have no means of verifying the accuracy of your statement; I was aware of some things being done as they went on; what I cannot recollect.

X Q. 2082. On February 20th, 1885, notice was sent by the Patent Office that your case was ready for issue, but was suspended 1566 until March 2, in view of a possible interference with another pending application; did your counsel advise you of this notice?

A. I do not know, nor do I know that such was the fact. I don't remember.

X Q. 2083. Did Mr. Broadnax ever tell you after the decision of the interference with Edison that there was a possibility of an interference with some one else?

Ans. I don't remember whether he did or not.

X Q. 2084. Never remember to have heard anything about a threatened interference?

A. It seems to me that at some time or other I heard something about an interference other than that with Edison having been threatened in that case, whether, after the issue of the patent, or during the progress of the case, or who I heard it from, or what its character was, or what it applied to, I cannot recollect.

X Q. 2085. Now, on February 28th, a long amendment was filed, which amendment I now show you; were you aware of the filing of that amendment, or consulted at the time in regard to it?

A. I am unable to identify the paper you show me, from recollection, as a copy of anything that I saw; much of what is contained in the paper seems familiar to me; whether I was cognizant of its filing before or at the time it was filed I cannot say; I do not recollect.

X Q. 2086. I show you what purports to be a copy of an amendment filed March 13th, were you cognizant of, or consulted with regard to the preparation of that amendment?

A. My answer to that question is in the same words as my last answer.

X Q. 2087. I understand this Mr. Sawyer died in the latter part of 1882; so far as you know were the Patent Office in the conduct of this application ever advised of his death?

A. I don't know.

1567 X Q. 2088. Do you know whether letters of administration were ever taken out on his estate?

A. I do not.

Adjourned till January 5th, 1888, at 1 p. m.

NEW YORK, *January 5th*, 1888.

Met and adjourned subject to agreement of counsel.

NEW YORK, *April 26th*, 1888.

Present, counsel as before, and the cross-examination of MR. MAN proceeded as follows:

X Q. 2089. On pages 403 and 401 of the printed record reference was made to the newspaper publication of certain letters of Mr. Sawyer, did you ever contradict the statement of those letters in print?

A. I do not remember to have ever published anything, and do not think I did.

X Q. 2090. Are you familiar with what is known as the "squirt" or "syringe" process of making hard carbon?

A. I have heard it described and have seen it in operation in the process of making pencils and pencil points of plumbago and similar substances.

X Q. 2091. Could pencils of carbon be made by such process from hard carbon as cheaply as pencils of carbon could be made by cutting fibrous material to the desired size and carbonizing it?

Objected to on the ground that the witness has stated that he was not practically familiar with the process.

A. I don't know, undoubtedly pencils of some quality, good or
bad, could be made cheaply by the syringe process. I am unable
1568 to state that a good pencil of hard carbon could be made by
that process, of sufficient tenuity as cheaply as the carbon
could be made by cutting fibrous material to the desired size, or selecting it of the desired size and carbonizing it, as I think they would require further manipulation, sizing and cutting to lengths and treatment after their first production from the syringe.

X Q. 2092. Were you familiar with this squirting process in 1878 and 1879?

A. I think so, as much so as I am now.

X Q. 2093. Did you ever try it in the manufacture of carbon?

A. We tried pencils of carbon so produced.

X Q. 2094. Did you ever make them yourselves?

A. No, not to my present recollection, but I am not quite certain.

X Q. 2095. Who made them for you?

A. I think it was the Eagle Pencil Co., but I cannot state positively.

X Q. 2096. Do you remember what license fee Wallace was to pay the Electro-Dynamic Light Co. on each lamp?

A. I do not remember now, but by reference to the testimony on some of these previous cases, I see a resolution of the Electro-Dynamic Light Company's trustee fixing it at three dollars per lamp. I assume this was correct and believe it to be so.

X Q. 2097. What did you estimate one of your lamps would cost to manufacture?

A. I don't know. We hoped to be able to make the lamps as cheaply as a quarter of a dollar apiece, but we never did build any so cheaply as that that were permanent lamps, nor nothing near it.

X Q. 2098. In several parts of your testimony you speak of your "workshops." By these I understand you to refer to your shops at 43 Centre street, Howard and Centre and Walker and Elm streets. Is that right?

1569 A. It is.

X Q. 2099. In the "Scientific American" of Dec. 7, 1878, is printed an article headed "The Sawyer-Man electric lamp." Do you know how such article came to be published?

A. Yes; a gentleman from that paper came to the office, or workshops, 94 Walker street, and got the information, and as I unstood, wrote, and the paper published that article.

X Q. 3000. Got it from whom?

A. From Mr. Sawyer and myself. We did not procure or pay for the publication, but consented to it.

X Q. 3001. In the Weston-Sawyer-Man interference the following newspapers containing reference to the Sawyer-Man, and Sawyer lamp, were offered in evidence by your counsel: The Journal of Commerce, N. Y., Oct. 30, 1878; Commercial Advertiser, N. Y., Oct. 30, 1878; Evening Post, N. Y., Oct. 30, 1878; Tribune, N. Y., Oct. 30, 1878; The World, N. Y., Oct. 30, 1878; Philadelphia Record, March 25, 1880; Boston Post, March 17, 1881; Beverly Banner, Nov. 13, 1880; Public Ledger (Philadelphia), Oct. 28, 1880; Boston Morning Journal, March 17, 1881, same paper of March 18, 1884; Daily Evening Traveler, March 17, 1881. Do you know how the several articles referred to came to be printed?

A. I only know in regard to the articles in the New York papers of October 30, 1878. As to those articles, I have to say that previous to that time we were exhibiting the electric light at No. 94 Walker street, and the reporters were continually running there and asking about it and wanting to publish something about it. A day or two previous to the 30th of October, to avoid their running there one after the other, they were all invited, I think, by Mr. Sawyer, to come together and see the lamps, and these articles of October 30th were the result, if I recollect rightly, of that
1570 exhibition made to the reporters. We did not procure or
pay for the publication, but the reporters made their own reports and published what they liked about it.

X Q. 3002. You are the same Albon Man that testified in the Sawyer-Man-Keith, Sawyer-Man-Maxim and Sawyer-Man-Weston interferences, and the William E. Sawyer referred to in those interferences, and who testified therein, was your co-inventor, William E. Sawyer?

A. Yes.

Defendant's counsel offer in evidence the following:

1. Interference record and testimony, Sawyer-Man-Keith interference, and the same is marked Defendant's Exhibit Sawyer-Man-Keith Record, April 26, 1888.
2. Interference record, Sawyer-Man-Maxim interference, and the same is marked Defendant's Exhibit Sawyer-Man-*Keith* Record, April 26, 1888.
3. Interference record, Sawyer-Man-Weston interference, and the same is marked Defendant's Exhibit Sawyer-Man-Weston Record, April 26, 1888.

Cross-examination closed.

Adjourned subject to agreement of counsel.

1571 New York, *May* 29, 1888.

Met pursuant to agreement of counsel.

Counsel for the respective parties present as before.

Redirect Examination of Albon Man.

R. D. Q. 3003. In response to question 10 of your examination-in-chief you say you do not recollect of having used cane in making your incandescent conductors in the spring of 1878. Please to state what you recollect as to the use of cane for that purpose in the fall of 1878.

A. In the fall of 1878 I obtained from Crooks' establishment in Fulton street (the same man who now has a sporting-material store, I think, on the corner of Gold street and Fulton) a great variety of woods, and among others, cane, such as so-called bamboo fish poles are made of. I took them to our workshop, corner of Elm and Walker streets, and gave them to Mr. Myers to be carbonized and tried for the conductors of electric lamps. I think they were all carbonized and tried, but I have no recollection of conductors made from this cane as distinguished from the other woods that we used.

R. D. Q. 3004. Please to produce, if you can, specimens of endogenous woods having interlacing fibres such as you carbonized in the spring of 1878, as you have stated, for your incandescent conductors.

A. I produce a specimen of the wood of the Grugru palm which has such interlacing fibres, although not a good specimen of the interlacing fibres of that wood. Whether the wood we used was of this kind or not, I do not know, but it was with more interlacing fibres than this, and similar in appearance, but more dense. I also produce a specimen of so-called mangrove, a wood growing in the West Indies and in the Island of Bermuda, with interlacing
1572 fibres. I think this wood is properly guaiacum, which is commonly called, together with other woods of similar character, growing in the same localities, lignum-vitæ, and is known in the neighborhood of its growth as mangrove. We used lignum-vitæ wood, carbonizing and making conductors from it, in the spring of 1878. From investigation of the growth of this wood, I am convinced that it is both an endogenous and an exogenous wood; exogenous in the main, but endogenous in the filling up of the aerial roots which it puts forth from its branches, and which become filled up by an endogenous growth, to become new bodies for the trees and afterwards take an exogenous growth. It is a good specimen of interlacing fibre.

R. D. Q. 3005. These woods, as I understand you, you carbonized, among others, in the spring of 1878, for the purpose of ascertaining whether or not they would make satisfactory incandescent conductors for your electric lamp?

A. Yes.

R. D. Q. 3006. Did you carry the experiments far enough to ascertain whether or not such woods would make satisfactory incandescent conductors. I am referring now to the woods having the interlacing fibres, and if so please to state what the result of your experiments was.

A. Yes, we made straight pencil conductors of these kinds of woods, cut to size and then carbonized; which were good conductors, but found no corresponding advantage from the interlacing fibre over the straight fibre to compensate for the greater difficulty of working out the pencils from the inlacing fibre wood.

R. D. Q. 3007. These specimens which you have produced, are they part of the identical interlacing fibre wood used by you in the spring of 1878?

A. No; they are only similar woods.

The specimen of woods are offered in evidence and *re-*
1573 marked respectively "Complainant's Exhibits 'Grugru
Palm' and 'Mangrove,' produced by Albon Man, May 29,
1888."

R. D. Q. 3008. What, if anything, do you know of paper made of bamboo or cane fibre?

A. I have seen such paper and have seen the process of manufacturing or separating the fibre for the paper stock. It was at one time quite extensively conducted in South Brooklyn and I saw it there.

R. D. Q. 3009. Is it an article now or was it then an article of well-known manufacture in the paper trade?

A. It was at one time and I do not know but it is now, of domestic manufacture, and I think it is also imported from China and Japan.

R. D. Q. 3010. You have stated upon your cross-examination as well as upon your examination-in-chief that in the fall of 1878, and in the winter of 1879, you and Mr. Sawyer had reduced your lamp to a good practical operative condition, and that the Electro Dynamic Light Company had by that time taken measures to have the lamps manufactured and put in public use on a commercial scale. Now please to state in a connected way why the Electro Dynamic Light Company did not proceed with the manufacture and introduction of these lamps into public use, and state generally what efforts were made and what was done toward the manufacture and introduction of the lamp by that company and its successors?

A. After we had got the lamp and other apparatus in a substantially practical shape in the fall of 1878, the company decided to go on to the manufacture and introduction of the lamps into use. Mr. Sawyer was one of the inventors, and he and I were the only persons understanding the work in all its details and nicety. I was absorbed in business and Mr. Sawyer was the superintendent. His habits of inebriation and dissipation were such after this determination was reached by the company as to interfere with the
work more and more, that the last of March or first of April
1574 1879, the company decided to stop work under Mr. Sawyer's
superintendence. In the meantime Mr. E. L. Myers had
become conversant with the details of the work and an arrangement was made by which the Messrs. Wallace, of Ansonia, who were largely interested and had been for a long time in electrical development, to go on with the work and manufacture of the lamps

and other apparatus, and put them into use under a royalty to the company of so much per lamp for each lighting plant they should establish. Mr. Myers went with them, and I think Mr. Sharp, a skilful workman who had been in our employ. Mr. Sawyer was hired and paid by the Electro Dynamic Co. or its stockholders, to also go to Ansonia and give his time and attention and the benefit of his knowledge, for some months to the work. Mr. Thomas Wallace became president of the Electro Dynamic Co., and the work was commenced. Mr. Sawyer's inebriate habits, immorality and dissipation so interfered with the work and disgusted the Messrs. Wallace that they would have nothing to do with him, he left and as soon as his term of service, for which he had been paid, expired, or perhaps before he came to the company and requested and demanded a personal license to himself for our inventions, although an exclusive license had before then been given to the Messrs. Wallace. This the company refused and Mr. Sawyer went off and went to work to organize a rival company. Mr. E. L. Myers about the time Mr. Sawyer left was taken sick and went to his home in Plattsburgh, New York, where he lingered along for awhile and died. There was no one but he (Myers), Mr. Sawyer and I who understood the details of the work. During his (Myers') sickness it was thought best by the Messrs. Wallace and the company that the work should be suspended until he recovered and was able to take it up. My business was such that I could not give attention to it personally, and Mr. Sawyer was hostile. After Mr. Myers'
1575 death, there being no one to conduct our work, Mr. Sawyer's new company, the Eastern Electric Manufacturing Co., having been in the meantime organized, it was thought best that the two companies should be in harmony, and as a result the patents were assigned to the Eastern Electric Manufacturing Company, which agreed to go on with the manufacture and introduction of the lamps into use. They did go on to manufacture some lamps, and exhibit them, and make commercial arrangements for their introduction into use. Mr. Sawyer quarrelled with them continually, and his habits were very bad, and finally that company sold out to the Consolidated Electric Light Company, which immediately went on with the manufacture of the lamps and other apparatus, and their introduction commercially, and is engaged in that work now upon a large scale.

R. D. Q. 3011. You have stated upon your cross-examination that you and Mr. Sawyer frequently made your incandescent conductors of fibrous or textile material without treating them electrically after carbonization, and used such conductors experimentally in your lamps. To what extent did you practice such experimental work, and what did you prove by it as to the ;practical sufficiency of such conductors?

A. In making the conductors of fibrous carbon from different substances and frequently in making different batches of fibrous carbon conductors from the same substances, we set them up in our lamps and ran them for the purpose of testing the quality of the carbon without treating them electrically. This was our method of

testing the conductors. Each lamp was marked on a tag or label attached to it, and a record entered of its performance, usually on this label. A considerable number of these lamps proved to be good lamps. The conductors lasted well and were run for lighting our shops, and for exhibition, until the conductors gave out. Most of them gave out soon, but some, as I have said, proved to
1576 be good conductors, without treatment. But of the same
conductors treated, nearly all, instead of a few, proved good. We therefore adopted the treatment as a rule, as an improvement upon the conductors, I mean the electrical treatment patented by Sawyer & Man, by patent No. 211,262, or some of its modifications.

R. D. Q. 3012. Do you wish to be understood as saying that by these experiments you satisfied yourselves that good illuminating conductors for incandescent electric lamps could be made of the fibrous material experimented upon, or used by you without treating them electrically as described by the patent referred to?

Objected to as incompetent and irrelevant, and calling for a conclusion of law, and not for any fact.

A. Yes, without adding to them any deposit carbon and leaving them purely fibrous carbons.

R. D. Q. 3013. But you considered the carbons, as I understand you, to be improved by the electrical treatment, and you therefore adopted the treatment of the carbons as a general practice?

A. Yes.

R. D. Q. 3014. What did you mean by your answer to cross-question 310, where you say that you do not think you were diligent in applying for your patents?

A. I do not think we applied for them as soon as we might have done. We delayed for various causes our applications, but we always made them within the time prescribed by the law, two years.

R. D. Q. 3015. This invention, as I understand you, referring to the invention of the patent in suit, was made in the spring of 1878, and more thoroughly tested and perfected in the fall of the same year. Now please to state when it was first explained to your solicitor and directions given to him to apply for a patent for it?

A. In the month of October, 1878, about the middle of the
1577 month. Mr. Sawyer and I explained the whole subject-mat-
ter to Mr. Broadnax, solicitor for the Electro-Dynamic Light Co., and I as president of the company then requested him to apply for patents for this invention. Mr. Sawyer wrote out a statement of it, I think at that time, which was handed to Mr. Broadnax. Renewed applications and requests were made to Mr. Broadnax by me and I think Mr. Sawyer, until we parted the last of March or first of April, 1879, or certainly up to some time in January, 1879, from which time Mr. Sawyer was averse to making any applications, and from about the 1st of April, 1879, absolutely refused to sign any new applications, and thereafter never did sign any new applications for the inventions of Sawyer & Man as joint inventors, except under

some special arrangement by which he thought he was to obtain some personal advantage.

R. D. Q. 3016. Then as I understand you, all the time that elapsed after the invention was explained to Mr. Broadnax and he was directed to apply for a patent for it until the time that the application was actually filed, was from the middle of October, 1878, until the 9th of January, 1880, about fifteen months?

A. Yes, that is correct.

R. D. Q. 3017. During this time was the invention in public use?

A. No, not to my knowledge, until the latter part of the fall or the first of December, 1879. I first heard of it the latter part of December, 1879, as being put to use by Mr. Edison, from a publication in the New York Herald in the latter days of December, 1879.

R. D. Q. 3018. What, if any, effort was made to keep all knowledge of the invention from the public from the time it was made down to the time that you saw its use published by Mr. Edison in December, 1879?

A. We (Sawyer and I) always cautioned our workmen not to say anything about what we were doing. We never explained to the public who saw lamps with this kind of carbon in them, how
1578 the incandescent burners were made or of what kind of carbon
they consisted, because the thing was not patented, but we did explain the matter to our friends and to some of the stockholders of the Electro-Dynamic Light Co., and to Mr. Broadnax, the solicitor of that company, and possibly to a few other people in confidence whom we were endeavoring to interest with us in our electric lighting scheme, and it was our custom to keep our workshop and laboratory locked and exclude persons not interested with us from the same, did not explain our inventions or speak of them to parties not interested with us, unless in exceptional cases where we desired to interest them and get them to come in with us, and there was a door between our workshop and the room in which our exhibitions were made at 94 Walker street, which was kept locked when exhibitions were being made or the lamps were being exhibited.

R. D. Q. 3019. Now as I understand you, it was in the latter part of December, 1879, that you first knew of any one else having made or obtained knowledge of the invention of the patent in suit, and your application for such patent was made on January 9th, 1880. Is that correct?

A. Yes, except such persons as were interested with and friendly to us who obtained the knowledge from us, and I mean that the first knowledge I had of any one else but us making use of such invention was in the latter part of December, 1879, though it may have been that I heard of Mr. Edison's making use of paper a short time prior to the publication in the Herald of December 21, to which you refer but only a few days or a short time previous.

R. D. Q. 3020. Referring now to cross-question and answer 546 upon what did you predicate your expectation that a complete system of incandescent lighting would be worked out by Mr. Sawyer by the last of March, 1878?

A. Upon his statement to me to that effect.

R. D. Q. 3021. Referring now to cross-question and answer 750, please to state how thick the sheets of paper and the paper 1579 stock was from which you made the incandescent conductor by the method described in your answer to that question?

A. The papier-maché that we turned out in the lathe was from a sixteenth to an eighth of an inch thick. The paper sheets worked out on glass plates or laps before working were about a thirty-second of an inch thick. The papier-maché worked out on the glass plates or laps was somewhat thicker, perhaps a twentieth of an inch thick before working.

R. D. Q. 3022. You say also in answer to question 750 " We also cemented masses of carbon not of the shape or size of the conductor required." What was the shape and size of such masses of carbon of which you made the incandescent conductor by the method referred to in that answer?

A. Flat piece of carbon made of charcoal, papier-maché carbon, paper carbon and flat sheets of mineral carbon of a size and thickness to turn out a conductor from in the lathe.

R. D. Q. 3023. What was the length and tenuity of the incandescent conductors made by you by the methods described in your answer 750?

A. The smallest cross-section would be, I think, equivalent to the twentieth of an inch or less in diameter, the greatest length, that of the circumference of a circle, of an inch in diameter. Some of them were very much larger and shorter than these dimensions; some less than half an inch in length and some as large as a twelfth of an inch in diameter. Some of the longest were of the smallest cross-section.

R. D. Q. 3024. You have stated that by these methods you made incandescent illuminating conductors from mineral carbon as well as from carbon of fibrous origin. Of which of these carbons did you make conductors of the greatest length and tenuity?

1580 A. The fibrous carbon. The mineral carbons were all comparatively short and thick.

Adjourned till Thursday morning at 11 o'clock.

THURSDAY, *May* 31, 1888.

Met.

Present: Counsel as before, and the redirect examination of Mr. MAX was continued as follows:

R. D. Q. 3025. Referring again to your answer to cross-question 750, at what period of your work with Mr. Sawyer in making your incandescent electric lamps did you use the method described in that answer of making the incandescing conductor?

A. In the early part of our work while at 43 Centre street, in the spring of 1878.

R. D. Q. 3026. How long did you continue to practice that method of making such conductors?

A. With the mineral carbons, straight pencils, we sometimes cemented them to a lap of glass and rubbed them down to make them thinner and more tenuous and sometimes I think we used the same method with straight pencils cut out of deposit carbon pure and simple after the process described in our patent, of manufacturing deposit-carbon conductors, to smooth them off and make them a regular size throughout their length, till about the 1st of January, 1879, but as soon as we established in our minds the advantages of cutting the fibrous material to shape and size before carbonization for conductors we no longer practised the working down of fibrous conductors, I do not think we did anything of this kind with the fibrous conductors after the 1st of April, 1878, (it may, however, have been a little later than that) unless in some exceptional case, and none occurs to me now. It was better and more convenient 1581 to make the fibrous material to shape and size and then carbonize it.

R. D. Q. 3027. Do you mean to be understood that you continued to use that method more or less in cases where you used mineral or deposit carbon, down to about the 1st of January, 1879, but that in the case of the incandescing conductors, made from fibrous or textile material you did not use it after about the 1st of April, 1878, as you now recollect?

A. Yes, that is substantially what I mean, that is, that we sometimes and exceptionally used it with a hard carbon up to the 1st of January, 1879, but that I recollect no such use of it with fibrous carbons after about the 1st of April, 1878, but we cut or formed the fibrous carbon to size and shape before carbonization and did not work them down after they were carbonized.

R. D. Q. 3028. Why did you discontinue that method of making your incandescing conductors from carbon or fibrous origin?

A. For the reason that they were easier made and better carbons if made by cutting or forming to shape and size before carbonization. In short, it was possible to make these conductors in that way, but it was not practical, for in addition to the mechanical difficulty of making the conductor in that way, the carbon was not pure and homogeneous.

R. D. Q. 3029. Referring now to cross-question 853 in which it is inferred that you had compared incandescing conductors made from fibrous or textile material with incandescing conductors made from deposited carbon pure and simple, for the purpose of ascertaining which of two conductors of the same size and shape were the best; did you ever make such comparison?

—. ——.

R. D. Q. 3030. Of what size and length were such conductors used in making such comparison?

A. They were of comparatively short lengths, the longest 1582 possibly an inch or an inch and a half in length, the *the* shortest about half an inch in length. Their size was various from extreme tenuity of less than a thirty-second of an inch up to possibly a twelfth of an inch in cross-section. I do not know that any of the carbons of the smallest cross-section, were of deposit carbon pure and simple.

R. D. Q. 3031. Have you ever made, or do you know of any method that has ever been practised of making an illuminating conductor composed of carbon obtained "by electric action, pure and simple," having the length and tenuity of the illuminating conductor in the defendant's lamp Exhibit No. 21, by which the quality of such conductor could be compared with a conductor of equal length and tenuity made of fibrous carbon?

A. I have never made a conductor of the tenuity and length of that contained in the exhibit referred to of carbon obtained by electric action, pure and simple, and I know of no method that has been practised of making a conductor of this length, and tenuity of carbon obtained from electric action pure and simple, by which such a comparison as you mention could be made between such a conductor and a conductor of the same tenuity and length made from fibrous carbon. I had not intended to testify that I had made a comparison between two such conductors of such length and tenuity. I will add, that for the purpose of determining the quality of the carbon, of which the conductor is composed, or for determining the character of the conductor, I do not think it would be necessary to have conductors for comparison of the length and tenuity of the conductor in the exhibit referred to, and I do not think that comparison between two such conductors of the same tenuity and shorter length is sufficient to ascertain the quality of carbon of which the conductors are composed, and the character of the conductors, and I intended to be understood in testifying as having made such a comparison.

1583 R. D. Q. 3032. Which of two conductors of the length and tenuity referred to, the one made of fibrous or textile material and the other of carbon obtained by electric action pure and simple, would you consider the best conductor for incandescent electric lighting? I am referring to the length and tenuity of the conductor in the defendant's lamp Exhibit No. 21.

A. The one, the fibrous conductor, is an article readily made and practical. The other, the deposit-carbon conductor, I have testified that I have never made, and know of no practice by which it is made of such length and tenuity.

R. D. Q. 3033. Referring now to your method of making or treating carbons, described in the patent to Sawyer and Man, 211,262, assuming the illuminating or incandescent conductor made of carbon of fibrous origin, treated to the minimum extent described by you, both upon your cross-examination and your examination-in-chief, could you, after such treatment, separate the fibrous carbon from the deposited carbon?

A. No.

R. D. Q. 3034. Is it or not true, then, that the body of the illuminating conductor, after such minimum treatment, remains a conductor substantially of carbonized fibrous or textile material?

A. It is true that it so remains almost wholly of carbonized fibrous material, and of the same texture as before treatment, so that if the carbonized fibrous material were removed, there would be nothing left of the deposit carbon, even if it were in one mass or line, which would constitute or be a conductor, that mass or line would require

a microscope to find it, but as the deposited carbon in the treatment would be distributed upon the fibres of the fibrous material, the deposited carbon for each individual fibre of the conductor would be separate and by itself, constituting lines of hollow tubes of the size
of the ultimate fibres of the fibrous conductor, and the shells
1584 of these tubes would be so extremely thin and fragile as to
crumble to dust with the slightest touch.

R. D. Q. 3035. State whether or not, as the result of your experience, the fibrous carbon illuminating conductor by the treatment of it according to the process described in the Sawyer-Man patent is improved when such treatment is carried to the minimum extent mentioned by you in your testimony.

A. My experience is that it is improved.

R. D. Q. 3036. Referring to cross-question 1670 please to state in what places the incandescent lamp, as made by you and Mr. Sawyer, would be capable of competing with gas as stated in your answer to that question?

A. I do not think I could enumerate all the places where it would so compete with and drive out gas. I will mention such as occur to me; for the head-lights of locomotives, for use on steamships, especially in signalling at night; for use in places in which explosive gases existed; for use in mills where safety from fire is desirable, especially in flouring mills, sugar works and the parts of cotton mills where lint and dust are liable to cause fire or explosion; for use with the camera, and in all places where an intense light derived from substantially one focus is desirable; for use in lighting under water; for use in lighting for ornamentation, such as ornamental grounds and groves; for use as an illustrative apparatus in colleges and schools; for use where water power was available and cheap and near at hand for ordinary illumination.

R. D. Q. 3037. State, if you know of any way, that has ever been practiced of making a carbon incandescent conductor of the length and tenuity used in the incandescing electric lamps of to-day of fibrous or textile material other than by cutting, selecting or forming it to size before carbonization?

A. No, I do not.

Adjourned till Friday, June 1, 1888.

1585 FRIDAY, *June* 1, 1888.

Met.

Present: Counsel as before, and the redirect examination of Mr. MAN was continued as follows:

R. D. Q. 3038. Please to produce, if you can, a specimen of the cane obtained by you at Crookes' establishment in Fulton street in the fall of 1878, as mentioned in your answer to redirect question 3003.

A. I produce a specimen of such cane which I recently obtained from Mr. Crookes.

R. D. Q. 3039. This cane, as I understand, you gave to Mr. Myers or some other workman in your shop, with directions to carbonize and make incandescent conductors of it?

A. Yes, to Mr. Myers.

Specimen of cane offered in evidence and marked Complainant's Exhibit No. —, East India Cane, produced by Albon Man, June 1, 1888.

R. D. Q. 3040. Now, in making your longest and most tenuous incandescent-treated conductors of vegetable or fibrous carbon, how did you proceed in cases where such conductors were to be subjected to the minimum treatment according to the process of the patent of Sawyer & Man, 211,262?

A. We selected the fibrous material of the size and length desired, formed it to shape, and then carbonized it, and then treated it, or if the selected material was not already of a desired size, we formed it to the size desired, put it in the shape desired, then carbonized it and then treated it.

R. D. Q. 3041. Now, in making your incandescing conductors of pure deposited carbon obtained by electric action, how did you proceed?

1586 A. In the same manner as in the last answer, using selected fibrous material, selected or formed to size and shape, then treating it by the electrical process until the deposited carbon was of sufficient thickness of itself to form a conductor, then removing the vegetable fibrous carbon, leaving a conductor of pure-deposit carbon.

R. D. Q. 3042. In both cases, as I understand you, you began with an incandescing conductor made of carbonized fibrous or textile material?

A. Yes, a conductor of that kind selected or formed to shape and size before carbonization.

R. D. Q. 3043. Why did you use in the production of such conductors an incandescing conductor, made of carbonized, fibrous or textile material selected or formed of the proper size previous to carbonization?

A. In the first case, because we wanted to make a conductor for use in the lamps of carbonized fibrous material, only improved by the electrical treatment, and we knew of no other way in which long and tenuous conductors, such as some of those that we used, could be practically and easily produced except by the use of the fibrous carbons selected or formed to size and shape before carbonization. In the second case, that of the deposit carbon, pure and simple, we used the incandescing conductor of fibrous carbon selected or formed to shape and size before carbonization, in order to give the same shape to the deposit made upon it and we used the fibrous carbon, vegetable carbon, for this substratum on which the deposit was formed, because the vegetable carbon was soft and could be readily removed after the deposit was formed upon it, to leave the pure deposit carbon incandescent conductor. If we had used hard or mineral carbons for this purpose they were too hard to be removed and separated by tools from the deposit carbon, pure and simple, of which we wished to form a conductor, and the attempt to remove them would break the deposit carbon.

1587 R. D. Q. 3044. In the production of these conductors then, as I understand you, an incandescing conductor of carbonized fibrous or textile material was necessary to begin with?

A. Yes, we deemed it so.

R. D. Q. 3045. You have stated that the Wallaces, of Ansonia, were to manufacture your lamps under a royalty. Please to state what that royalty was to be and what it included?

A. My recollection of the thing is that they were to pay a royalty of three dollars per lamp for the use of all the inventions of Sawyer & Man, owned by the Electro-Dynamic Light Co., based upon the number of lamps in the different lighting systems or plants that they should establish. As an illustration, if a plant established by them was one containing a hundred lamps the royalty would be once for all, three hundred dollars, notwithstanding the lamps might be renewed in the same plant.

Adjourned to June 13, 1888.

1588 New York, *June* 12, 1888.

Met pursuant to agreement of counsel.

Present: Counsel as before, and the recross-examination of Mr. Man was commenced and continued as follows:

R. X Q. 3046. When testifying on your direct examin- in this suit did you recollect the getting of any bamboo for carbonization?

A. My recollection on the subject has been refreshed since I testified in regard to the matter. In my direct examination I recollected them getting somewhere and trying some endogenous wood of the larger or tree growth, such as some of the palms. I do not know which. If I knew, I have forgotten, and have forgotten where I got them. Since then I went to Crookes' place in Fulton street corner of Cliff street to get some lance-wood, such as I got from him and tried in 1878 and had my attention called to the getting of a great variety of woods from Crookes at that time which I took to 94 Walker street, carbonized, and had tried for the conductors of incandescent lamps, among which was another endogenous wood that I have not mentioned, that I am satisfied I then got and took to be tried at our workshop, No. 94 Walker street, with the other woods that I got from Crookes'. I have no further recollection in regard to the matter than that I got this wood, took it to our shop to be carbonized and tried, and have no recollection of the carbonizing and trying of this wood as distinguished from any of the others.

R. X Q. 3047. Who was it that called your attention to the getting of a great variety of woods from Crookes'?

A. I knew that I had got a variety of woods from Crookes' and my attention was called to the subject-matter by a young 1589 man that I have known as Harry Crooke, and the circumstances attending the getting of the wood were recalled by him and recollected by me.

R. X Q. 3048. What did he say to you?

A. He said that he took me up into the workshop where his father, or adopted father, as I have since learned he was, was at work, selected the woods while there, called my attention to several of them, among others this one endogenous wood (bamboo) which his father was then working, showed me the working of the wood which was then very peculiar and ingenious and gave me samples of it with the other woods.

R. X Q. 3049. This you had forgotten all about, as I understand?

A. Yes, I had not thought of it until that time.

R. X Q. 3050. Is it now your recollection that he suggested your taking this piece of bamboo and that you did not ask for it?

A. No, it is not. It is my recollection that I asked him for strong fibrous woods, all the kinds he had and that he took me up into the workshop to see what they had and showed me the different kinds of woods that his father was working, the bamboo and that he showed me the process of manufacture and that I asked him for the pieces of it.

R. X Q. 3051. You have, I understand, no recollection of having carbonized or tried it?

A. No, sir, not as distinguished from any of the others.

R. X Q. 3052. Did you ever get any more bamboo?

A. No, I don't think I ever did. I do not know that this was bamboo proper, it was cane, such as so-called split bamboo fish-poles are made of.

R. X Q. 3053. What do you mean by saying in your 3051st answer "not as distinguished from any of the others"?

A. The carbonizing at 94 Walker street, and preparing the
1590 conductors was mostly done by Mr. E. L. Myers, some of the
shaping by Mr. Sawyer. The woods I got were mostly prepared and carbonized by them and I believe that all the different kinds were tried that I took to the shop, but I am unable at this length of time to recollect and distinguish all the different kinds of woods, nor to testify, and I know that I have not named all that we got and all that were tried, but I am unable to testify positively in regard to several of the different kinds that I recollect, their individual use and trial. Among these is bamboo.

R. X Q. 3054. All that you know then is that getting a great variety of woods at Crooks', you got some bamboo, under the circumstances you have mentioned, and took it to the workshop to be used?

A. Yes, with the addition that I gave directions for the woods that I took there to be tried.

R. X Q. 3055. But whether bamboo was tried or not, you do not know?

A. I cannot answer; I cannot testify positively that it was.

R. X Q. 3056. In answer to your 3004th question you refer to woods having interlacing fibres. Do you remember what the kinds of woods having interlacing fibres that you tried were?

A. I don't know. It was one with interlacing fibres; I would know it if I saw it again, and have tried to find it, but have been unable to do so.

R. X Q. 3057. What endogenous woods have interlacing fibres?

A. The larger or tree growths such as some of the palms, I think.

R. X Q. 3058. Were conductors ever ma*k*e from this endogenous wood?

A. Yes, some straight pencils were made from it.

R. X Q. 3059. Was this wood tried to any extent?

1591 A. Not very extensively. A few batches of pencils were made from it.

R. X Q. 3060. How did it compare, in your estimation, with willow?

A. The conductors were very troublesome to make. They were good enough, but no preference was established for them in any way, and if I recollect rightly we thought the carbon was not as pure as the willow carbon.

R. X Q. 3061. In your 3007th answer, referring to the woods produced by you, you say they are similar woods to the endogenous woods with interlacing fibres which you tried. If I am correct in understanding you, you do not mean that you remember trying Grugru palm and mangrove; but what you do mean is that they are similar to these in being endogenous and having interlacing fibres?

A. As to the Grugru palm you are correct; but as to the mangrove, we did use lignum-vitæ, of which I understand the mangrove to be a species. As to this kind of mangrove it is not mainly an endogenous wood, but only, if I am right, takes on the endogenous form of growth in part only as to the interior of its aërial roots, which I think, from my investigation, are filled up so far as the pith or interior of these roots are concerned by endogenous growth, and also take an exogenous growth after they reach the ground and become new bodies for the trees. There are several kinds of woods which are commonly called in the neighborhood of their growth, mangrove. This one that I produce is called there mangrove and is lignum-vitæ, whether there are other kinds of lignum-vitæ I do not know. I only know that this kind of wood which I produce looks like that which we used which was called lignum-vitæ.

R. X Q. 3062. In your 2010th answer you say the company decided to go on with the manufacture and introduction of the lamps into use. How was this decision evidenced?

A. It was a decision reached at a board meeting of the company's trustees, and, I suppose, recorded in the minutes.

1592 R. X Q. 3063. Do you know where these minutes are?

A. No, I do not.

R. X Q. 3064. Was it explained to the board what lamp and apparatus the company had which they considered in practical shape for introduction?

A. I do not remember.

R. X Q. 3065. Do you remember what the lamp was and what the apparatus which it was decided to introduce and manufacture?

A. Only that it was like those which had been produced up to that time, and leaving a discretion as to modifications to the superintendent.

R. X Q. 3066. What apparatus other than lamps were to be manufactured and introduced?

A. Switches, resistances, regulators, meters, safety devices, cutouts and holders and connections for the lamps.

Adjourned till Wednesday, the 13th inst., at 10½ a. m.

NEW YORK, *June* 13, 1888.

Met pursuant to adjournment.

Present: Mr. Broadnax for complainant and the witness; and after waiting an hour and a half, and no one appearing on behalf of defendant, the further examination of Mr. Man was adjourned till Thursday, the 14th inst., at 1 p. m.

THURSDAY, *June* 14, 1888.

Met pursuant to adjournment.

Present: Mr. Broadnax for complainant and the witness. No one appearing for defendant the examination was adjourned till Friday, the 15th inst., at 1 p. m.

1593 FRIDAY, *June 15th*, 1888.

Met pursuant to adjournment.

Present: Mr. Broadnax for complainant. No one appearing for defendant, the examination was adjourned till Monday, the 18th, at 11 a. m.

NEW YORK, *June* 18, 1888.

Met.

Present: Counsel for the respective parties and the witness, and the examination of Mr. MAX was continued as follows:

R. X Q. 3067. You speak of the apparatus the company decided to manufacture. Please state what facilities for manufacture the company possessed.

A. I have already stated that fully. We had a workshop, tools and apparatus which I have named, and we had work made outside at a great variety of places.

R. X Q. 3068. Was it intended to do the manufacturing in the workshop or to have the articles made outside?

A. The main portion of the work was to be made outside; the setting up and assembling or putting together, and some other work, such as making carbon conductors, was to be done in the shop.

R. X Q. 3069. What horse power did you have available in the shop?

A. One small steam-engine. I don't remember the horse power, perhaps six horse power or less.

R. X Q. 3070. How many men did the machinery in the shop admit of employing with profit?

A. Half a dozen or more.

R. X Q. 3071. Can you tell me at what place outside of the shop the various articles or their parts were to be manufactured?

1594 A. I have already fully testified in regard to this matter. The glass-work at glass factories, the metal-work at different metal-working establishments of different kinds. I have already specified these as fully as I can.

R. X Q. 3072. What metal-working establishments was the metal-work to be done at?

A. I have already, as fully as I can, testified in regard to where we got the metal-work done. There was no direction given by the company that I recollect, that the metal-work, glass-work or other work was to be done at any particular place.

R. X Q. 3073. Where were the switches, resistances, regulators, meters, safety devices, cut-outs, and holders, referred to in your 3066th answer to be manufactured?

A. Partly in the shop and partly outside, as the other was.

R. X Q. 3074. Do you know at what places outside?

A. I do not remember that any direction was given by the company in regard to it. I cannot recollect the names of the people. They were brass-founders and machinists, and instrument-makers, and metal-spinners, and wire-coverers.

R. X Q. 3075. Did the company get any special tools or machinery after their decision to undertake the manufacture?

A. Yes, a great variety of patterns and samples, and we were all the time buying tools and having them made, of different kinds.

R. X Q. 3076. What special tools and machinery did the company get after its decision to manufacture, and to what extent did they go to fit up the shop so as to enable them to manufacture?

A. I cannot remember at this time to particularize all the things that were got or all the things that were done.

R. X Q. 3077. To what expense did the company go in this direction?

1595 A. I can't recollect the figures, but it was very large expense, thousands of dollars.

R. X Q. 3078. Do you mean it spent thousands of dollars in fitting up the workshop after its decision to manufacture?

A. Not the workshop of the company alone, but the apparatus used by all the different people who were manufacturing, all or most of them. The company had to pay for the special tools and apparatus of the different manufacturers necessary to produce the work cheaper and with facility, and for the time consumed in making such tools and apparatus. As an illustration: With H. L. Judd & Co., who made a large amount of metal-work for us, we paid for the making of tools, or rather machines for making the metal appliances of the base of the lamp, and for making the corrugated and folded conductors leading into the lamp, and for the metal apparatus underneath and above the diaphragm within the lamp. With others we did in the same manner, paid for the fitting up to make the different parts.

R. X Q. 3079. How much in all did the company pay for the special tools which Judd had to get for the purposes enumerated?

A. I cannot recollect. They made them.

R. X Q. 3080. About how much?

A. I can't tell.

R. X Q. 3081. What other manufacturers got in special tools for the doing of your work?

A. I cannot remember to name them. Special tools were made for producing the stop-cocks and grinding them, for pressing out the caps, for covers which covered the stop-cocks, for making the spun-metal caps which covered the base of the lamps, for making the clamping rings for the base of the lamps.

R. X Q. 3082. How much did the company expend in special tools and machinery for its workshop after its decision to manufacture?

1596 A. I do not know. No separate account was kept of the matter.

R. X Q. 3083. Can you tell me approximately?

A. Thousands of dollars were expended as a whole, but I do not know any way of distinguishing the expenditures for special tools and apparatus from the other expenditures.

R. X Q. 3084. Where did the company get the money they thus expended?

A. From the sale of its stock.

R. X Q. 3085. What was the capital of the company?

A. I can't recollect.

R. X Q. 3086. How much money was ever paid in.

A. That I can't recollect. I knew both, but it don't occur to me now, I should have to refresh my recollection to find out.

R. X Q. 3087. Did the company keep any books showing the monies paid in and expended?

A. Yes.

R. X Q. 3088. Where are they?

A. I don't know. The last I knew of them they were with Mr. Broadnax.

R. X Q. 3089. Were any meters actually constructed?

A. Yes.

R. X Q. 3100. By whom?

A. Two or three were partially constructed but not finished, in the workshop of the company in part, and in part by work outside. A complete meter was made I don't know who by, after Mr. Sawyer and I separated.

R. X Q. 3101. At what outside place was the work on the meters done?

A. I can't recollect where the parts were made.

R. X Q. 3102. Were any regulators made outside?

A. The parts were made outside.

R. X Q. 3103. Where?

A. I don't know.

1597 R. X Q. 3104. From whom were the special tools and machinery which the company got after its decision to manufacture obtained?

A. I can't recollect, a great number of people, here and there and everywhere.

R. X Q. 3105. You refer in your 3010th answer to an arrangement made with the Messrs. Wallace, of Ansonia, was that arrangement in writing?

A. Yes.

Counsel for defendant gives notice that they will move to strike from the record all the testimony of the witness given on his redirect examination relating to any arrangement made between the Electro-Dynamic Light Co., and the Messrs. Wallace, of Ansonia, and insist upon the original paper being produced.

Complainant's counsel, in response to the objection noted by defendant's counsel, calls his attention to the fact that it has already been proved that the agreement or contract referred to has been lost and cannot be produced.

R. X Q. 3106. I understand you do not know of your own knowledge what was done by the Messrs. Wallace under this agreement?

A. Only by reports from Mr. Wallace, Mr. Sawyer and — Mr. E. L. Myers, to the company, and to me as an officer.

R. X Q. 3107. You say in your 3010th answer that Mr. Sawyer was hired by the Electro-Dynamic Light Co., or its stockholders, which was it?

Objected to as immaterial and not cross-examination.

A. The stockholders contributed stock which they held, was sold, and the proceeds went to the company, and in part was paid to Mr. Sawyer.

R. X Q. 3108. Had the stock of the treasury of the company been exhausted?

Same objection.

1598 A. There was no stock in the treasury of the company, but stock was held by a trustee for the benefit of the company. I think that was not exhausted at the time.

R. X Q. 3109. Why did the stockholders individually contribute their stock?

Same objection.

A. In order to induce Mr. Sawyer to go to Ansonia and superintend the work there, or advise in regard to it and to interest Messrs. Wallace, who bought part of the stock that was sold.

R. X Q. 3110. Why was not the trust stock used for this purpose?

Same objection.

A. I do not know now, but I suppose it was for the purpose of keeping the company good, and not depleting it by the arrangement made with Mr. Sawyer and Mr. Wallace.

R. X Q. 3111. In your 3010th answer you say the Eastern Electric Manufacturing Co., to whom the patents were assigned, "agreed to go on with the manufacture and introduction of the lamps into use," with whom was this agreement made?

Same objection.

A. The agreement was between the Electro-Dynamic Light Co. and the Eastern Electric Manufacturing Co.

R. X Q. 3112. Was the agreement in writing?

Same objection.

A. I don't think so, but I don't recollect positively.

R. X Q. 3113. What was the agreement?

Same objection.

A. Before the patents were assigned to the Eastern Electric Manufacturing Co., or to Mr. W. H. Church, and from Church to that company, an agreement, after a great deal of negotiation, was reached between the two companies. Under that agreement the
assignment of the patent was made to the Eastern Electric
1599 Manufacturing Company, and that company agreed to go on
and manufacture and introduce the lamps and other apparatus. Whether this agreement was reduced to writing, I cannot now recollect.

R. X Q. 3114. In the same answer you say "They (the Eastern Electric Manufacturing Co.) did go on to manufacture some lamps," do you mean they manufactured them themselves, or had them made for them?

Same objection.

A. I think they did the manufacturing, in part, themselves in their workshop in Fulton street, New York, and in part had the work done outside, as the Electro-Dynamic Light Company did.

R. X Q. 3115. Did they acquire the tools and machinery of the Electro-Dynamic Light Co.?

Same objection.

A. No.

R. X Q. 3116. What became of them?

A. I bought them from the Electro-Dynamic Light Co., such as they had in their shops, and such as I could find with the different manufacturers who had done work for the company, except the engine, some of the pulleys and shafting, and some general tools, and one lathe, and perhaps some other things which were sold off to different people at the time when we closed the shop at 94 Walker street.

R. X Q. 3117. What have you done with them?

Same objection.

A. Part of them I still have, and part of them I have sold, and part of them I lent to Mr. Sawyer and never got them back again.

R. X Q. 3118. Did you keep, lend or sell the major part?

Same objection.

A. I think the major part is sold, much the major part in bulk, not in value, of what I had left after lending to Mr. Sawyer; I think I lent him about half what I got.

1600 R. X Q. 3119. What did you realize from those you sold?

Same objection.

A. I don't know; I sold them at odd times.

R. X Q. 3120. About how much?

Same objection.

A. Two or three to five hundred dollars I should think.

Adjourned for lunch.
Resumed after lunch.

R. X Q. 3121. What was the value of the special tools and machinery you bought from the Electro Dynamic Light Co., exclusive of dynamo machines and experimental apparatus; I refer to tools and machinery?

Same objection.

A. I do not know how much of it was only adapted to the special work which was to be performed, and not useful for other purposes. Some of it, such as lathes, tools, drills, was good in general workshops. Some of it I sold for old junk. Some of it I gave away to get rid of it, and the storing of it.

R. X Q. 3122. From what persons other than the Electro Dynamic Light Co. did you get the special tools and machinery which had been made for work to be done for that company?

Same objection.

A. Some of it I got from Mr. Judd, part of what we had, and part was burned up in their factory. Some of the patterns and forming tools I got from the metal-spinner in Centre street. Some of it Mr. George Sawyer went round and collected for me.

R. X Q. 3123. Is Judd the only person you can mention?

Same objection.

1601 A. He is the only person whose name I recollect.

R. X Q. 3124. Do you know, of your own knowledge, that the Eastern Electric Manufacturing Co. did any manufacturing?

Same objection.

A. Yes.

R. X Q. 3125. Did they fit up a workshop?

Same objection.

A. They had a workshop fitted up.

R. X Q. 3126. Capable of manufacturing on an extensive scale?

Same objection.

A. No; I think not on a very extensive scale, and not for the complete work of making and setting up lamps and other apparatus, but for assembling and setting up the manufactured parts of lamps and other apparatus.

R. X Q. 3127. Where was their workshop?

Same objection.

A. In Fulton street, New York, I can't remember where.

Witness here says:

"The tools and apparatus for making glass-work were most of them left at the glass factories where the glass-work was done. I never got them."

R. X Q. 3128. How much room did they have?

Same objection.

A. As I recollect it, one loft, or perhaps one loft and part of another, or the whole of another, I can't recollect.

R. X Q. 3129. What was the size of this loft?

Same objection.

A. I should think, speaking only from recollection, twenty-five by fifty or sixty feet deep, one loft complete and part or the whole of another loft of the same size.

R. X Q. 3130. To what extent did they go in the matter of tools and machinery?

1602 A. I don't know. They had a large amount of tools and machinery there.

R. X Q. 3131. You do not know as a matter of fact what work was done at this workshop?

Same objection.

A. Yes, I know some of the work that was done. I don't know the amount. There was a whole machine shop there of very special tools and large apparatus of all kinds.

R. X Q. 3132. Were these bought by the Eastern Electric Manufacturing Co. before or after its consolidation with the Electro Dynamic Light Company?

Same objection.

A. I don't know, part were bought before and part after.

R. X Q. 3133. You say they had work done outside. Do you know where?

Same objection.

A. No.

R. X Q. 3134. What has become of the tools and machinery of the company?

Same objection.

A. I don't know.

R. X Q. 3135. You were a large stockholder in that company?

Same objection.

A. I was a stockholder.

R. X Q. 3136. Do you know where the books of that company are showing the money expended by them in machinery, tools and experiments?

Same objection.

A. No.

R. X Q. 3137. Where did you last see them?

Same objection.

A. I do not know that I ever saw them, but it seems to me that they were shown to me at or about the time when the patents 1603 were assigned from the Eastern Co. to the Consolidated Co. with reference to the value of the tools, machinery and apparatus of the Eastern Co. or their cost. It may have been, however, that it was only the account *of* inventory that I saw and not the books.

R. X Q. 3138. Who was the last person, so far as you know, in whose custody they were?

Same objection.

A. I don't know that I ever knew in whose custody they were, and am not certain that I ever saw them.

R. X Q. 3139. In your 3010th answer, referring to this company you say "they did go on to * * * make commercial arrangements for their introduction into use." To what commercial arrangements were you referring?

Same objection.

A. A contract made with some Chicago people for the use of the lamps and apparatus in Chicago; a contract made with St. Louis people for the use and introduction of the lamps and other apparatus in St. Louis, a contract made with some Philadelphians of like character for the State of Pennsylvania, a contract made with Boston people, and other contracts, I can't remember where or with whom.

R. X Q. 3140. About when were they made?

Same objection.

A. After the sale of the patents by the Electro-Dynamic Co. to the Eastern, and before the sale from the Eastern to the Consolidated. I should say from some time in 1881 forward.

R. X Q. 3141. Were they in writing?

Same objection.

A. Yes.

R. X Q. 3142. Where are they?

Same objection.

A. I don't know.

Defendant's counsel objects to any testimony in regard to the subject-matter of these contracts and insists on the production of the originals.

1604 R. X Q. 3143. In the same answer you say the Consolidated Electric Light Co., after acquiring the patents, went on with the manufacture of the "lamps," &c. Do the consolidated company manufacture and sell a lamp similar to those manufactured in 1879 in Walker street?

Same objection.

A. Yes, in some respects.
R. X Q. 3144. In what respects?

Same objection.

A. They manufactured a lamp using a fibrous carbon; they treat the carbon after the Sawyer & Man patent. They support the conductors by a separate piece, similar to the base of the Sawyer-Man lamp, or equivalent to it; project this support into the interior of the lamp chamber, making it the equivalent of the diaphragm of the Sawyer & Man lamp. They make an arch or loop-shape carbon, similar to those that were made by Sawyer & Man. They use an exhausted or inert atmosphere, or both, as Sawyer & Man did, and they make the chamber wholly of glass, as Sawyer & Man did, and they produce light by incandescence of the conductor, as Sawyer & Man did. They make arrangements for connecting the lamp to conductors; they make arrangements in the lamp for connecting it with conductors and setting it upon fixtures, as Sawyer & Man did; and use a metal base around the bottom of the lamp, similar to the spun cap used by Sawyer & Man.
R. X Q. 3145. In what lamp does the consolidated company use an inert atmosphere?

Same objection.

A. In all their lamps.
R. X Q. 3148. At what pressure?

Same objection.

A. At an exhausted atmosphere; I don't know what pressure—very small and inert by reason of the exhaustion.
1605 R. X Q. 3149. What do you mean in your 3144th answer when you say the complainants use an exhausted or inert atmosphere?

Same objection.

A. Just what I said.
R. X Q. 3150. Do you use the terms as synonymous?

Same objection.

A. Yes.
R. X Q. 3151. In referring to the lamp made by complainant have you in mind one of their standard commercial lamps?

Same objection.

A. Their ordinary lamps, varying somewhat in form and in details of workmanship from time to time.

R. X Q. 3152. Do you consider the present standard lamp of complainant as substantially like Complainant's Exhibits Sawyer-Man Lamp No. 3, January 12, 1888; Sawyer-Man Lamp No. 2, January 12, 1888, and Sawyer-Man Lamp No. 4, January 12, 1888, with the exception of the form and substance of the carbon conductor?

Same objection.

A. They are not similar in form or in appearance, but they are similar in principle in the respects which I have stated, and involve the use of the same patents and inventions or devices in whole or in part.

R. X Q. 3153. Why does the complainant manufacture and sell its present form of lamp rather than such lamps as are shown in the exhibits?

Same objection.

A. I do not know, but suppose that they consider the present form of lamp superior.

R. X Q. 3154. In what respects?

Same objection.

A. In improved workmanship and skill, due to manufacture, and in simplification of the parts due to manufacture and the experience of use.

1606 R. X Q. 3155. Has the complainant any installation at the present time, so far as you know, where a thousand lamps are in circuit in multiple arc?

Same objection.

A. I do not know.

R. X Q. 3156. Do you know whether a thousand lamps such as they now manufacture could be put in a building like this (the Equitable) in multiple arc and run from dynamos in the basement?

Same objection.

A. I don't know, I think they could.

R. X Q. 3157. Have you any idea of the size of the copper wires required to be used to convey the current to the lamps in such an installation?

Same objection.

A. I have made no computation in regard to it.

R. X Q. 3158. What should you say was the resistance of the conductor of the lamp Exhibit Sawyer-Man Lamp, January 5th, 1888?

Same objection.

A. Less than an ohm.

R. X Q. 3159. Suppose you had a thousand such lamps in this building in multiple arc fed by a current from a dynamo in the basement what would have to be the diameter of the copper conductors?

Same objection.

A. Very large. Such a lamp is not well adapted to such an installation in multiple arc. Its resistance is too low.

R. X Q. 3160. When did the complainant first begin to manufacture and sell lamps?

Same objection.

A. Immediately after the organization of the company, I cannot now recollect the date. It is in the record in this case. I think it was in the fall of 1882.

R. X Q. 3161. Do you know whether there was then on the 1607 market a lamp having an appearance and structure of general similarity to the lamp the complainant now manufactures?

Same objection.

A. Yes, I think there were several kinds of lamps at that time on the market similar in general appearance. I don't know as to their details.

R. X Q. 3162. Was the Edison lamp one of those to which you refer?

Same objection.

A. I think the Edison lamp was similar in general appearance.

R. X Q. 3163. About when did the Eastern Electric Manufacturing Company cease to make or have made lamps for them?

Same objections.

A. I think about the same time the Consolidated was organized.

R. X Q. 3164. In your 3011th answer you say "each lamp was marked on a tag or label attached to it and a record entered of its performance." Referring to these records when testifying in the case on patent 211,262 between the same parties you said:

"X Q. 528. Who kept the records and what has become of them? A. Mr. Sawyer for the most part made out the cards, but the thing was very irregularly done and the records on the cards were very incomplete. I never knew what became of those that were thrown into Mr. Sawyer's desk, and the last time I recollect seeing any of them was in seeing them tied to a lamp that was given to Mr. Broadnax, counsel for the company, which had been handed by Mr. Sawyer to Mr. Arnoux to hold, showing the arched form of carbon at a time when Mr. Edison published something in the newspapers referring to the loop form of carbon; and also the card

1608 attached to another lamp which I gave to Mr. Broadnax to be used as an exhibit. What was done with the cards on those lamps then I do not know.

X Q. 529. What was the object of keeping these memoranda?

Same objection and notice.

A. As a guide to our experimental work.

X Q. 530. If that be so, what explanation have you to give of their incompleteness and your ignorance of them after they were thrown in Sawyer's desk?

Same objection and notice.

A. Their incompleteness was due to carelessness; their usefulness was in a great measure at an end for the purpose for which they were kept when the carbons or lamps were broken, or at an end, or changed."

Is such your present recollection of the facts?

Same objection.

A. Yes.

Adjourned till Tuesday, the 19th inst., at 1 p. m.

1609 TUESDAY, *June* 19, 1888.

Met pursuant to adjournment.

Present: Counsel as before, and the examination of Mr. MAN proceeded as follows:

Witness desires to state in addition to his last answer that since making the answers quoted in that question he has found one or two globes of lamps with cards or labels still adhering to them.

R. X Q. 3165. Have you such lamps in your possession?

Same objection.

A. There are two of the globes here present.

The globes referred to containing the labels are produced and marked in evidence "Complainant's Exhibit Globes with Labels, June 19, 1888."

R. X Q. 3166. In your 3015th answer you state you explained the whole matter of the invention in controversy to Mr. Broadnax and requested him to apply for a patent in October, 1878. Did Mr. Broadnax refuse to apply for a patent?

A. I don't know that he did.

R. X Q. 3167. Why did he not obey your request and apply for a patent?

A. I think there were several reasons.

R. X Q. 3168. Did he give you any reason why he did not?

A. Yes, he told me several times in regard to it.

R. X Q. 3169. You say in the same answer "Renewed applications and requests were made to Mr. Broadnax." Did he continue to disregard these applications and requests?

A. I don't think he ever disregarded them. On the contrary, he did a good deal of work in regard to them according to my best recollection.

1610 R. X Q. 3170. What reason did he give you for not obeying your request and applying for a patent?

A. One reason was that the thing would keep; that there was time enough to make the application; that he was very busy with other work for the company; that he was endeavoring to formulate claims in regard to the matter, and that he was in doubt in regard to the patentability of the invention because it was charcoal and charcoal had been used before in electric lighting.

R. X Q. 3171. Any other reasons?

A. I do not now remember any other statements in regard to it, for the delay.

R. X Q. 3172. From October, 1878, until March, 1879, what work did Mr Broadnax do for the company?

A. I don't think I could remember the details of the work he did, only some of it. He — a large number of applications for patents, foreign and domestic, for us, and was engaged in several interferences, to the best of my recollection.

R. X Q. 3173. How many applications do you think were filed between the times mentioned?

A. That I don't remember.

Witness desires to state that, discussion intervening, the last question was asked before he had completed his answer to the preceding question, which he does as follows:

Mr. Broadnax was also engaged in drawing contracts and agreements between the Electro-Dynamic Light Company and different people, attending the meetings of the board of the company, and made frequent journeys to Washington with reference to patents and interferences. This testimony I give as the best of my recollection of what he did and was doing for the Electro-Dynamic Light Company during the period you mention. My recollection is that his time was completely absorbed or nearly so, with the business of the company to the suspension of other business.

1611 R. X Q. 3174. What interferences was he conducting during this time?

A. I cannot remember them to name them.

R. X Q. 3175. How many times did he go to Washington?

A. I don't know. My recollection is a great many times.

R. X Q. 3176. About how many?

A. I can't recollect.

R. X Q. 3177. Can you give no idea?

A. No, not that would give any definite information on the subject.

R. X Q. 3178. What agreements or contracts did he prepare during this period?

A. That I can't recollect, only some of them.

R. X Q. 3179. What ones do you recollect?

A. I remember his drawing some agreements between the company and Mr. Sawyer and myself and two or three or more parties of gentlemen, called syndicates, and the Electro-Dynamic Light Co., having reference to foreign patents, and these are all that I do now recall.

R. X Q. 3180. Did Mr. Broadnax present bills for his services?

A. Yes, I think so.

R. X Q. 3181. Who to?

A. The Electro-Dynamic Light Co., I think.

R. X Q. 3182. Did those bills contain a statement of the services rendered?

A. I do not know.

R. X Q. 3183. Was the company informed in any way of the services performed by Mr. Broadnax?

A. Yes, they knew of everything that was done in a general way.

R. X Q. 3184. How were they informed?

A. At the board meetings.

R. X Q. 3185. By oral or written statement?

1612 A. Perhaps by both, I don't recollect. Mr. Broadnax was usually or frequently at the board meetings of the company and its officers, which were held very frequently, sometimes several times a week.

R. X Q. 3186. Were his bills paid by the company?

A. I think so.

R. X Q. 3187. By check?

A. I don't know whether by checks or cash.

R. X Q. 3188. Did the company have a bank account?

A. That I don't recollect, or whether he was paid by checks of the company or by checks of Closson & Hays, or others; I don't know if paid in checks and where payments were in cash, if any were made, whether the cash was handed to him by me or by Closson, Hays, or by other officers of the company. I don't know; I think, however, the payments were usually made by Closson & Hays, who acted as bankers for the company.

R. X Q. 3189. Did the Electro-Dynamic Light Co. ever have a bank account?

A. That I don't recollect, other than an account with Closson & Hays.

R. X Q. 3190. Did they have money in the hands of Closson & Hays and draw checks upon them?

A. They had money in the hands of Closson & Hays, whether they drew checks upon them I don't recollect.

R. X Q. 3191. Please explain in what way the debts of the Electro-Dynamic Light Co. were paid.

A. They were paid by the treasurer, who at the time was Mr. Jacob Hays, I think, or Mr. Lawrence Myers. Different members of the company at different times advanced money to the company, or sometimes paid some of its bills, for which the treasurer gave them credit.

R. X Q. 3192. Did the treasurer make payments out of his personal moneys?

1613 A. I do not remember that he did. He may have done so and charged it to the company till the money came in to him.

R. X — 3193. Did the treasurer keep a bank account as treasurer of the company?

A. I don't know, as I have said.

R. X Q. 3194. If the company had no bank account in what way did the company pay out or receive money as a company?

A. I have not said that it had not a bank account.

R. X Q. 3195. You have no recollection on the subject?

A. No.

R. X Q. 3196. Who kept the books and accounts of the company?

A. I think a clerk of Closson & Hays.

R. X Q. 3197. Where were the books kept?

A. At their office, corner Nassau and Pine streets.

R. X Q. 3198. Where was the stock book kept?

A. There.

R. X Q. 3199. Who wrote up the minutes?

A. The secretary.

R. X Q. 3200. Who was he?

A. I can't recollect; a part of the time Mr. Sawyer.

R. X Q. 3201. Where was the minute book kept?

A. At the same place.

R. X Q. 3202. Where was the office of the company?

A. At the same place.

R. X Q. 3203. Were the board meetings held there?

A. Yes, and at the workshops of the company.

R. X Q. 3204. Are Closson & Hays in business now?

A. I think not.

R. X Q. 3205. Who composed the firm?

A. I don't know; I know some of them.

R. X Q. 3206. Who?

A. Mr. Closson and Mr. Jabob Hays.

R. X Q. 3207. Are they living now?

A. I think they are.

1614 R. X Q. 3208. Were either of them a director or officer of the company?

A. Both of them, I think. I am not certain as to Mr. Closson.

R. X Q. 3209. Do you remember how much Mr. Broadnax's bill amounted to for the period mentioned?

A. I do not.

R. X Q. 3210. Do you know what has become of his bills or receipts?

A. I do not.

R. X Q. 3211. Nor of the books of the company?

A. No.

R. X Q. 3212. Were you or the company dissatisfied with Mr. Broadnax's failure to apply for a patent?

A. I only remember in regard to that, being urgent with Mr.

Broadnax that the thing should be done, and his rendering excuses in regard to it or giving reasons for the delay.

R. X Q. 3213. Do you remember whether you were satisfied with the reasons he gave?

A. I do not remember. I should think his reasons for delay, such as giving his attention to other matters more pressing, instead of to this particular case, were satisfactory to me at the time; but I did not agree with him as regards to the patentability of the invention, and frequently argued that question with him, and got him to go to the shops to see the thing and be better informed.

R. X Q. 3214. You speak of arguing the question of patentability with Mr. Broadnax. Please tell me what position he took on the subject in these discussions with you, and what positions you took.

A. I only recollect his telling me that he had endeavored to formulate specifications and claims upon the matter, which he said were not satisfactory to himself. I think he showed them to me, or some of them, and that he said
1615 that he was in doubt about getting any claims that
would stand. Mr. Sawyer and I had furnished him at first, about the middle of October, 1878, with a written statement of the invention. I think that after Mr. Broadnax had formulated some of the claims and specifications, that he and I discussed the matter as to the claims he had prepared, and that he was in doubt about any of them being good, and I thought they were, or some of them were, and that they would stand. I think I prepared, myself, some specifications and claims in regard to the matter after our first discussion of it, after he had prepared provisional or suggestive specifications and claims. I think that after that he prepared other specifications and claims which I saw, and I think these papers, including the original papers furnished to Mr. Broadnax by Sawyer and Man, were sent or given to Mr. Sawyer to revise, perhaps more than once, I think the last I saw of them they were with Mr. Sawyer. This occurred in the fall of 1878, and continued on until, perhaps, the 1st of January following, and perhaps later. Now I may not have given the direct order of things done or the discussion had. I cannot recall it to my memory to speak of it more clearly. I remember stating to Mr. Broadnax that the thing was new and evidently useful, and that it ought to be and I believe it was, patentable. I remember his referring to the matter of charcoal having been used before for electric lighting, and even if it was new it was not necessarily patentable, and any way there was no hurry about it, that we had two years in which to apply for the patent, and I remember him asking me if anybody else was using it, and if anybody knew of it except ourselves.

R. X Q. 3215. Were you aware of the previous use of charcoal or was Mr. Broadnax the first to inform you of it?

A. I was aware of it and I think the first papers I prepared for Mr. Broadnax and gave to him in October, 1878, contained a statement that charcoal had been used for incandescent lighting.

1616 R. X Q. 3216. Was there any discussion between you as to the arch form?

A. Yes, we both thought that was patentable at that time.

R. X Q. 3217. Do you both think it was new?

A. I believe we did, but subsequently discovered that an arch form of incandescent conductor, a something approaching that form, made of metal, had been previously used.

R. X Q. 3218. Did you discover this before or after the application was filed?

A. I think not till afterwards. I do not wish to be understood that the arch form for a carbon incandescent conductor was not then new, for I believe it was.

R. X Q. 3219. Can you not give me more clearly than you have the reasons given by Mr. Broadnax for thinking the invention was not patentable, and the reasons you gave him for thinking it was?

A. No, I could not.

R. X Q. 3220. Did the company know of these discussions between yourself and Mr. Broadnax?

A. I think the thing was talked of at the board meetings, as all our matters were freely talked of there, but the details of the talk between Mr. Broadnax and me I do not think they knew.

R. X Q. 3221. The invention belonged to the company, did it not?

A. It did.

R. X Q. 3222. Did you treat the subject as though you were dealing with your individual property, or did you consider it your duty to be guided by what the owners of the property might wish, and in order that they might act intelligently keep them fully informed?

A. I don't know what you mean. I was acting for the company in regard to an invention where I was co-inventor; I was president of the company and was acting solely for its interests, 1617 and my personal interests through the company. I had no secrets from my fellow-members of the board and did not endeavor to keep anything from them, if that is what you mean, and tried to keep them fully advised of all that was being done.

R. X Q. 3223. Did any members of the board know of the discussions between yourself and Mr. Broadnax on the subject-matter of this invention, and your requests to him to apply for a patent?

A. I don't know further than that the policy of the company was to get patents for all inventions as fast as could be done consistently, and that I was instructed to carry out that policy. As to how much of the details of the different patents the different members of the board or any of them knew, I cannot at this length of time state.

R. X Q. 3224. Did any members of the board know of Mr. Broadnax's delay in the matter?

A. I do not remember.

R. X Q. 3225. What were Mr. Broadnax's habits so far as you knew with reference to promptness and diligence in attending to the affairs of the company?

A. I do not think we ever made any complaint of Mr. Broadnax in regard to promptness and diligence.

R. X Q. 3226. The latter part of your 3015th answer might create the impression that after April, 1879, and before the application was in fact drawn up, Mr. Sawyer refused to sign an application for a patent on the invention in controversy, such is not the fact, however, as I understand?

A. I intended to be so understood. Mr. Sawyer refused to sign any and all applications for joint inventions of Sawyer and Man. I do not mean to be understood that an application for this particular invention was presented to Mr. Sawyer on behalf of the Electro-Dynamic Light Co. after he refused to sign all and every application for the joint inventions of Sawyer and Man, until the application was prepared which resulted in the patent in suit, which he did sign.

1618 R. X Q. 3227. Was an application for a patent in the invention in controversy ever presented to Mr. Sawyer with a request that he execute the same until the application which resulted in the patent in suit was presented to him?

A. Yes, I think so.

R. X Q. 3228. When?

A. In the fall of 1878, or early in January, 1879.

R. X Q. 3229. By whom?

A. I think the papers were prepared by Mr. Broadnax, and sent or given to Mr. Sawyer to modify and execute them.

R. X Q. 3230. And Sawyer refused?

A. Sawyer did not do it.

R. X Q. 3231. What reason did he give?

A. I have reference to the papers that I have before referred to in regard to this matter which were sent to Mr. Sawyer or given to him by Mr. Broadnax for correction and amendment. I do not remember talking with Mr. Sawyer about the matter until some time in February or March, 1879, after these papers were given to him. At that time I went over with Mr. Sawyer the unpatented inventions of Sawyer and Man, among others this subject-matter, with a view to get him to sign applications for patents for all of them. He refused to do so, but more subsequently consented to sign certain applications and assignments and refused to execute any others. The reasons he gave were, as he claimed, that the company was not treating him fairly, and that he was going to sever his connection from the company, and if he could not continue as superintendent that he would do all he could to injure the company, in substance, or at least that he would not do anything to help the company that he was not compelled to.

Adjourned till Wednesday, the 20th inst., at 10½ a. m.

1619 WEDNESDAY, *June 20th*, 1888.

Met pursuant to adjournment.

Present: Counsel as before, and the examination of Mr. MAN was continued as follows:

R. X Q. 3232. Do you feel quite positive that an application covering the invention of the patent in suit was prepared by Mr. Broadnax, and sent or brought to Mr. Sawyer for execution?

A. Yes, for examination, correction and execution.

R. X Q. 3233. Have you seen the application that was sent him?

A. I think the papers were shown to me by Mr. Broadnax before they went to Mr. Sawyer.

R. X Q. 3234. Were you satisfied with the application as prepared and sent?

A. I do not remember enough about it to state.

R. X Q. 3235. Was the execution in the form for execution and filing?

A. I am not certain.

R. X Q. 3236. Had you signed it?

A. No, sir, I don't think I had, or at least I do not remember that I had, but I may have done so.

R. X Q. 3237. How do you know such a paper or application was sent or given to Mr. Sawyer for correction and execution?

A. I only know of it as one of the things that I was trying to get done and to get Mr. Sawyer to do, and by another fact as follows: Some little time, a few days as my recollection goes, after the shop at 94 Walker street was closed, and while Mr. Sawyer had an office at the corner of the alley on Walker street, between Elm and Broadway, Mr. Broadnax at my request went there to see Mr. Sawyer and get him to execute some applications for patents, among others, one for this invention. He came
1620 from Mr. Sawyer's place directly to my office, No. 3 Mercer
street, and reported to me that Mr. Sawyer refused to execute any paper. The same day, or the next day, I went to see Mr. Sawyer and tried to induce him to execute the papers that Mr. Broadnax had prepared, and he would not. I feel confident that among these papers was an application for a patent for this invention, and that Mr. Broadnax either took it to him there then, or that Mr. Sawyer had it there then, and the best of my recollection is, that it was another and renewed application than the one or ones previously sent to Mr. Sawyer; but my recollection is not sufficient to swear positively to it. But in confirmation of the matter I remember talking with Mr. Sawyer about this invention when I went to see him after Mr. Broadnax called on him.

R. X Q. 3238. Did Mr. Broadnax tell you he had prepared and sent an application for a patent on this invention to Mr. Sawyer in the fall of 1878, or in January, 1879, for correction and execution?

A. I can't undertake to remember the conversation between Mr. Broadnax and myself at this length of time in detail. Whether Mr. Broadnax told me so, whether I derived the information from Mr. Sawyer or from myself handing him the papers, I cannot say.

R. X Q. 3239. Did you bring him the application to sign?

A. I don't know.

R. X Q. 3240. Did he ever tell you he had received such an application?

A. He talked with me about the application and its contents, and about Mr. Broadnax's opinion in regard to patentability.

R. X Q. 3241. Did you ever ask him whether he had received such an application?

A. I don't remember.

R. X Q. 3242. Did he ever show you any application?

A. As I have said, or intended to say, my best recollections
1621 of the matter are, that Mr. Sawyer and I looked over the papers together, but whether we did or not, I cannot be certain, or whether we simply talked about and discussed them as a matter known to both of us.

R. X Q. 3243. Have you any distinct recollection of seeing an application for a patent on this invention in Mr. Sawyer's possession?

A. As I have said before, I think and believe that I did, but as remembering a distinct paper in regard to the subject-matter which I saw in Mr. Sawyer's possession, I cannot say that I distinctly and positively remember it, but only that I distinctly and positively recollect the preparation of such papers for Mr. Sawyer's revision and execution, and recollect talking with him about them after the papers were prepared and he had them.

R. X Q. 3244. If it be the fact that an application for a patent on the invention in controversy was prepared and sent to Mr. Sawyer for execution, in the fall of 1878, or in January, 1879, as you think and believe, can you tell me whether the company was informed of such fact?

A. I, as president of the company and chairman of its executive committee, was informed of the fact, which is, I suppose, information to the company.

R. X Q. 3245. Who were the others on the executive committee?

A. I think Mr. Sawyer was one; I do not recollect who the other was, but my impression is that Mr. Lawrence Myers was the other; I should think so, but I can't recollect.

R. X Q. 3246. Who, on the board, if any one, was informed that such application had been prepared and sent to Mr. Sawyer?

A. I don't know other than I have stated.

R. X Q. 3247. Do you remember whether you discussed the specific application with Mr. Sawyer, and whether he refused to sign it?

1622 A. Yes, I remember discussing the application with Mr. Sawyer and Mr. Broadnax's ideas in regard to patentability, and I also remember discussing the subject-matter with him before the first memorandum was sent to Mr. Broadnax in October, 1878, and afterwards from that time forward until in January, 1879, at several times, and again I remember trying to get him to complete and execute the application for a patent for this invention shortly before we left 94 Walker street, when he positively refused to do so. And again, after Mr. Broadnax visited him at his office, at the corner of the lane or alleyway and Walker street, when he positively refused to execute any application. I remember subsequent conversations with him on the subject at different times, up to and shortly before the application was made, which resulted in the patent at which he refused to unite with me in any applications for patents for the benefit of the company.

R. X Q. 3248. In your interviews with Mr. Sawyer over this specific application sent to him for execution between October, 1878, and January, 1879, is it your recollection that he refused to sign the application, or objected to its claims and statements?

A. It is my recollection that he simply neglected the matter, and that I urged him to go on and complete it; not that he objected to anything that Mr. Broadnax had done, or any claim that Mr. Broadnax had prepared.

R X Q. 3249. What was it Mr. Sawyer neglected; to sign the application or to criticise and correct it?

A. To revise and sign it.

R. X Q. 3250. Did he ever express himself to you as satisfied or dissatisfied with its statement and claims?

A. Well, I don't recollect in those exact terms; I remember his stating, in substance, that he could better or improve the statement or claims, or both, and I remember his discussing with me whether an application simply covering the loop or arch form of the
1623 conductor, cut or made to shape and size before carbonization,
would not be sufficient without any reference to the character of the carbons, as to which Mr. Broadnax had expressed his doubts as to patentability.

R. X Q. 3251. Was any other application covering the invention of the patent in suit prepared than the one which you think was sent to Mr. Sawyer for correction and execution between October, 1878, and January, 1879, until the application which was filed was prepared?

A. I have said that I think Mr. Broadnax prepared a new application which he presented to Mr. Sawyer for execution, when he called upon him at his office, at the corner of Walker street and the alley. Of this I am not positive, but it is the best of my recollection.

R. X Q. 3252. When was this?

A. Just after the shops at the corner of Walker and Elm streets were closed, I should say in the month of April, 1879.

R. X Q. 3253. Why was this second application prepared?

A. In order to get Mr. Sawyer to execute it.

R. X Q. 3254. Was not the first application satisfactory to him or you?

A. I don't know; it was not executed and Mr. Broadnax had several conferences with Mr. Sawyer about the matter before the time of preparing and presenting this last application in the fall of 1878, and early in 1879.

R. X Q. 3255. Can you give me no reason why this second application was prepared?

A. I can't recollect the details in regard to it. I assume that it was in order to get Mr. Sawyer to immediately execute and not delay, and perhaps to conform to what Mr. Sawyer's ideas and mine in regard to what the application should be, or what it should contain.

All after first sentence objected to as irresponsive.

1624 A. I know it was done to conform to my desire and request to bring the matter to a close.

R. X Q. 3256. How did the second application differ from the first?

A. I don't know that it differed at all, and I don't know but it did.

R. X Q. 3257. How do you know Sawyer ever received the second application?

A. From Mr. Broadnax telling me that he presented it to him, and Mr. Sawyer's admission to me that he had done so when I went to see him about it.

R. X Q. 3258. Did you ever execute this second application?

A. I do not remember whether I did or not.

R. X Q. 3259. Did you ever ask Sawyer to execute it?

A. Yes.

R. X Q. 3260. Was any one present?

A. Part of the time during the conference between him and me some one else was present. I think either Mr. Church or Mr. George Sawyer, and part of the time Mr. Sawyer and I were alone at my request.

R. X Q. 3261. Did Mr. Sawyer refuse to sign this second application, or object to its claims and statements?

A. He refused to sign any and all applications including the one for this invention.

R. X Q. 3262. Did he object to the statement or claims of this second application?

A. No; he simply objected to it because it was for the benefit of the Electro Dynamic Light Co.

R. X Q. 3263. What were the other applications which he objected to sign at this time?

A. I can't recollect what they were; there were several of them.

R. X Q. 3264. Mention those you do recollect.

1625 A. I don't recollect any of them to specify them without going through and looking up; I could not tell what they were.

R. X Q. 3265. What would you have to go through and look up?

A. The things that Sawyer and I had done together, which were not patented, and I do not know that I could now sufficiently refresh my recollection to tell what any of them were. I know that included among the papers which Mr. Broadnax then took to him were several assignments and several applications.

R. X Q. 3266. Do you remember whether any of the applications were ever executed and filed?

A. I don't know whether any of them were ever executed, but I cannot be certain.

R. X Q. 3267. Were any of the assignments executed?

A. Yes, I think some of the assignments or others for the same invention were subsequently executed by Mr. Sawyer.

R. X Q. 3268. Did you inform the company of Mr. Sawyer's refusal?

A. Yes, they all knew it, that is, his refusal to execute any papers for the benefit of the company.

R. X Q. 3269. Did they know of his refusal to execute this and other applications for patents?

A. I think so.

R. X Q. 3270. How were they informed of it, and who were informed.

A. I informed the board at a board meeting.

R. X Q. 3271. Did you explain to the board the several inventions which he had refused to sign applications for?

A. I don't know; I related to the board what had taken place between Mr. Broadnax and Mr. Sawyer, and between Mr. Sawyer and me in a general manner.

R. X Q. 3272. Who was present at the board meeting?

A. I cannot recollect.

R. X Q. 3273. Mention such as you do recollect.

1626 R. X Q. 3274. Who were the directors of the company at this time?

A. I do not recollect, I can recollect some of them.

R. X Q. 3275. Name those you do recollect.

A. Jacob Hays, Lawrence Myers, Wm. H. Hays, I think Mr. Hugh McCulloch, I think Mr. H. L. Judd. I was a director or trustee.

R. X Q. 3276. Which of these gentlemen were present?

A. I cannot recollect.

R. X Q. 3277. What action did the board take when you informed them of Mr. Sawyer's refusal?

A. If my recollection serves me they sent for Mr. Sawyer.

R. X Q. 3278. Did he come?

A. Either then or at a subsequent meeting he did.

R. X Q. 3279. Did you inform the board of your estimate of the value of the property for which application had been prepared, and which Mr. Sawyer refused to execute?

A. I do not remember.

R. X Q. 3280. Did the board or the company take any action to induce or compel Mr. Sawyer to sign the applications?

A. I have said they sent for Mr. Sawyer, and that at that or a subsequent meeting he was present for the purpose of inducing him to perform his agreements with the company and execute necessary and proper papers.

R. X Q. 3281. Were you present at the meeting referred to?

A. I was.

R. X Q. 3282. Who else was there?

A. I do not remember, a quorum of the board.

R. X Q. 3283. Mention whom you remember other than Mr. Sawyer and yourself.

A. I cannot remember to particularize.

R. X Q. 3284. What took place at this meeting?

A. Generally Mr. Sawyer refused to go on with the 1627 company, and said he would make a proposition to the company.

R. X Q. 3285. Did he refuse to execute the application?

A. He refused to do anything with the company other than to say that he would make a proposition to them.

R. X. Q. 3286. Was there such a discussion, or did you make such explanation as that the board were aware that he refused to execute applications for patents on inventions which the counsel for the company had prepared, and which inventions were the property of the company?

A. I think the board so understood it.

Adjourned till Friday the 22d inst., at 11 a. m.

1628 FRIDAY, *June* 22, 1888.

Met.

Present: Counsel as before, and the examination of Mr. MAN continued as follows:

R. X Q. 3288. What efforts, if any, were subsequently made by yourself or the company to induce Mr. Sawyer to sign the second application?

A. I cannot remember details. I can only say generally that I urged Mr. Sawyer a great many times from this time forward till the application was made which resulted in the patent, to unite with me in an effort to obtain a patent for the invention, and that Mr. Broadnax, counsel for the company, was directed and requested to apply to him to have the thing done, and I believe did so.

R. X Q. 3289. Did the company as a company do anything?

A. I don't remember further than my own action. The company acted through me.

R. X Q. 3290. At about what time was this second application given to Mr. Sawyer to execute?

A. You speak of it as a second application. I think it was, but do not wish to swear to the identity of papers. I have stated that my best recollection was that it was shortly after our leaving 94 Walker street and in the month of April, 1879, but I cannot undertake, after so long a period, to be positively definite as to them. It may have been a little earlier or a little later. I think the expression "spring of 1879," would positively cover the time.

R. X Q. 3291. What is your best recollection of when the meeting was held at which Mr. Sawyer was present?

A. I can only fix it as soon after Mr. Sawyer's refusal to execute any papers in the spring of 1879.

R. X Q. 3292. Did Mr. Sawyer persist in his refusal from the time of the meeting till January, 1880, when the application for the patent was filed?

1629 A. At different times after this and prior to the making of the application which was filed Mr. Sawyer promised me that he would execute an application for this invention, but sent to or applied to personally by Mr. Broadnax, neglected or refused or postponed doing anything about it, and did not so far as I know except to talk to me. In his talks with me he sometimes refused, sometimes postponed the matter, and sometimes promised me he would attend to it.

R. X Q. 3293. And does this represent his attitude from the time of the meeting till January, 1880?

A. No, not wholly. From some time in September, 1879, up to the making of the application which was filed, he was actively hostile to the Electro-Dynamic Light Co.

R. X Q. 3294. Now from the time of the board meeting, at which Sawyer was present, until September, did you inform the board of your and Mr. Broadnax's efforts to get Mr. Sawyer to sign this application, and of your inability to do so?

A. I do not remember.

R. X Q. 3295. Did the board consult counsel as to whether they could compel Mr. Sawyer to sign the application, or whether they could file it without his signature?

A. I do not remember.

R. X Q. 3296. Did the board do anything to protect their rights so far as you know?

A. I do not remember what they did about it further than my own efforts in charge of the matter of the company.

R. X Q. 3297. Did you inform them of your efforts and their failure?

A. I presume so, I don't remember in regard to it.

R. X Q. 3298. You say from September on he was actively hostile to the company. Did he peremptorily and positively refuse after September to execute the application?

A. He peremptorily and positively refused to do anything
1630 with the company, or for its benefit, unless the company
would grant to him a license for the use of all the inventions, which the company refused to do.

R. X Q. 3298. Did this refusal include the refusal to execute this application?

A. The refusal included every invention.

R. X Q. 3300. Do you mean to answer "yes" to my question?

A. In that way, yes.

R. X Q. 3301. Do you remember whether he was asked to sign this application after September?

A. I do not remember as a specific thing, until some short time before the application was filed.

R. X Q. 3302. Were the company aware of his refusal to do anything?

A. I think they were.

R. X Q. 3303. Did the company take any steps to secure their rights in this matter after September?

A. Yes.

R. X Q. 3304. What did they do?

A. They counseled with Mr. Broadnax in regard to the matter, as to what their rights were in a general manner, and what was best to be done under the circumstances.

R. X Q. 3305. Did he advise the company?

A. I do not remember what his advice was.

R. X Q. 3306. Between October, 1878, and January, 1880, Sawyer did at different times execute applications and assignments to the company, did he not?

A. Yes.

R. X Q. 3307. It appears from the exhibits in the case printed in the interference record, that numerous assignments were executed by Mr. Sawyer transferring property to the Electro-Dynamic Light Co. from October, 1878, to August, 1879; what explanation have you to offer for his executing these papers, and not executing the application to which you have referred?

A. I think I have already explained that fully.

1631 R. X Q. 3308. Perhaps so, but please do so again.

A. I have explained the delays in getting Mr. Sawyer to sign an application for this patent up to the time of the breaking up of the shop at 94 Walker street, that from some time before breaking up the shop the company was dissatisfied with Mr. Sawyer and his management as superintendent which Mr. Sawyer knew, and that Mr. Sawyer was averse to making applications during that time, and delayed and put them off, and that after Mr. Sawyer's discharge, as superintendent, and the breaking up of the shop, he only signed applications and assignments by special agreement or arrangement with him in each particular case by which he thought he was obtaining some personal advantage, or under which he was unable to get money or dispose of stock of the company which he held

R. X Q. 3309. On December 9, 1878, Sawyer joined in an assignment to the company of several applications for patents on his sole inventions. What special consideration or inducement was given him for this?

A. I did not state that there was any. It was done under his general agreement.

R. X Q. 3310. On December 9, 1878, Sawyer joined in an assignment to the company of certain joint applications signed by Sawyer and Man. Was any special consideration given him for this?

A. I have not stated that there was any special inducement for any of the assignments or applications made by him until his discharge as superindendent.

R. X Q. 3311. On July 30th, 1879, Sawyer executed an assignment to the company upon application for an electric lamp filed April 3d, 1879. What special inducement was offered or given him for this?

A. I cannot remember the details of the arrangements by which he was induced, from time to time, to sign applications or assignments after his discharge as superintendent. I can only say generally that at the time the arrangement was made with 1632 the Messrs. Wallace, under which Sawyer received a large consideration in money and otherwise, he agreed in substance to execute such papers, assignments and applications as the counsel to the company advised were necessary and proper, part of which he performed, as in the execution of the papers to which you refer, but frequently after repeated attempts to get him to do so, and by pushing him to perform what he had agreed and sometimes he was only induced to do so by finding for him purchasers of the stock of the company which he held, or by making loans to him. I cannot remember the details of the inducements to him in any particular case.

R. X Q. 3312. You do not remember then what, if any, special inducement or consideration, was given to him for the execution of the paper referred to?

A. No.

R. X Q. 3313. On the 3d of February, 1879, Sawyer and Man executed the assignment of a number of patents to the company; was any special inducement given to him for the execution of this paper?

A. I have already stated that I do not know of any special inducement to him to sign papers other than his general agreement prior to his discharge as superintendent.

R. X Q. 3314. On May 21st, 1879, Sawyer executed a general release in favor of yourself and others. What special inducement or consideration was given him for this?

A. I answer as before that I cannot recollect the inducement in any particular case. I remember it was given in connection with the arrangements made with the Messrs. Wallace.

R. X Q. 3315. On July 30, 1879, Sawyer executed an assignment of an application for a sole invention of his in electric lamps. What special consideration or inducement was offered him for this?

1633 A. I answer as before, that I do not remember the special inducement in any particular case.

R. X Q. 3316. Was Sawyer ever offered any special inducement or consideration to sign the applications which was prepared by Mr. Broadnax covering the patent in suit?

A. I don't remember.

R. X Q. 3317. Who conducted the interviews or negotiations with Mr. Sawyer with reference to the executions of these applications and assignments?

A. I some; Mr. Broadnax some; I think Mr. Jacob Hays some; I have reference to the papers made after his discharge as superintendent.

R. X Q. 3318. What explanation have you to offer for the sending of Mr. Sawyer to Ansonia by the company after his neglect or refusal to sign an application for a patent on an invention belonging to the company?

A. I do not think it needs explanation, and I do not desire to make any. Do you desire one?

R. X Q. 3319. I would not have asked the question if I had not.

A. I don't desire to make any explanation.

R. X Q. 3320. When the application for the patent in suit was filed, was either Mr. Cheever or Mr. Baldwin informed that a prior application had been prepared?

A. I don't remember.

R. X Q. 3321. You never told them?

A. I don't remember whether I did or not.

R. X Q. 3322. If the subject of this invention had been one of so much discussion between yourself and Mr. Broadnax, would it not have been a very natural thing to have done?

A. I don't know.

R. X Q. 3323. From the record in the interference between Weston and Sawyer-Man it appears that the minute book of the Electro-Dynamic Light Co. was in your possession on December 13, 1882; was it then in your possession?

1634 A. No, I think not, further than it was handed to me to refer to extracts from the minutes copied on pages 69 and 70 of the interference (printed) record of Edward Weston against Sawyer and Man.

R. X Q. 3324. Where was that testimony given?

A. If I recollect rightly, at my office, No. 3 Mercer street.

R. X Q. 3325. What is your recollection as to the custody of the book; was it in your possession, or was it brought there?

A. It is my recollection that it was brought there by Mr. Broadnax.

R. X Q. 3326. Did he leave it there or take it away?

A. I have no recollection.

R. X Q. 3327. Did you ever see the minute book after the occasion referred to?

A. I don't recollect.

R. X Q. 3328. Did you ever try to find it?

A. Yes.

R. X Q. 3329. Did you find it?

A. No, I do not think I did, but perhaps I did. I recollect trying to find it and not being able to do so. I mean that I don't know, but that after I saw it at my office I saw it again, and I don't know that I did, but at a subsequent period I searched thoroughly for it and could not find it.

R. X Q. 3330. The extracts from the minutes of May 20 speaks of "a royalty of three dollars a lamp for such lamps as they should put up." Does this refresh your recollection as to whether the royalty was to be three dollars a lamp whether such lamps were original or renewal lamps, or whether the royalty was to be paid on original lamps, and that renewals were not to be subject to royalty?

A. No, because at the same meeting as appears by the extract from the minutes, a committee was appointed to draw up 1635 the details and prepare the license. In regard to this whole matter permit me to say that it is my impression that the royalty was applicable only to the lamps as first put up, and not to renewal lamps, but in the absence of the agreement or license I do not wish to be understood as swearing positively that such was the fact.

R. X Q. 3331. From the minutes of Nov. 25th it would seem that an agreement had been made with Mr. Wallace, and that the company was directed to execute it. Was a written agreement ever made?

A. I think so, but I don't know where it is. It was cancelled afterwards.

R. X Q. 3332. Do you remember how the business was to be done under this agreement?

A. The Messrs. Wallace were to manufacture and sell under all the patents of the company and the inventions belonging to the company, all the different apparatus, and were to pay for their exclusive license to do so a royalty of three dollars per lamp as compensation for the use of all the inventions; and my impression is, but I cannot swear positively to the fact, that the royalty was limited to the lamps as first set up or installed, and not to renewal lamps or plants which they had previously set up and supplied with lamps. They were to sell to the public and make reports to the Electro-Dynamic Light Co.

Adjourned till Monday the 25th inst., at 11 a. m.

1636 NEW YORK, *June 25th*, 1888.

Met pursuant to adjournment.

Present: Counsel as before, and the examination of Mr. MAN was continued as follows:

R. X Q. 3333. Referring to your 3018th answer wherein you say—

"We (Sawyer and I) always cautioned our workmen not to say anything about what we were doing"

which of your workmen knew of this invention at the time to which you refer and was so cautioned by you?

A. We cautioned Mr. Wm. Sawyer, Mr. George Sawyer and Mr. E. L. Myers, and the others from time to time.

R. X Q. 3334. Please mention the names of the others to whom you refer.

A. There was a Mr. Keating and Mr. Sharp and the people who did work for us outside. Mr. Judd's folks, Mr. Lothrop and Mr. Edsall who knew most about our work in Judd's shops. I do not remember the names of others and I do not mean to say that all those I have named knew of this invention, though they may have done so, except Mr. Keating.

R. X Q. 3335. Who of Judd's folks do you think knew of it?

A. Edsall and Lothrop, if they did know about it, and Mr. H. L. Judd himself, possibly.

R. X Q. 3336. Are Edsall and Lothrop with Judd now?

A. I think they are, I don't know.

R. X Q. 3337. What were they employed as?

A. Foreman and superintendent.

R. X Q. 3338. At his factory in Brooklyn?

A. Yes, in State street, Brooklyn.

1637 R. X Q. 3339. Do you remember their first names?

A. I think Mr. Edsall's name was William; I do not remember Mr. Lothrop's.

R. X Q. 3340. In the answer above referred to you say: "We did explain the matter to our friends and some of the stockholders of the Electro Dynamic Light Co." Mention the friends to whom you explained it.

A. I cannot, except as to some few.

R. X Q. 3341. Mention the few.

A. I explained many of our matters to Mr. Wm. Halley and to Mr. James M. Jackson who were in the office with me at No. 3 Mercer street. I frequently explained matters to different members of the board of trustees of the Electro Dynamic Light Co. I remember explaining it to Mr. E. D. Griswold, a neighbor of mine, and to Mr. Allen, who was in the same office with Mr. Griswold; I remember explaining it to a neighbor, Mr. Rowe, of Brooklyn. Edward Rowe.

R. X Q. 3342. Was this all before the application was filed?

A. Yes, I think so; all of it.

R. X Q. 3343. Do you mean to be understood by 3339 answer that the matter of the invention in controversy was explained to the gentlemen you there mentioned?

A. Yes, or some of them.

R. X Q. 3344. Which of them?

A. I think it probable that it was explained to all of them, but I cannot be certain at this length of time. I explained our inventions generally to them, and therefore think this matter was included. It would be proper to say that I omitted Mr. Broadnax, counsel for the company, to whom very full explanations were give both by myself and Mr. Sawyer.

1638 R. X Q. 3345. Were Mr. Alley and Mr. Jackson in your employ?

A. They were my assistants in the Lorillard office.

R. X Q. 3346. What was Mr. Griswold's business?

A. He is a manufacturer of cotton goods in Massachusetts. He lives in Brooklyn.

R. X Q. 3347. What is Mr. Rowe's business?

A. I don't know that he has any business now. He was engaged in the straw-hat business, an importer.

R. X Q. 3348. To what stockholders of the Electro Dynamic Light Company was the matter explained?

A. I don't know; I should think to nearly all of them that I met. They frequently talked to me about our inventions.

R. X Q. 3349. If you were desirous of keeping the matter secret why did you explain it to the gentlemen named, if in fact you did do so?

A. I cannot remember the reasons. It was done in confidence with them.

Adjourned till Thursday the 28th inst., at 11 a. m.

1639 Met pursuant to adjournment.

Present: Counsel for complainant, and witness and counsel for defendant not appearing, adjourned to Monday, July 2, 1888, at 1 o'clock p. m.

JULY 2, 1888.

Met pursuant to adjournment, and counsel for defendant not appearing, adjourned to July 3, 1888, at 1 o'clock p. m.

NEW YORK, *July* 3, 1888.

Met pursuant to adjournment.

Present: Counsel as before, and the examination of Mr. MAN continued as follows:

R. X Q. 3348. If, as you say, applications covering the inventions in controversy were prepared and the subject of their preparation and execution was a matter of the extent of discussion your testimony would indicate, what explanation have you to make of the fact that in the interference between Sawyer-Man and Edison no reference was made or testimony produced as to these several things?

Objected to as immaterial and for the further reason as not cross-examination, as there was no question of laches raised or inquired into or even alleged.

A. I do not know that the matter needs explanation. So far as counsel and others are concerned, I am not in position to make explanation for them. So far as I myself am concerned, if my testimony in the interference does not refer to this subject-matter, it was because my attention was not called to it, and I was not questioned in regard to it that I recollect.

R. X Q. 3349. Do you remember in whose possession you last saw the memoranda in relation to this application or the application themselves?

A. In Broadnax, the counsel's hands, or Mr. Sawyer, I do not recollect which.

1640 R. X Q. 3350. You speak of selling some of the machinery which at one time belonged to the Electric Dynamic Light Co. Do you remember to whom you sold it?

A. I sold a lathe, lathe tools and other tools to a Mr. Bigbee in Brooklyn. I sold a lot of stop-cocks and chemical apparatus, retorts, receivers and I don't know what, all to a dealer in such things. I don't know what his name was. He came to the place in Pacific street, where they were, and selected them out. I sold several parcels to different old-material men. I don't know their names. I sold some gearing and counter-shafts to a machinery man in Centre street. I don't recollect who else I sold to at different times, and I don't recollect the names of any of the parties except Mr. Bigbee.

R. X Q. 3351. You have mentioned the names of several gentlemen to whom you believed you explained, or who were informed in other ways of the making of the invention in controversy prior to the application. Why were they not called in the interference?

A. I don't know. I suppose because their testimony was not necessary or not thought to be so by counsel managing the case.

R. X Q. 3352. Did the Eastern Electric Manufacturing Company ever have a bank account?

A. I don't know.

R. X Q. 3353. Do you know where the books of the Eastern Electric Light Co. are, or any of them?

A. No.

Recross-examination closed.

1641 Questions by Mr. BROADNAX, complainant's counsel:

R. R. D. Q. 3354. In answer to recross 3318, and also in answer to question 3319, you stated that you did not desire to make any explanation of the sending of Mr. Sawyer to Ansonia by the Electro-Dynamic Light Co. after his neglect or refusal to sign an application for a patent on an invention belonging to the company. Please to state what your recollection is of the reason why Mr. Sawyer was sent to Ansonia after such a refusal or neglect to sign such application.

A. As I stated before, I do not desire to go into that matter, because I do not consider it necessary to the case; I have nothing to conceal in regard to it. Do you consider it necessary that I should make answer. If you do, I will do so.

R. R. D. Q. 3355. Of course I want an answer, or an explanation, if there be one?

A. I have already testified that the company had refused to go on with Mr. Sawyer as superintendent of its workshops, and that Mr. Sawyer insisted upon it that he should be such superintendent or the work should not go on. Things had come to such a pass that there was violent antagonism between the company and Mr. Sawyer; on his part, at least. There was nobody but myself and in part, Mr. E. L. Myers, a very young man and inexperienced in manufacturing, who knew about the work of the company; I could not give my attention to it, and the only remedy against Mr. Sawyer, on the part of the company, would be litigation, which was advised against by the counsel for the company. Under these circumstances a concession was made on the part of the company to Mr. Sawyer, and the Messrs. Wallace were brought in to do the manufacturing, in order that the manufacturing might go 1642 on, and Mr. Sawyer was paid to give advice and instruction at Mr. Wallace's place in Ansonia, but not as superintendent of the manufacture.

R. R. D. Q. 3356. Do you mean by your last answer that Mr. Sawyer was sent to Ansonia at that time for the purpose of conciliating him and to get him to remain sober and work diligently in harmony with the company's interests?

Objected to as leading and calling for a conclusion.

A. I mean that the arrangement was made to conciliate Mr. Sawyer and it was only entered into on his promise and agreement with the company to remain sober, and behave himself in other respects and work diligently and in all ways to promote the interests of the company.

R. R. D. Q. 3357. State whether or not Mr. Sawyer carried out the agreement referred to in your last answer?

A. He did not, as I have stated in testimony before.

1643 Questions by defendant's counsel, Mr. Tomlinson:

R. D. X Q. 3358. When this agreement was made was Sawyer conciliated and friendly?

A. For a little and until the matter was closed, and until he got the money and other considerations going to him under the agreement.

R. D. X Q. 3359. While in this mood was he asked to sign the application?

A. I don't know.

R. R. X Q. 3360. What was the necessity for conciliating Mr. Sawyer?

A. I have already stated that; to avoid litigation and prevent antagonism on his part, and to get him to work for the company's interests.

R. R. X Q. 3361. Why, when he was conciliated, was he not requested to sign this application?

A. I think he was. I do not know. I think he was by the counsel for the company, Mr. Broadnax, and I, myself, personally urged him to go on and complete the applications for patents for the unpatented inventions of himself and me together, including this, not specifically, but generally.

R. R. X Q. 3362. Did he refuse when Mr. Broadnax made the request?

A. I only know from the report sent to me and made to me by Mr. Broadnax that he did not do it, and Mr. Broadnax could not get him to do it.

R. R X Q. 3363. Was this the first indication that you had of Sawyer's unfriendliness after being conciliated by the agreement?

A. I don't remember. I do not mean to be understood in my answer before this that Mr. Sawyer did not sign any applications or papers after this, but that such was the complaint made to
1644 me by Mr. Broadnax, coupled with a request that I should see Mr. Sawyer about the matter, which I did.

R. R. X Q. 3364. If the fact be that Mr. Sawyer was placated by the agreement temporarily, and signed papers, while so placated, in the company's interest, what is your explanation of this application not having been signed with the others?

A. Mr. Sawyer only signed a few of the papers that were sent to him, and not all, but neglected or postponed them and did not execute them, and sometimes refused absolutely, as I was informed by Mr. Broadnax. The matter of this invention was one that he did not execute at that time.

R. R. X Q. 3365. But why can you give me no explanation as to this specific application?

A. Not more than others.

R. R. X Q. 3366. But you give me no explanation as to the others.

What was the reason for not signing the others, whatever you mean by "others"?

A. Much of the time Mr. Sawyer was not in condition to do any business. Further, I believe that Mr. Sawyer was actuated by a motive to retain a hold upon the company by not executing the papers which were sent to him and which he was requested to execute, in the hope that he could get further consideration for doing so, either by being retained in the payment of the company, or by getting further consideration for everything that he did for the company.

R. R. X Q. 3367. I do not understand from your answers the cause of the neglect or refusal of Sawyer to sign an application for this invention while he was conciliated by this agreement, nor do I understand whether you mean to say whether he was requested to do so. The exhibits in this case show that all the patents of Sawyer and Man were assigned by him to the company, that he assigned one or two patents and applications on his separate inventions and executed a general release to you and to the com-
1645 pany. When I ask you for an explanation of his not sign-
ing an application for this invention, you refer in general terms to his neglect or refusal to sign papers but do not give me any explanation why this specific paper was not signed?

A. Not as distinguished from the others.

ALBON MAN.

Sworn to before me this 12th day of July, A. D. 1888.

WM. T. FARNHAM,
Notary Public, County and State of New York.

Complainant's counsel here gives notice to defendant's counsel that he now closes his affirmative proofs in this case, but it is agreed between counsel, that if any merely formal matter has been inadvertently omitted which may be necessary or proper to complete the matter of the foregoing deposition, such as the filling in of dates, marking exhibits or offering as exhibits matters or papers which have been referred to, and the like, either party may put in such formal matters; and it is further agreed that no objection shall be taken to any of the proofs heretofore put in by complainant in this cause, upon the ground that it was not put in within the time limited by the rules of the court; nor shall any objection be taken to any such proofs upon the ground that it was not put in and certified to by one of the standing examiners of the court, but the whole of the foregoing deposition may be sworn to and certified before William T. Farnham, the notary public, by whom the deposition was actually taken, and such deposition and proof accompanying and making part of the same shall stand in the case the same to all intents and purposes, and have the same force and effect as if they had been taken before, sworn by and certified to by
1646 Timothy Griffiths, Esq., who was originally selected as the
examiner, before whom such proofs were to be taken.

Witnesses:—
John C. Tomlison, for defendant.
Broadnax & Bull, for complainant.
July 12th, 1888.

Q. 3368. I place in your hands a paper. Please to examine it and state what it is?

A. It is a paper belonging to the Electro-Dynamic Light Co., dated January 9th, 1880, signed by Charles A. Cheever, witnessed by W. K. Applebaugh and W. D. Baldwin, and is an agreement made by and between the Electro-Dynamic Light Co. and Charles A. Cheever, of the city of New York.

Q. 3369. Is this the same agreement referred to in your New York deposition relating to the provisional sale of the invention of the patent in suit, or a part thereof, to Charles A. Cheever?

A. It is.

Q. 3370. This is the original agreement, as I understand you, entered into by Mr. Cheever with the Electro-Dynamic Light Co.?

A. It is. I desire to state in this connection that from about 1881 or 1882, or prior thereto, I have not seen or had access to this paper until within the last few days, or at least have not seen it or been able to do so, although I inquired for it.

Paper offered in evidence and marked "Complainant's Exhibit Cheever agreement March 27, 1889."

1647 Q. 3371. What, if any, explanation do you wish to make of the paper which you have examined and identified as the agreement between the Electro-Dynamic Light Co. and Charles A. Cheever?

A. In the New York case in answer to cross-question 318, at page 407 of my printed testimony, the following question was asked me:

"What is your recollection as to whether under the arrangement with Mr. Cheever, the Electro-Dynamic Light Co. was to have the use of the invention?"

My answer was:

"My recollection of the matter is that the Electro-Dynamic Light Co. were to have the right to use the invention or some part of it by an understanding with Mr. Cheever."

To the next cross-question, No. 318*b*, (*318b*), same page, I was asked:

"Was this expressed in the written agreement?"

To this question I answered:

"My impression is it was not. My recollection is not clear about it, though."

The production of the written agreement with Mr. Cheever refreshes my recollection upon this subject, and I now remember that it was the intention to sell to Mr. Cheever only the arched horseshoe or V-shaped incandescent conductor, of whatever carbon it might be made, and not the conductor or other forms which does not comprise the whole invention but excludes, or was intended to exclude, conductors of other shapes of whatever carbon they might be formed or made.

Q 3372. I place in your hands Defendant's Exhibit Baldwin-Wallace Letter, January 8, 1880. Please to refer to the last clause of that letter and explain what it means, as you understand it?

A. The purpose of this letter was to make it perfectly plain that the Electro-Dynamic Light Co. controlled the application for a patent made in its behalf by an attorney, the writer of the 1648 letter, selected by Mr. Cheever, and to make it clear that Mr. Cheever's interest had reference only to the arched or pointed form, V-shaped carbon conductor.

Q. 3373. Do you mean without reference to the kind of carbon of which the conductor might be made?

A. I do.

Q. 3374. What was your understanding as to the novelty of the illuminating conductor being made in the form of an arch or loop or V-shape at the time this agreement with Cheever was made, irrespective of the kinds of carbon of which that conductor might be made?

A. At that time we deemed this form of incandescent conductor novel and original with us, and believed that we were the first to make incandescing conductors for electric lamps of those forms.

Q. 3375. Do you mean carbon incandescing conductors?

A. I do, and not only carbon but all incandescing conductors of that form, I think, but certainly those made of carbon.

Q. 3376. And was it that form of carbon conductor that you negotiated, or that the Electro-Dynamic Light Co. negotiated to sell to Mr. Cheever?

A. It was conductors of those forms, as they are mentioned in the contract, and those forms only.

Q. 3377. Please to examine the paper now handed you, and state what it is?

A. It is a copy of the Scientific American, a paper published in New York, dated December 7, 1878, containing a printed article and illustrations headed, "The Sawyer-Man electric lamp."

Q. 3378. How recently have you read the article mentioned by you, published in that paper, called the "Sawyer-Man electric lamp"?

A. I have not read it very recently. I will read it now.

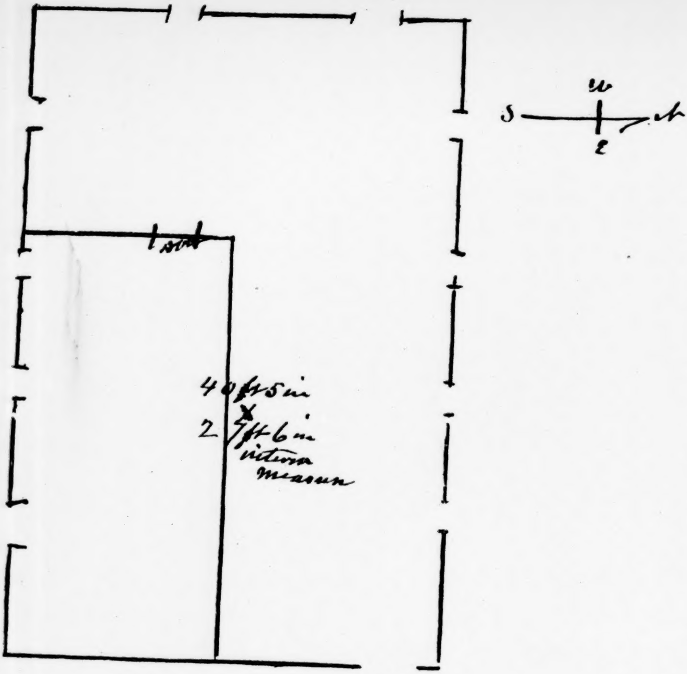
Adjourned till 2 p. m.

1649 Resumed after adjournment.

Witness continues:

I have now read the article referred to.

Q. 3379. State, if you please, whether you find any reference in that article to the making of the illuminating conductor of carbonized, fibrous or textile material?



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vs
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Complainants Exhibit
Main's diagram Centre
Street Shop March
27 1889
W. T.
S. E.

No. 286.
C. E. Light Co.
v.
McK. Light Co.
p. 1651

A. I see no reference in this article to the carbon conductor, as to how it was made or what it was made of.

Q. 3380. State, if you know, why there was no reference made in that article to the making of the illuminating conductor for your lamps, of carbonized, fibrous or textile material?

A. Because it had not been patented nor an application filed for it up to that time.

Q. 3381. Was it or not the purpose of yourself and Mr. Sawyer to keep all knowledge of that invention or discovery from the public before an application for a patent for it had been filed?

A. It was, not only in regard to this but also in regard to other things and other kinds of carbons, but we did disclose these things to a few people in confidence, and we could not keep it entirely from the knowledge of our workmen, or some of them.

Said Scientific American is offered in evidence (proof of publication being waived by defendant's counsel) and the same is marked "Complainant's Exhibit Scientific American Article, produced by Albon Man March 27, 1889. W. T. F., S. E."

Q. 3382. Have you recently measured the size of the rooms occupied by the Electro-Dynamic Light Co. as a shop on the corner of Walker and Elm streets?

A. I have.

Q. 3383. Please to give the several dimensions of those rooms, and please to make a diagram of them marking the dimensions on the diagram?

(Witness makes a diagram and hands it to Mr. Broadnax.)

1650 Q. 3384. Please to describe the diagram you have made, giving the dimensions marked on it?

(Here follows diagram marked p. 1651.)

A. The entrance was on Walker street, at the southwest corner of the building. The building stands on the northwest corner of Walker and Elm streets. A hall seven or eight feet wide, with a staircase, leads to the second story, extending back from Walker street, according to my measurement, seventeen feet six inches. From this hall in the second story a door led into the front room, on the corner of Walker and Elm streets. Another door opened from the hall into our engine-room. The front room, according to my measurement, was seventeen feet six inches deep on Elm street, and eighteen feet six inches wide on Walker street, with two windows on Walker street and one on Elm street. At the southwest corner of this room were two doors, together five feet wide, opening on a hatchway extending from the ground floor to the top of the building. At the northwest corner of this room a door opened into the back room, which, according to my measurement, was twenty-two feet six inches in length on Elm street, and about nineteen feet deep. Opening out of the back room and near to the door from the front room was an open space about three and a half

or four feet wide, leading into the engine-room, which is seven feet wide and about seventeen feet long. At the north end of the engine-room was a water-closet and sink. At the northwest corner of the building is a light-hole, a shaft about four feet square extending from the ground floor to the roof. There were two windows in the back room looking on Elm street, a brick partition wall between the back room and the engine-room, a brick partition wall between the engine-room and the hall, and a simple board, wooden partition between the hall and the front room and between the front and back room. The dimensions I have given are interior dimensions and are substantially accurate, but not positively so,
as I had to take them with a tape-line without assistance.
1652 The height of the rooms is about twelve feet to twelve feet
six inches. The height from the first floor to the roof in the light-hole at the northwest corner is about thirty-nine feet.

Q. 3385. These rooms of which you have made a diagram and given a description, as I understand you, occupied the whole of the second floor of the building?

A. The rooms and the hallway did, except the hoistway at the front end of the hallway on Walker street, about five feet by seven or eight.

Q. 3386. Do the description and the diagram you have made and given represent the rooms at the time they were occupied by the Electro-Dynamic Light Co.?

A. They do.

Q. 3387. What does the circular figure represent in the side room?

A. The engine and boiler.

Q. 3388. And this engine and boiler, as I understand the diagram, were accessible from the hall leading to the stairway and also through the door or passageway from the back room near the partition wall, between the two rooms?

A. Yes.

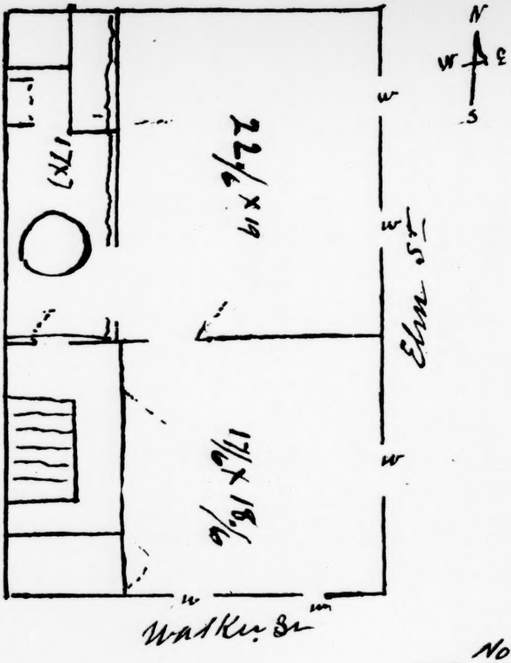
Diagram offered in evidence as part of the witness' deposition and the same is marked "Complainant's Exhibit Man's Diagram Walker and Elm Shop, March 27, 1887."

Q. 3389. Have you also measured the size of the shop occupied by you and Mr. Sawyer at 43 Centre street. If so, please to make a diagram marking the dimensions thereon?

A. I have made such a diagram and now produce it.

Q. 3390. Please to describe the diagram produced by you, giving its several dimensions?

A. The entrance to the premises was through a passageway from Centre street, and the premises were in a rear building or rear part
of a building up two flights of stairs, I think. The entrance
1653 to the room was at its northeast corner. There were windows
on the northwest and south sides of the room. The room is forty feet five inches long, east and west, and twenty-seven feet six inches wide, interior measurement. I should think it was ten or twelve feet high. This room was divided by a partition, partly of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No. 286.
C.E. Light Co
v.
McK Light Co
p. 1654

Consolidated E L Co
v
McKeesport L Co

Complainants Exhibit
Harris diagram Walker & Elm Shop
March 27 1889
W.P.H.
S.E.

canvas and partly of boards, into two rooms, the smaller one in the southeast corner, being about twelve feet wide, north and south, and twenty feet long, east and west. I have placed the window openings in the diagram from recollection only, and they are only substantially correct as to position and number. That is, there were several on each side of the room and several at the west end of the room.

Diagram offered in evidence and marked "Complainant's Exhibit Man's Diagram Centre-street Shop, March 27, 1889."

(Here follows diagram marked p. 1654.)

I had not seen this place until to-day since 1878. The diagram represents it as it was then.

Q. 3391. In addition to the electric lamps made by the Electro Dynamic Light Co., at the shop corner of Elm and Walker streets, what other and additional apparatus or parts of apparatus were made there as parts of your system of electric lighting?

A. Very little manufacturing, except of carbons and models and patterns, was done at No. 94 Walker street. The several parts of lamps, excepting carbon conductors, were divided up and the separate pieces were sent to different shops and mechanics to be manufactured and finished. The carbons were made at 94 Walker street, except the holders made of carbon, which were sent out with patters to be made. The several parts were returned by the mechanics who manufactured them, finished and ready to be assembled and set up, to our place, 94 Walker street. In addition to lamps we had manufactured in the same manner switches, resistances, parts of a regulator, parts of, or a complete meter, brackets, and
I don't know what all. Mr. Sawyer also started on his
1655–1665 own account the manufacture of a dynamo, by H. L.
Judd & Co., of Brooklyn, which was subsequently completed and paid for by the Electro-Dynamic Light Co., and the machine was sent to 94 Walker street while we were there, and tested and tried, and subsequently sent back to Mr. Judd in Brooklyn. I had intended in my correction of testimony in the New York case given this morning, to have mentioned this dynamo, as I was very thoroughly cross-examined in regard to dynamos in the New York case, and I failed to recall this one, and it is only within the last week or ten days and since I testified in the New York case, that it has come to my recollection.

While I am on the question of corrections I understand the testimony in the interference case with Edison is introduced in this case in some way, and in the printed testimony in the interference case and perhaps in the record I am made to *same*. "We went to 43 Centre street on the sixth or seventh of February, 1878. Of this there can be no doubt," or in substance this. The word February is a mistake, and should read March; whether it was a *lap-us lingua* of mine, or an error in taking down or printing the testimony, I do not know. The fact is, we went to 43 Centre street on the 6th or

7th of March, 1878. I well knew that fact and intended to so testify. I had at one time a letter from Mr. Sawyer, dated March 7th, 1878, showing the time of our going there and which is now handed to me by counsel for complainant, and I now produce it.

Q. 3392. Is this letter, referred to by you, in the handwriting of Mr. Sawyer, and was it received by you at about the time of its date?

A. It is, and it was received by me on the date of its date. In it I was asked to come to the place, 43 Centre street, that day, and did go there that day, though I think I also went there the day previous.

1666 Letter offered in evidence and marked "Complainant's Exhibit Sawyer's Letter, dated March 7th, 1878. March 27, 1889."

Q. 3393. Referring now to the dynamo mentioned by you in the previous answer as having been designed by Sawyer and made in whole or in part by Mr. Judd, is that the same dynamo that is described and claimed in letters patent of the United States granted to William E. Sawyer February 8th, 1881?

A. It is substantially the same thing.

Patent offered in evidence and marked "Complainant's Exhibit Sawyer's Dynamo Machine, patent of February 8, 1881. March 27, 1889."

Adjourned till Thursday, the 28th inst., at 11 a. m.

THURSDAY, *March* 28, 1889.

Met pursuant to adjournment.

Present: Amos Broadnax, Esq., for complainant and Grosvenor P. Lowrey and Walter K. Griffin, Esq., for defendant.

Q. 3394. I place in your hands letters patent of the United States granted to William E. Sawyer and Albon Man, No. 229,476, for improvement in electric switches, dated June 29, 1880. Please to state whether the switch illustrated and described in that patent was made or caused to be made by you and Mr. Sawyer for the Electro-Dynamic Light Co. while your shops were at the corner of Walker and Elm streets?

A. A large number of these switches, some of plaster of Paris add more of soapstone, were made for us while we were at 94 Walker street, and the parts sent to us at that place and assembled by ourselves or our workmen, and I have a large number of them now, and their parts.

1667 Patent offered in evidence and marked "Complainant's Exhibit Sawyer-Man Soapstone Switch Patent, March 28, 1889."

Q. 3395. I place in your hands letters patent of the United States, 210,152, dated November 19, 1878, granted to yourself and Wm. E. Sawyer for improvement in switches for electric lights. Please to state whether you and Mr. Sawyer made or caused to be made such switches at the shop of the Electro-Dynamic Light Co. at the corner of Walker and Elm streets, New York?

A. We had manufactured the parts for a large number of switches and safety devices shown in the illustration of this patent and set up a considerable number of them, I don't know how many, at our place, 94 Walker street, corner of Elm street, and I have some of the completed switches and many of the parts not set up now. We also made or caused to be made a large number of the switches embodying the idea of this patent, using circular instead of sliding movement, as embodied in a switch that I now produce, of which a considerable number were set up, I don't know how many, while we were at 94 Walker street, and of which I have a considerable number completed still, and the parts for many more. The switch produced has never been put to actual use, but was made in its different parts at different places by special tools and machinery adapted for its manufacture.

Patent offered in evidence and marked "Complainant's Exhibit Sawyer-Man Switch Patent 210,152, March 28th, 1889."

Switch produced by the witness also offered in evidence and marked "Complainant's Exhibit Sawyer-Man Switch, produced by Albon Man, March 28th, 1889."

Q. 3396. I place in your hands reissued letters patent, No. 10134, dated June 6, 1882, originally patented June 25, 1878, to yourself and Wm. E. Sawyer for electric lighting system. Please to state
whether the apparatus described and illustrated in that
1668 patent were made and used or caused to be made and used
by you and Mr. Sawyer at the shop of the Electro-Dynamic
Light Co., corner Walker and Elm streets, in this city?

A. They were.

Q. 3397. I place in your hands letters patent of the United States granted to yourself and Wm. E. Sawyer, No. 205,305, dated June 25, 1878, for improvement in regulators for electric lights. Please to state whether the apparatus described and illustrated in this patent was made or caused to be made by you and Mr. Sawyer and used at the shop of the Electro-Dynamic Light Co., corner of Walker and Elm streets, in this city?

A. Before going to the corner of Walker and Elm streets, according to the best of my recollection, patterns for the several parts of the apparatus described in this patent were made by us and the parts ordered. They, or some of them, were set up while we were at 94 Walker street. Whether any completed regulators were made, I do not recollect, and believe that at most only one was tried experimentally, but not in connection with our system of electric lights which we had set up for exhibition. My impression is that the parts for several regulators were assembled at the place, 94 Walker street, according to the plan of that patent, but not put to actual use. One regulator we ran experimentally complete, and I remember the parts shown in figure 3, as a whole, being set up and run there, and some of the parts separately from the rest.

Patent offered in evidence and marked "Complainant's Exhibit Sawyer-Man Regulator Patent, March 28, 1889."

Q. 3398. I place in your hands letters patent of the United States 210,151, dated Nov. 19, 1878, granted to Wm. E. Sawyer for electric meter. Please to state whether Mr. Sawyer or yourself, or the Electro-Dynamic Light Co. made or caused to be made the 1669 instrument or apparatus described and illustrated substantially in that patent at your shop, corner of Walker and Elm streets.

A. We did, and ran it there in connection with our electric lighting system, and made patterns and ordered the parts made for several more.

Said patent offered in evidence and marked *March 29, 1889," with the understanding on be-* "Complainant's Exhibit Sawyer-Man Electric Meter Patent, March 28, 1889."

Q. 3399. Between what dates were the several apparatus described and illustrated in these several patents to which we have been referring assembled, set up and used at the Walker and Elm street shop?

A. From the time we went to Walker and Elm streets, which, according to my recollection, I fix as the last of September, 1878, between that date and about the 15th, 16th or 17th of March, 1879, when I ceased to work in connection with Mr. Sawyer.

Q. 3400. And were all of the electric lamps referred to by you in your testimony in the New York case assembled and set up in that shop, 94 Walker street, during the same period?

A. Not all. The greater number were. Some were assembled and set up before we left 43 Centre street, in May or June, 1878. Some, and possibly a larger number, were assembled and set up after we left 43 Centre street, and before we went to 94 Walker street, at the shops at the corner of Howard and Centre streets.

Q. 3401. State as nearly as you can how many electric lamps were certainly set up and illuminated at the Walker and Elm street shop between the 1st of October, 1878, and the 15th of March, 1879.

A. I cannot fix that number, as I have stated before. It was a large number, in my judgment exceeding one hundred, and according to my recollection, as I look back upon it, running to 1670 between two and three hundred, but the manner of our work was such, lamps being used over and over again, and modified and changed in whole or in part, as to their interior works, that I cannot be certain in regard to the matter. I prefer to say that a very large number of lamps, without fixing definite numbers, was made, set up, and run there between the dates given in the question, and further, the manner of their manufacture in separate and distinct parts by workmen and manufacturers outside of our shop, at separate and distinct places, and the finished parts being brought to us there and set up by us and run. Whether lamps in use were new or modified, or refilled or refitted lamps is a matter which confuses my recollection.

Q. 3402. Please to state whether or not, between the dates you have given, Mr. William Sharp was employed at the shop of the Electro-Dynamic Light Co., corner of Walker and Elm.

A. He was, during part of the time.

Q. 3403. State as near as you can recollect when his employment at that shop commenced, and when it terminated.

A. He commenced work at that place, I should think, some time about the middle or last of October, and continued in the employment of the Electro-Dynamic Light Co., with possibly some intermissions of a few days at a time, until about the 15th, 16th or 17th of March, 1879, when I discharged him, and he was immediately re-employed by Mr. Wm. E. Sawyer, and continued at work at the same place, if I recollect correctly, with some intermissions, possibly, until about the middle of May, 1879, when the shops were broken up.

Q. 3405. Please to state the cause of Mr. Sharp's dismissal.

A. The Electro Dynamic Light Co. and I, as its president, were dissatisfied with Mr. Sawyer by reason of his drunkenness. I consulted with my cotrustees and with Mr. Sawyer, and remonstrated with him and told him that the work could not go 1671 on in that way, and, in substance, that if he continued his inebriation, we should shut up the shops. I consulted with my cotrustees, and it was agreed that if Mr. Sawyer did not mend his habits, I should shut up the shop and discharge the employees, except Mr. Edwin Myers. I went to the shop at the time when I discharged them, found Mr. Sawyer drunk, and his father and Mr. Sharp both under the influence of liquor. I immediately sent to the bank for money, discharged and paid off all but Mr. Myers, and stopped the work, so far as the Electro Dynamic Light Co. was concerned. I reported my action to the board at the meeting of the 20th of March, 1879, and it was approved. Before this meeting I had reported to the several trustees of the company what I had done, and why I had done it.

Q. 3406. Previous to the closing of the shop, as you have stated in your last answer, and the termination of your co-operation and work with Mr. Sawyer, had you admonished him that unless he discontinued his intemperate habits you would close the shop and discontinue your work with him?

A. I had.

Q. 3407. Frequently?

A. Very frequently.

Q. 3408. In closing the shop and discontinuing your work with Mr. Sawyer were you or the Electro-Dynamic Light Co. influenced in any way by the failure or any want of success of your electric lamp or inventions appertaining to your system of electric lighting?

A. In one sense we were, in another sense we were not. We believed in our system of electric lighting and in our electric lamps and in the patents that we had obtained and inventions that we had made, and believed that they were practical and successful, and it was not for any want of confidence in them that we stopped work,

but in the work done by Mr. Sawyer, in his drunkenness.
1672 As to its practicability we had not confidence, and in that sense our action was influenced in stopping the work, by want of practicability in the lamps made and set up by Mr. Sawyer, or under his direction while he was drunk, and we attributed this want of practicability solely to Mr. Sawyer's drunkenness.

Q. 3409. Had you any want of confidence in Mr. Sawyer to make the lamp and work all the inventions of your system if he would remain sober?

A. No, I had none, and I do not believe that any other members of the board of trustees had.

Q. 3410. Referring now again to Mr. Wm. Sharp, please to state what opportunity he had of observing what was being done at the Walker and Elm street shop during the time he was employed there?

A. Mr. Sharp's place of employment was in the back room. He had little or no opportunity to know what was going on in the front room, except as he occasionally went out and into the building in going to or returning from his work he might possibly pass through the front room. He had an opportunity to see, if he looked, the work that was going on in the back room except such as was conducted in the engine-room, which, from his position in the shop could not be seen by him ordinarily unless he left his work and went to the engine-room door or entrance. How much he knew or understood of it, I don't know. He was not an electrician or chemist. His business was a metal-finisher.

Q. 3411. What were his duties or work as a metal-finisher?

A. To make the pattern things according to drawings and directions for the different things he wanted to order made. And in this connection, the modifications which we wanted made in our lamps which we had run, were frequently if not usually placed in his hands. He sometimes assisted Mr. Myers or Wm. Sawyer in taking down lamps that had been run, but not usually, and in finishing up metal-work of all kinds.

1673 Q. 3412. In what capacity was he employed?

A. Simply as an ordinary workman, a mechanic.

Q. 3413. Did he occupy any confidential relation with either you or Mr. Sawyer?

A. We did not tell him of or discuss the things we wanted to do or accomplish in his presence or with him. His relations were only so far confidential that he was requested not to talk about the things that he did do, with any one outside.

Q. 3414. Did that request extend to anything that he saw?

A. Yes, and the request was general to all the workmen in the shop.

Q. 3415. Was it any part of his duty, or did he in fact assemble the several parts of the lamps and put them up at the shop?

A. That was not his ordinary work, but was done by Mr. Wm. Sawyer, Mr. Wm. E. Sawyer and Mr. Myers, ordinarily. I think, however, that Mr. Sharp may have put up a few lamps.

Q. 3416. Whose duty was it to make the carbons that were used in the lamps, and who, in fact, did make them and put them in the lamps?

A. Mr. Myers had charge of that matter under Mr. Wm. E. Sawyer and myself, and usually treated the carbons and put them in the lamps, exhausted and charged them and sealed them off. Mr. Wm. E. Sawyer, however, frequently put in carbons into the lamps, some that were made by himself, but mostly those that were made by Mr. Myers, and did a good deal of the electrical treatment of carbons which Mr. Myers ordinarily did, and Mr. Wm. Sawyer frequently put the carbons into the lamps and ordinarily set them up. Mr. Myers, under my direction, did all or nearly all the carbonizing in the furnace. I do not think Mr. Sharp had anything to do with carbon.

Q. 3417. In view of Mr. Sharp's position there, is it prob-
1674 able that he would know what the carbons were made of,
how they were carbonized, or what kind of carbons were put
in the lamps?

A. The fact is, that I thought that Mr. Sharp would know and recollect more than he appears to do by his testimony, at least as to the form of carbons and the carbonization and the materials carbonized. His opportunities for knowing were dependent only upon his own observation, and not upon information conveyed to him by us. As to the material of the carbons before treatment I should think it highly improbable that he could know what the material of the carbons actually treated was, further than that I think he saw the carbonization going on in the furnace by Mr. Myers and might have inferred that it was the carbons thus made that were being treated by Mr. Myers and Mr. Wm. E. Sawyer. After the carbons were treated I do not think Mr. Sharp could know what they were made of. The carbons when carbonized were taken care of and locked up by Mr. Wm. E. Sawyer in his desk in the front room and in the drawer of the table in the center of the front room to which Mr. Sharp had no access, of course. The carbons were given out by Mr. Sawyer to Mr. Myers to be treated and put in the lamps, and to his father to put in the lamps or in the holders for treatment.

Q. 3418. Was Mr. Wm. Sharp's employment and the condition and arrangement of the shop and the division of the work such that many different kinds of carbon could be made there and used in the lamps without Mr. Sharp's knowing anything about it, unless he was specially told of it?

A. Yes, such was the fact, and he could only know it by attending to that which was none of his business, or being told of it, but, at the same time, I had believed that Mr. Sharp, from the condition of things, must have positively known of the making of carbons
from paper, wood and other substances, as according to my
1675 recollection Mr. Sharp made several kinds of punches for
cutting out paper for carbons. It may be that I am mistaken in my recollection and that these punches were made by old Mr. Sawyer; still, even if Mr. Sharp made the punches, as they were not used in the back room, but all the material for carbons were cut

and shaped in the front room, he may not have known what they were for. I mean to say, in this, that there was abundant opportunity for Mr. Sharp not to know what was going on, and that he did, in fact, know, as I believed at the time, very lit-le of what was being done. That part only which he could see and observe while attending to his work with his back to the rest of the shop, ordinarily, but the carbonization was conducted in a room connecting to that in which he was, and it seems to me that if he had exercised any thought upon the matter he must have known that the carbonization was for the purpose of electric lighting, and some of the materials that were carbonized were in plain sight in his room, and it was no infrequent thing for the vegetable and fibrous carbons to be openly exposed on the table and on Mr. Sawyer's desk in the front room. It is true, however, that Mr. Sharp had no business whatever in the front room. Again, these carbons were taken by Mr. Myers and Mr. William E. Sawyer to the back room and treated upon the chemical platform right back of where Mr. Sharp usually worked. I think no explanation whatever was made to him, but he might have seen them.

Complainant's counsel states upon the record, in the presence of defendant's counsel, that, not having been able to get a copy of the deposition of Mr. William Sharp, he is unable to proceed with the examination of this witness as to Sharp's deposition, and, therefore, defers such further examination as to that deposition until he is able to get a copy of the same, and proceeds with the examination of the witness on another branch of the case.

Q. 3419. Please to state what, if any, correspondence you have
had with any one connected with the Edison Electric Light
1676 Co. as to uniting the interest of the Edison Electric Light
Co. with the interest of the Electro Dynamic Light Co. in
incandescent electric lighting, and please to give the name of the person or persons with whom you corresponded, either in writing or orally, as president of the Electro Dynamic Light Co.

A. I had a correspondence with Mr. Grosvenor P. Lowrey, counsel now present, to whom I was referred by Mr. Wright, of Drexel, Morgan & Co., as the attorney of the Edison Electric Light Interest or Company. I don't know whether it was a company or being promoted by Drexel, Morgan & Co., and in which I understood Mr. Lowrey to have some personal interest. In the fall of 1878, I invited Mr. Lowrey to our place, at No. 94 Walker street, and showed him our lights, or some of them, and some of the things we had. I had a conversation with him, I think, at my office, No. 3 Mercer street, upon the subject-matter of uniting in some way the Edison interest with the Sawyer and Man interest, with a view of preventing subsequent litigation and injurious competition. On the 30th of October, 1878, I received a letter from Mr. Lowrey, dated that day upon this subject-matter. On the 31st of October, 1878, I replied to that letter. On the 2d of November, 1878, I received another letter from Mr. Lowrey, dated that day, and on the 6th of November, 1878, I received another letter, dated that day, from him.

Q. 3420. How was this correspondence initiated between you and Mr. Lowrey?

A. First by my seeing glowing statements in the newspapers of what Mr. Edison was doing or about to do in incandescent electric lighting, and my thinking by the widespread notoriety of Mr. Edison in electric lighting and knowing what we ourselves had done, that it would be better to have Mr. Edison as a coworker than an opponent; and second, hearing that Drexel, Morgan & Co., with whom I had frequent business at the time, were interested with Mr. Edison, I took occasion to speak to Mr. Morgan 1677 of that firm, and tell him in substance that we, Sawyer & Man, had done a good deal in electric lighting by incandescence, had some very good inventions and patents in regard thereto, and some good lights, and expressed my views personally that good business policy would indicate the propriety of a union of interests between us in the field of incandescent lighting. Mr. Morgan referred me to Mr. Wright of that firm, as having charge of the subject-matter, and Mr. Wright referred me to Mr. Lowrey as the attorney and interested in the matter. I saw Mr. Lowrey in accordance with Mr. Wright's suggestion. Then, or soon afterwards, I invited him, in some way, to go to 94 Walker street and see what we had. The result was the correspondence between us, the dates of which I have given.

Q. 3421. Can you give the time of your first interview with Mr. Morgan?

A. No, except that it was a week or ten days, perhaps more, and it may not have been so long, before Mr. Lowrey visited 94 Walker street.

Q. 3422. After your first interview with Mr. Morgan, how much time elapsed before your interview with Mr. Wright?

A. I think it was the same day.

Q. 3423. How long after that before your interview with Mr. Lowrey?

A. At this length of time I cannot state with accuracy. My best recollection is, it was some days subsequent to my interview with Mr. Morgan and Mr. Wright, and it was several days after this before Mr. Lowrey came to 94 Walker street. I should think a week or more; perhaps it may have been two weeks.

Q. 3424. What was the nature of your business with Drexel, Morgan & Co. at that time?

A. Buying foreign exchange of them, and buying letters of credit for my clients.

1678 Q. 3425. Please to examine the paper now shown you and state if you recognize it as one of the letters referred to by you as having been received by you from Mr. Lowrey?

A. I do; that is the letter dated October 30th, to which I referred.

Letter offered in evidence and marked "Complainant's Exhibit, Lowrey Letter of Oct. 30, 1878. March 28, 1889."

Adjourned till Friday, the 29th inst., at 11 a. m.

NEW YORK, *March 29th*, 1889.

Met pursuant to adjournment.

Present: Counsel as before, and the examination of Mr. MAN was continued as follows:

Q. 3426. You have referred to a letter addressed to you by Mr. Lowrey, dated Nov. 2, 1878. Can you produce the original of that letter?

A. I cannot, and don't know where it is. The last I saw of it, it was in the hands of William E. Sawyer, then secretary of the Electro-Dynamic Light Co., to the best of my recollection.

Q. 3427. Have you made search for the letter?

A. I made search through my papers some time ago for all the papers connected with the Electro-Dynamic Light Co., and am confident I haven't got it.

Q. 3428. Do you know of your own knowledge that the record of that letter found in the minute book of the Electro-Dynamic Light Co. is a true copy of that letter?

A. I do. I compared all this correspondence, as recorded in the minute book with the original letter and press copy that I made of the letter. I wrote to Mr. Lowrey with the record in the minute book at the time they were made with Mr. William E. Sawyer, the then secretary of the company.

1679 The copy of said letter as recorded in the minute book of the Electro-Dynamo Light Co. is offered in evidence, and is marked "Complainant's Exhibit Lowrey's Letter of Nov. 2, 1878. March 29, 1889."

Counsel for defendant, Mr. Lowrey, being present, notwithstanding the general reservation of the right of objection till the close of Mr. Man's testimony, states that he will cause a search to be made for a letter-press copy of such letter, if it exists, and will produce it for the use of the complainant if found, but that as he has no recollection of such a letter, he now notes an objection to this method of proving the letter, that a sufficient ground had not been laid for producing a copy in place of the original, and that the original, if produced, and the copy are incompetent, irrelevant and immaterial as between the parties to this action and upon the issues thereof.

Q. 3429. Please to examine the paper now handed you and state if you recognize it as the original letter written you by Mr. Lowrey, November 6, 1878?

A. This is the original letter dated November 6, 1878, to which I referred, addressed to me by Mr. Lowrey, and received by me and recorded in the minute book of the Electro-Dynamic Light Co.

Letter offered in evidence and marked "Complainant's Exhibit Lowrey Letter of November 6, 1878. March 29, 1889."

Q. 3430. Are these three letters all the letters you received from Mr. Lowrey on the subject of this correspondence?

A. I can only say that I think so, and that I do not recollect any others.

Q. 3431. Are these letters in the handwriting of Mr. Lowrey and signed by him?

Mr. Lowrey being present and shown the letter of November 6,
says that the signature is his, and from examination of the
1680 two letters of October 30 and November 6, he has no doubt
they were both written in his office although the letter of
October 30th does not purport to be an original letter, but to be a
copy, both as to its body and signature, and he has no doubt that it
was written by his direction.

A. I think this answers your question fully. They are the original papers received by me from Mr. Lowrey.

Q. 3432. Was the other letter, I mean the letter of November 2, 1878, in the handwriting of Mr. Lowrey?

A. I think the letter of November 2nd purported to be a dictated letter from Mr. Lowrey. My impression is that it was in typewriting, but of this I am not certain. It may have been in manuscript. It is referred to in the letter signed by Mr. Lowrey, personally, dated November 6, 1878, and there stated to have been dictated to his stenographer by him.

Q. 3433. What, if any, answer did you make to these letters that was in writing?

A. I answered according to my recollection in writing, only the letter from Mr. Lowrey to me, dated October 30, 1878, and my answer thereto is recorded on pages 31, 32, 33 and 34 of the minute book of the Electro-Dynamic Light Co. My letter is dated October 31, 1878, and its receipt by Mr. Lowrey is acknowledged in his letter to me of November 6, 1878, and in his letter of November 2, 1878.

Q. 3434. Can you produce the original of the letter referred to by you in your last answer?

A. I cannot.

Q. 3435. Why?

A. I sent it to Mr. Lowrey.

Q. 3436. Was it recorded in the minute book before you sent it to Mr. Lowrey?

A. It was not.

Q. 3437. From what was the record made in the minute book of that letter?

1681 A. From a letter-press copy of that letter which I made before I sent it.

Q. 3438. Can you produce the letter-press copy from which the record was made?

A. I cannot; I gave it to Mr. Sawyer, the secretary of the Electro-Dynamic Light Co., to record it in the minute book, take care of it, and file it with the papers of the Electro-Dynamic Light Co.

Q. 3439. Did you compare the record of that letter in the minute book with the letter-press copy you have mentioned, and do you know of your own knowledge that the record of the letter in the minute book is a true copy?

A. I did so compare it with the record in the minute book with

Mr. Wm. E. Sawyer, the secretary, and I believe it to be a true copy of the letter I sent to Mr. Lowrey, and think I know it is.

Counsel for complainant calls on defendant's counsel to produce the original of this letter, to be offered in evidence.

Mr. Lowrey being present, says that counsel for defendant has never received any such letter, that in his personal character Mr. Lowrey will examine his file of personal letters deemed to be of sufficient importance to be preserved, and if such a letter is found he will produce it. That he has no present recollection of receiving such a letter.

The record of letter referred to as found in the minute book of the Electro-Dynamic Light Co. is offered in evidence as "Complainant's Exhibit Man's Letter to Lowery of October 31st, 1878, March 29, 1889," with the understanding on behalf of complainant's counsel, that if the original is produced it may be substituted for the copy found in the minute book.

Q. 3440. Did you have any personal interviews with Mr. Lowrey regarding the subject-matter of these letters? If so, please to state what was said at such interviews, as you recollect it.

1682 A. I had several interviews with Mr. Lowrey prior to his going at my invitation to No. 94 Walker street, in which I endeavored to impress upon him my views that it would be advantageous to both the Edison people and the Electro-Dynamic Light Co. that their interests should be united and their inventions worked together, rather than to be antagonistic or rival interests, this, as a business proposition, addressed to business men. I myself at the time believed that we were very far in advance of Mr. Edison in incandescent electric lighting, as I saw his attempts and experiments published in the periodicals of the day, and as I had heard of them from others, and I expressed this belief to Mr. Lowrey as an inducement to the Edison people to unite with us. On the day of his visit to 94 Walker street Mr. Lowrey and I went from that place, according to my recollection, to my office, No. 3 Mercer street. We there had a conversation, in which Mr. Lowrey, in substance, expressed himself pleased with what he had seen and that it was more or better, or both, than he had anticipated, and promised to confer with other people interested in the Edison invention or inventions, and I think we canvassed in some measure, the appointment of committees on the part of the Electro-Dynamic Light Co. on the one side, and on the part of the Edison electric light people on the other side, or Mr. Lowrey for them, to confer together in regard to the propriety of a union of interests and the basis of a union, if any should be deemed practicable, or advisable, and Mr. Lowrey at this interview, I think, promised to further confer with me or write me.

And on receipt of his letter on the 31st of October, 1878, on the same day the Electro-Dynamic Light Co., at a meeting of its trustees, did appoint such a committee of whom I was one, and I verbally advised Mr. Lowrey of their appointment, and some further conversation was had between us of a like character to that that had gone before. I think this was the same day or the day following the 31st of October, 1878. I do not think I had any further 1683 conference with Mr. Lowrey, after the receipt of his letter dated November 2, 1878, which was an utter surprise to me, until long afterwards at several times when I casually met him, and simply possibly referred to the subject-matter. I think in the summer of 1880, after the organization of the Eastern Electric Manufacturing Company, I again brought up the subject-matter of either a union of the interests of the Electro-Dynamic Light Co. and the Edison Electric Light Co., or the sale of the patents and inventions of the Electro-Dynamic Light Co. to the Edison Electric Light Co. with Mr. Lowrey, but nothing was accomplished and the matter was dropped.

Adjourned one hour for lunch, to resume at 2 p. m.

Resumed at 2 p. m.

Witness continues:

Several persons indirectly approached me and the other directors of the Electro-Dynamic Light Co. to know whether the patents and inventions belonging to that company would be sold. It was after conference between myself and other trustees thought best that I should call on Mr. Lowrey in regard to the matter, as it was supposed or understood that these inquiries came from or were instigated by the Edison Company. I accordingly called on Mr. Lowrey in regard to the matter, referred to previous attempts at negotiations, and perhaps to the inquiries that had been made, and asked him whether the Edison people desired to enter into negotiations. He told me, as near as I can recollect, that he was not advised of any such thing, that it was hardly in his province then, that other people had charge of such matters and advised me, I think, to see Mr. Wright, of Drexel, Morgan & Co. This, I think, is the substance of what took place in the summer of 1880, as I recollect the time of it.

Q. 3441. Referring now to the correspondence and interviews with Mr. Lowrey in the fall of 1878, when did such interviews and correspondence terminate?

1684 A. Immediately after my receipt of his letter of November 2, 1878, so far as any conference was concerned, or interviews. The last correspondence, so far as I know or recollect, was his letter to me dated November 6, 1878.

Q. 3442. Was he then one of the counsel of the Edison Electric Light Co.?

A. I only know from his being a lawyer and from being referred to him, and by my interviews and correspondence with him. I supposed him to be so.

Q. 3443. How often did Mr. Lowrey call at the shop of the Electro-Dynamic Light Co. on the corner of Elm and Walker streets in the fall of 1878?

A. I only remember the one occasion to which I have testified, and which is referred to in the correspondence between us.

Q. 3444. Was that occasion in the daytime or in the evening, and were your lamps exhibited to him at that time?

A. My recollection is that it was in the daytime, and that the room was darkened by putting up movable shutters which we had at the windows, that several lamps were lighted up and turned off to show that one could be turned off without affecting the others, and turned down to less incandescence by means of switches to show that one lamp or more could be run at one incandescence while the others were running at a different incandescence, the lamps individually giving such light as was desired within their limits of luminosity; that the dynamo-electric machine that was running the lamps was shown to him, and the switch or switches by which the lamps were turned off and their luminosity governed.

Q. 3445. State, if you recollect, how many lamps were in circuit at that time?

A. I cannot state further than that I remember that several were lighted at the same time in order to show that one could be turned off or reduced in brilliancy without affecting the others.

1685 Q. 3446. What was the duration of Mr. Lowrey's visit at that time, as you recollect it?

A. I could not undertake to state that at this length of time, definitely. My impression would be from half an hour to an hour.

Q. 3447. Do you know anything of a visit of Mr. Lowrey to the works of the Electro-Dynamic Light Co., corner of Walker and Elm streets, in the spring of 1879? If so, please to state what knowledge or information you have about such visit?

A. About a week or ten days after the 20th of March, 1879, I knew of Mr. Sawyer having invited gentlemen from, or representing the Edison Company, to witness an exhibition at evening of our electric lights and apparatus at that place. I was not present at the exhibition inside the building, but saw the illumination of the building, or our rooms, as I passed by there, and I heard that the Edison people were there that evening, and that Mr. Lowrey was among them. I do not know it personally, except by reputation.

Q. 3448. This exhibition made by Mr. Sawyer at that shop, mentioned in your last answer, was after you discontinued to work with him, as I understand you, and after you had closed the shop, so far as the Electro-Dynamic Light Co. was concerned.

A. It was, and also after Mr. Sawyer had made a proposition to the Electro-Dynamic Light Co. to interest other people, which had been accepted, at least provisionally by the Electro-Dynamic Light Co., and the exhibition was made by Mr. Sawyer, as I understood, in order to interest other people in accordance with his proposition.

Q. 3449. As I understand you, you had no personal knowledge of this exhibition beyond what you have stated, or of the causes which led to it. Am I right in my understanding?

A. Not quite. I knew that the exhibition was to be made: I knew the object of the exhibition, and knew that it was
1686 made. I knew the object of it through Mr. Sawyer, and I

think, Mr. Church. I have already stated in my testimony that it was made by Mr. Sawyer in pursuance of an attempt to carry out his proposition before then made to the Electro-Dynamic Light Co. to interest other people.

Counsel for defendant, Mr. Lowrey, calls the attention of the counsel for complainant to the intention already expressed by Mr. Lowrey to limit, so far as is possible, the future cross-examination of this witness, in order that the already overburdened record may be limited as far as is practicable. He also calls attention of counsel for complainant and of the court to the character of the testimony, as being called out and permitted from the witness, it being a very large part hearsay and inference from assumed facts which would seem to force upon counsel for defendant a prolonged cross-examination to separate that which is really material and competent from that which is not so, and lest counsel for complainant may be misled and also the witness by the absence of any present objections, under the arrangements heretofore made, he now calls attention to the tendency of the testimony, both questions and answers, to spread beyond suitable limits, and asks counsel to restrain it. Mr. Lowrey makes this statement not in any way imputing either to witness or counsel a purpose of this sort and merely to guard them against what must necessarily lead to the statement of broad objections and to the unnecessary prolongation of cross-examination.

Counsel for complainant says in reply that he has finished his examination of the witness upon the topics upon which he has been last examined and that he has asked him no more questions than he thought were fairly necessary to corroborate the testimony of other witnesses that he proposes to call.

Q. 3450. Please state how the Consolidated Electric Light Company came to be formed?

A. Sawyer having fallen out with Messrs. Wallace, re-
1687 turned to New York in the month of September, 1879, in a
very antagonistic frame of mind and demanded a license under the patents to go on and manufacture, although he knew that Messrs. Wallace & Sons held an exclusive license from the company. This was refused him. Thereafter he devoted himself to active antagonism to the Electro-Dynamic Company and its interest in every way.

In the early part of 1880 he succeeded in organizing an opposition company entitled the Eastern Electric Manufacturing Company, and in the meantime he devoted himself to writing articles to the newspapers, which he told me were intended to injure the Electro-Dynamic Light Company and myself, and to belittle the work that we had done, and in this connection he wrote a book entitled "Sawyer on Electric Lighting." Mr. Edwin Myers was taken sick in the fall of 1879, and after a lingering illness died. There was no other person acquainted with the manufacture except myself, and I was too absorbed in other business, which I could not leave to attend to it. The hostile activity of Mr. Sawyer and the Eastern Electric

Manufacturing Company, which he had organized, continued, Sawyer refusing to unite in applications for patents, reissues and in the prosecution of interference proceedings, and otherwise injuring us, until finally, in order to put an end to the matter, an agreement was made by which the patents and inventions belonging to the Electro-Dynamic Light Company were in the spring of 1881, sold and conveyed to the Eastern Electric Manufacturing Company. Sawyer agreed that he would thereafter cease his hostility and work actively for the interest of the patents. This he did for a little while. He soon became hostile to the Eastern Electric Manufacturing Co. His habits were so bad that no one could work with him, and he had parted with, hypothecated and sold all his interest in the company. Then, in order to get the patents actively at work, a consolidation was made with the American Electric Light 1688 Co., which agreed to furnish capital and go on with the work, and the Consolidated Electric Light Co. was the result of this union, which was effected in the fall of 1882, and the business of manufacturing and selling incandescent electric lamps under the patents of Sawyer and Man, has been actively carried on from that date.

Adjourned till Saturday, the 30th inst., at 11 a. m.

SATURDAY, *March 30th*, 1889.

Met pursuant to adjournment.

Present: Mr. Broadnax for complainant, and Mr. Lowrey for defendant, and the examination of Mr. MAN proceeded as follows:

Q. 3451. Referring again to the testimony of Mr. Wm. Sharp, he says in answer to question 50 as to machinery, that you had at Walker street:

"They had a small dynamo, a lathe, a grindstone, a boiler and engine. I might say there were two vices in there."

Is that a description of all the machinery you had at that place?

A. It is not.

Q. 3452. How is it deficient?

A. There was all the time two dynamos, a large one of the largest size then built by Arnoux & Hochhausen, and a small one built by them, and part of the time three or more dynamos. There were two lathes there, a chemical bench, permanently fitted up, a water exhaust, permanently fitted up, mercury exhausts, barometers and mercurial g*ua*ges, permanently fitted up to the wall above the chemical bench or table, galvanometers, on the same bench, switches and other electrical apparatus, and a very complete and extensive chemical apparatus, a set or partial set of carpenters' tools, 1689 and tools for doing special work, turning tools and bench tools of all kinds, a steam engine and boiler, and on the partition in the back room an electrical meter and a number of switches, a locked cupboard at the south end of the workmen's bench, to the right of Mr. Wm. Sawyer's place, filled with work and apparatus and materials, and at the other end of the bench a cupboard with a cloth cover at the left of where Mr. Sharp worked, filled with chemical apparatus and materials. In the front room there was a large table in the centre. At the south side, between the windows, a table filled with testing and measuring apparatus, with a set of galvanic batteries underneath it; opposite that, on the other side of the room, a large screen; on the north side, next the hall, was Mr. Sawyer's private desk and revolving chair, and there was a set, I think, of half a dozen common chairs in the room. There was on the centre table a variety of testing apparatus. There was a stand for a camera and photometer, used for both, lamps put up on brackets on all sides of the front room, arrangements on the chandelier for lamps, a movable lamp on the centre table connected to the chandelier; in the back room brackets at different points for setting up lamps, apparatus for treating carbons in both oil and gas, and a great variety of things I can't enumerate. I have omitted several switches in the front room and several in the back room, and electric circuits running in both rooms, and electrical resistances, rheostats fastened to the walls and partitions. One of the lathes was a large or medium sized lathe, intended to be run by power, and adapted to doing a great variety of work. It also had a pedal that could be attached, but was too heavy to be run practically by foot. The other lathe was quite small and adapted only to turning. It was a foot lathe.

Q. 3453. What do you mean when you say you had a "water exhaust" in the shop? Please to describe it, stating its general construction and mode of operation?

1690 A. It consisted of a lead pipe, thirty six or eight feet long, run from the roof of the building down through the light or air shaft at the northwest corner, with an enlarged air chamber at the top. Through the top of the air chamber, soldered in, entered the water pipe, connected on our floor to the Croton water system, with a faucet for turning the water on or off. This pipe was diminished in size in the air chamber at its lower end, and nearly entered the waste pipe connected with the lower end of the air chamber, of which I have spoken. The waste pipe at its lower end was turned up and had an air-tight reservoir or trap, large enough to hold water enough to fill the pipe with water as high as it would rise with atmospheric pressure. From the upper air chamber at its upper end ran a small lead pipe, soldered into the air chamber, which passed down to our floor in the light-hole, and from thence through the brick wall, and was carried on the north wall of the building to a point just above the chemical table, where it ended with a small stop-cock and screw-nipple, by which to connect it with the exhaust system of the lamps. This is a general description only.

Q. 3454. Was this apparatus used to exhaust the lamp chamber of its air?

A. It was.

Q. 3455. What degree of exhaustion in your last chamber was obtainable by this apparatus?

A. Sometimes more and sometimes less, according to the flow of water in the Croton water *water* system. When the flow of water was good we could obtain by it an exhaust whose pressure was substantially equal to the tension of water vapor at ordinary normal temperature of the atmosphere, or about that. It was such an exhaust that the height*h* of the mercury in the g*ua*ge which measured it could hardly be distinguished from the height*h* of the mercury in the barometer standing beside the mercury gauge.

1691 Q. 3456. What other, if any, apparatus did you use in your shop at the corner of Walker and Elm streets, for the purpose of exhausting your lamps?

A. The ordinary mercury exhaust, on the principle of the Bunsen or Geissler pump, worked by filling a chamber with mercury, driving out the air, shutting the stop-cock by which the air escaped, opening a stop-cock to the space desired to be exhausted, and then allowing the mercury which filled the chamber to escape through a vertical tube of the length of about thirty-six inches, and repeating the operation. I also had a Sprengle pump. I do not now remember or recall whether it was used there or not.

Q. 3457. Mr. Sharp in his deposition testifies as follows:

(Counsel reads from question 213 of his examination-in-chief to 216.)

Please state who made that lamp. I mean the lamp of figure 49 in Sawyer's book.

A. Referring now only to the spiral leading-in-conductors of that lamp, made of concentric spiral tubes, for the first lamp of this pattern Mr. Sharp turned from wood the form for bending the tubes constituting the conductors, and he and I bent them and fitted them together and fastened them to a diaphragm and a lamp base at his place in Brooklyn, in the month of April, 1878, according to the best of my recollection. I have a distinct recollection of the work and of the difficulties we met with in executing it and keeping and fastening the conductors so that they would not by the least movement touch each other, and so, short circuit the lamp. It is proper, however, to remark in justice to Mr. Sharp, that I did not tell him and he did not know what he was doing or what the apparatus was for, and that the holders above the diaphragm were not put on by him, but were at 43 Centre street, and that this apparatus was separate and distinct from the two lamps to which he has referred in his testimony and was made before either of those to which he referred.

1692 Q. 3458. Referring to the lamp marked the horseshoe lamp, figure 52 in the Sawyer book, what kind of carbons were used in that lamp?

A. Mostly, if not entirely, carbons made from wood and paper. It may be that some few lamps were set up of this form with circular discs or rings turned from sheet French carbon or sheets of gas-retort carbon; but I do not think so in lamps of this size, or diameter of lamp chamber.

Q. 3459. The carbon burner of this lamp as it appears by this drawing in Sawyer's book, appears to be thicker at its junction with the holders than in the center. How do you account for that appearance?

A. We made carbons that were so, but this may be in the illustration, only a fault in drawing or representation, or it may represent a flat twisted-paper carbon, of which we used some.

Adjourned for lunch.

Resumed after lunch.

Q. 3460. What do you mean by a flat twisted-paper carbon? Please to take a piece of paper, cut it and illustrate what you mean.

Witness takes a piece of paper, cuts it, and says: "I bend it in the form of a loop and twist it, at the same time so that the plane of the paper at its two ends will be the same, so as to be held in the two holders flatwise, as illustrated."

Q. 3461. Do you mean by that that the ends of the conductor when twisted as you have illustrated will show the breadth of the conductor, and the top of the arch will show the thickness of the paper?

A. Yes, that is it.

Q. 3462. And did you make such conductors as long as this shown in figure 52 of Sawyer's book?

A. Yes, I think so, and longer.

Q. 3463. Referring now to the carbons made of willow
1693 about which you have testified; of what kind of willow did
you make such carbons?

A. We made them from willow osiers—basket willow—which I got, and from willow twigs, from weeping willow.

Q. 3464. What part of the weeping willow did you use?

A. The pendulous twigs of the growth of the year or year previous, both, the long sweeping branches or twigs of the weeping willow.

Q. 3465. How did you prepare them for carbonization?

A. Selecting them, removing the bark, some of them that were fine enough, boring out the pith, bending them and carbonizing them whole, after being bent, some of them carbonizing in straight pencils without being bent, with and without the pith removed in both cases. Some of them we split up, shaped them to the size we wanted, then bent them and carbonized them or carbonized them in straight pencils. The same with regard to the osier or basket willow, except that none of these were small enough to form conductors and so had to be split and shaped to size.

Q. 3466. Where your carbons proved defective how long would it take to take the lamp apart and put in a new carbon?

A. Where one lamp alone was taken, perhaps ten minutes. If more were taken in a batch, a less average time, but if the lamp required any cleaning it would take longer.

Q. 3467. In that case, give the maximum time it would take in the hands of a fairly skillful man?

A. Mr. Sawyer was accustomed to say, and I think he was correct, that he could take down and set up from ten to a dozen lamps an hour, putting new carbons in them.

1694 Q. 3468. How many lamps and parts of lamps did Mr. Sharp make for you before he went into the employ of Sawyer & Man?

A. That would be impossible to tell, as to the parts, because he worked at a great many parts of different lamps and made other parts for lamps which we already had, to change their internal work. I do not now remember but two lamps that were made complete at his shop in Brooklyn, or at most three, and those did not have the carbon conductors in them. The two that he has mentioned and the concentric spiral lamp, which I have mentioned; I do not think the holders for the conductor were in this last-mentioned lamp, but they may have been. I don't think he put them in, but I don't know. The best of my recollection is that he did not.

Q. 3469. Mr. Sharp testifies in cross-questions and answers 567 to 568, inclusive, that there were no galvanic batteries in the office room, corner of Walker and Elm streets. What is your recollection about that?

A. There certainly were, as I have testified. I have them now and can produce them.

Q. 3470. Redirect question 603 of Sharp is as follows:

"At your home or shop in Brooklyn did you ever bore several dozen glass base plates for Mr. Man or Mr. Sawyer?

"A. I have a slight recollection of drilling one or two holes, but no such quantity as one or two dozen."

What is your recollection as to that?

A. My recollection of the subject-matter is that before we got molds for making the holes in the glass base plates of the lamps at the same time that they were blown, that I had the holes bored in them by a lapidary in Ann street, New York; that I took one of those over to Mr. Sharp's place to have him fit the tubular binding screws to it; that something happened to it, and that I proposed to get another one bored; that Mr. Sharp told me that that was 1695 unnecessary, as he could drill them. I asked him how he would do it, and he said with an ordinary steel drill. I had never heard of such a thing before and it was new to me, and I asked him to show me how he did it. He got a piece of glass and took a steel drill, and after hardening it, drilled the glass with it; but in doing so the inside or further part of the glass where the drill passed through last was bursted out around the edges; that to prevent this we got a tube and after drilling with the steel drill until the point of the drill came through the glass we used the tube with emery and water or turpentine, and succeeded in making smooth holes through the glass. We were having at the same time these glass base plates made at the glass factory in Brooklyn, and finding that Mr. Sharp could drill them, as I was returning home, I called at the glass factory, got my pocket full of the glass bases, took them to Mr. Sharp, and he did drill them. I wish to add that in none of these cases did Mr. Sharp know what the things he was doing were for, at least, I did not tell him. I mean during the period while we were at 43 Centre street, except in the one case some time after his work was done, I told him it was for an electric lamp.

Q. 3471. What other interferences did you have with your patents other than your interference with Mr. Edison?

A. We had an interference with Maxim & Keith, declared March 4th, 1879. That interference was dissolved March 2nd, 1880. We had also an interference with Brush & Fuller, which was declared April 29th, 1879, and dissolved January 5th, 1880. We had also an interference with Hiram S. Maxim, declared August 16th, 1880, dissolved July 10th, 1883. We had also an interference with Edward Weston, declared October 1st, 1881, and decided September 24th, 1884. The subject-matter of the first interference was treating and making carbons for incandescent electric lighting electrically in an atmosphere of hydrocarbon. The subject-matter of the
1696 second interference was an electrical switch for controlling
the currents in electric lighting. The subject-matter of the third interference was an electric regulator for governing currents in electric lighting. The subject-matter of the fourth interference was for the treatment of carbons for incandescent electric lighting in a hydrocarbon bath or atmosphere.

The complainant having called Albon Man, and offered in evidence his printed testimony and accompanying exhibits taken in the case of The Consolidated Electric Light Co. *vs.* The Edison Electric Light Company, pending in the circuit court of the United States, in the southern district of New York, and in like manner, his printed testimony and exhibits taken in the interference proceedings between Sawyer and Man and Thomas A. Edison, and it being understood that said Man is to be produced as a witness in this case to be subject to further cross-examination upon the testimony in the said two other cases, should defendant desire it after reasonable opportunity to examine the printed testimony now offered, the defendant now consents to the introduction of said testimony and exhibits without other objection than such as already appear upon the records now introduced.

Counsel for defendant notifies counsel for complainant that defendant now offers to enter into the same stipulation in respect to the testimony of any witness for Sawyer and Man in the interference above referred to, who shall be produced by the complainant for further cross-examination, as Mr. Man has been.

(COUNSEL'S NOTE: The testimony of Albon Man taken in the interference case referred to above, is printed in volume 3 of this record as follows: First deposition, pages 102–125; second deposition, pages 205–210; third deposition, pages 572–600.)

Adjourned till Monday, April 1st, at 3 p. m.

1697 TUESDAY, *April 2d*, 1889.

Met pursuant to adjournment.

Present: Mr. Broadnax for complainant and Mr. Lowrey for defendant, and the examination of Mr. MAX was continued as follows:

Q. 3472. State, if you please, who did the carbonizing at your shop at the corner of Walker and Elm streets?

A. Mr. Edwin L. Myers, principally under my direction. I did some, and Mr. William E. Sawyer, I think, did a little.

Q. 3473. Please to state if you recollect of making any lamps at your shop at Walker and Elm streets of the form substantially shown by the sketch now shown you.

A. I do.

Q. 3474. State if you recollect how many of such lamps were made.

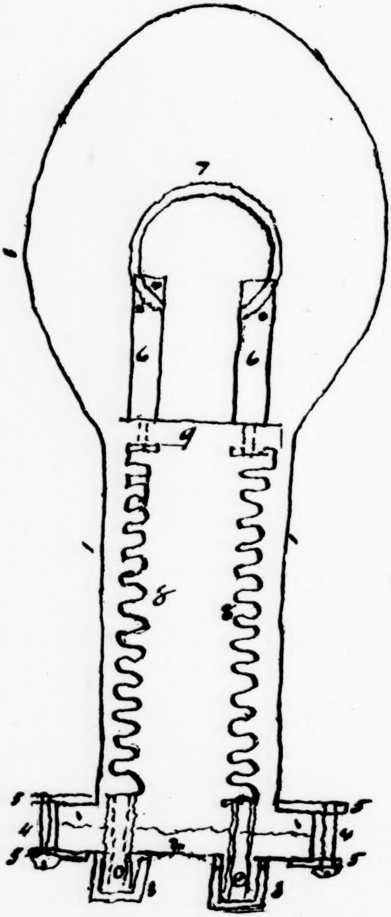
A. I cannot be precise as to numbers at this date, of that exact form of globe; my best recollection, I would say, about a dozen.

Q. 3475. Please to state how they came to be made, and state if you have any parts of such lamps that you can produce.

A. We had blown while we were at the corner of Centre and Howard streets a number of sizes of globes, as many, I think, as six or seven different sizes in diameter and of great variety and length. They were mostly straight tubes, with a flange at the lower end like test tubes in shape, but some of them had round bulbs blown on the closed end of the tube. The smallest size of these globes or lamp chambers had an internal diameter of about one inch and their length was from four to six inches; we had them set up at about the time of our going to Walker and Elm streets, or soon
1698 afterwards, a batch of something like a dozen lamps. Some of these had little round bulbs at the top. I did not like the shape of them. It was not pretty and after trying to draw something satisfactory to myself I called upon my friend, James McDonough, an artist and designer, and now president of the American Bank Note Company, and he drew for me the design of the tulip-shaped bulb shown in the drawing which I have produced and which I made. I took the drawing to Mr. Hahn, glass-worker, in North William street, and about a dozen of the straight tubes of the internal diameter of about an inch and the length of about four to six inches, already ground and fitted to the glass discs or bases of the lamps already used, and on which the works were set up, and the workman at Mr. Hahn's (they called the workman "Gus." I think his name was August Wedekind) blew the upper part of the tubes into the tulip-shaped form of bulbs, and I took them back to our shop in Walker street and had the lamps set up in them, and they were run there. I am unable to produce any parts of these lamps except the short spiral conductors, which I now produce, and do not know what became of them. I only know we had them and run them. I produce a piece of soapstone from which the diaphragms of these little lamps were turned, showing the diameter of the diaphragm of these small lamps in its circular part. I may have some of these diaphragms and might be able to produce them, but I have not found them yet. My attention was called to this matter in regard to this little

No. 286.
C.E. Light Co.
v.
McK. Light Co.
} p. 1699

Consolidated
vs
McKeesport
Complts Exhibit
Man drawing
of bulb shaped
Lamp April 2/89
WJJ
S.E.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lamp by the testimony of my daughter, Mrs. Ives, yesterday. I have spoken in my testimony of the small lamps and lamps with bulbs, but not those, if I recollect right, of this particular form.

Drawing and conductors and soapstone produced by witness, offered in evidence and marked "Complainant's Exhibits Man Drawing of Tulip-shaped Lamp and Exhibit Conductor of Tulip-shaped Lamp and Soapstone or Disc of Tulip-shaped Lamp, all of April 2, 1889."

(Here follows diagram marked p. 1699.)

1700 Q. 3476. Please to take the sketch produced by you and mark its several parts with letters or figures of reference, and describe its several parts on the record.

A. No. 1 is globe of lamp with flange; No. 2, glass base; No. 3, binding screws and cups with stop-cock; No. 4, binding screws of clamping rings; No. 5, clamping rings; No. 6, upright carbon clamps for incandescent conductor; No. 7, incandescent conductor; No. 8, copper conductors corrugated; No. 9, diaphra-m soapstone.

Q. 3477. What kind of carbons were used in those lamps?

A. Mostly small circular rings or loops. I think one or two of them were fitted up for straight pencils.

Q. 3478. What were they made of?

A. Carbonized wood and paper usually.

Q. 3479. Cut to size before carbonization?

A. Yes, sized and shaped before carbonization.

Q. 3480. Who, if any one of your family, did you take to see these lamps?

A. Early in the fall of 1878 I took some friends, Mr. and Mrs. Greenough, who were visiting at my house, my daughter Ida, and my sister-in-law, Alice Watkins (the two ladies who testified in my presence here yesterday), over to our shop in Walker street, and showed them our lamps, as the ladies testified yesterday. This was soon after our going to Walker street. I do not mean to testify that this kind of lamps was what was shown to them, for I do not remember, but I do wish to be understood that at that time we had the small lamps of this kind, and also many other kinds of lamps.

Q. 3481. When did you make the sketch which you have produced?

A. I made it in pencil mark last evening, finished and inked it this morning and just now.

Q. 3482. Does the sketch represent the lamp as made by you in 1878 as accurately as you can now recollect it?

1701 A. It does as accurately as I can recollect. It is not drawn to scale, except approximately, by the eye. It does correctly represent the general appearance of the lamp.

Q. 3483. Do your daughter and Miss Watkins identify it as of the form of globe which they saw and about which they testified yesterday?

A. They do, both of them.

Cross-examination by Mr. LOWREY:

X Q. 3484. In the letter produced by you referred to in your 3419th interrogatory, purported to be signed by Mr. Lowrey, dated October 30th, 1878, there appears to be a reference to an article in the morning paper. I hand to you a copy of an article from the New York Times of October 30, and ask you whether you understand that that is the article referred to.

It is understood that the copy referred to in the question is to be compared with the original and corrected by the examiner, and when so corrected to be treated as original.

A. Several of the newspapers contained more or less extended notices of our lights, I think on the morning of October 30th; of course I cannot say what one Mr. Lowrey referred to in that letter; I think the New York Times published an article that morning; my recollection is that it has already been introduced in evidence; I may be wrong.

X Q. 3485. Have you now read the Times article, and do you find the statements therein contained substantially correct?

A. Substantially correct, only as a newspaper reporter would write out an account of what he saw.

X Q. 3486. Do you see anything in that article to which you would wish to call attention as being incorrect in substance?

A. The reporter assumes, perhaps, in the article that he knew 1702 all that Sawyer and Man had done. I think he gives a pretty correct description, so far as it goes, of what he saw.

X Q. 3487. Can you tell from whom this or other reporters about that time obtained this information, whether from you or Mr. Sawyer, or both?

A. The reporters had been running there to our shop. We had to stop our lathe to run the dynamos. We would just simply show them the light and get rid of them, to go on with our work, not only reporters but other people. I think Mr. Sawyer sent notice to all the papers to have them all come at once, and they did come and the lights were shown to them. I was present part of the time. While I was there they asked questions of Mr. Sawyer and of myself, some of which we answered and some of which we did not answer, and the next morning these articles came out in the papers.

X Q. 3488. Mr. Man, I call your attention to cross-interrogatory 5, addressed to Franklin L. Pope, in this case and hand you at the same time an electric lamp bearing the stamp of Sawyer-Man upon the metal socket, and will ask you while examining the lamp to listen to the description of a lamp which I take from the interrogatory above referred to, and will ask you to say whether that is a correct description of the structure and mode of making of the lamp now in your hand?

"The lamp consists of what may be called two parts, one part consisting of an enclosing globe or bulb made entirely of glass; the other part consisting of an incandescing conductor and wires to which it is attached in the interior glass portion. The inside part

contains a filament of carbon first united mechanically and then electroplated to two small platinum wires. These platinum wires pass through the glass, the glass being sealed around the wires by the fusion of the glass. The inside part is then inserted in the glass bulb and the seal is made by hermetically sealing the glass
1703 bulb and the glass of the inside part by fusion of the glass; the lamp, as an entirety, being now complete, the air is exhausted from the top of the bulb, where the 'tit' is, and which previously was an open tube, and, after being exhausted, a hermetical seal is made at this point by the fusion of the glass."

A. In regard to the lamp you hand me, the description is a substantially correct one, except in particulars in which I am not able to judge from the mere appearance of the lamp, to wit: The attachment of the carbon conductor to the leading-in wires or conductors, and to the atmosphere of the lamp, of which I can know nothing by appearance. The description is not accurate as to the manner in which the leading-in conductors are passed into the lamp, nor in the support of those conductors.

X Q. 3489. Are those the only divergences of substantial importance that you note?

A. Yes.

X Q. 3490. State if you know by whom that lamp was manufactured, and for what purpose.

A. I do not know, except for the purpose, apparently, of electric lighting.

X Q. 3491. Do you not recognize that as a lamp of the Consolidated Company, made under the Sawyer and Man patents?

A. No; not of the Consolidated Company or the Sawyer and Man Company. I do not wish to be understood that it was not made by them, but that I do not recognize it. The particular part of it that I do not recognize is the attachment of the conductor to the leading-in wires.

X Q. 3492. Does this lamp conform in all essential particulars to the principles of construction under the Sawyer and Man patents with which you are familiar?

A. I think it contains many of the things which we patented, or substitutes or equivalents for them.

1704 The lamp is offered in evidence and marked "Defendant's Exhibit Sawyer & Man Electric Co.'s Lamp No. 1, April. 2, 1889."

X Q. 3493. I hand you now another example of a lamp, and ask you to state what that is, if you know.

A. That is, I think, a Sawyer & Man lamp, made by the same company.

Said lamp put in evidence, and marked "Defendant's Exhibit Sawyer & Man Electric Co.'s Lamp No. 2, April 2, 1889."

X Q. 3494. Tell me, if you know, whether lamps of the type of either of these exhibits are in general use in connection with the electric lighting system of the complainant.

A. I know only that many lamps similar in general appearance to these, without going into details as to construction, are in use all over the country, and I understand them to be put out under the general direction of the complainant, or its licensees.

X Q. 3495. I now show you a lamp, which has been put in evidence in the case of The Consolidated Electric Light Co. *vs.* The Edison Electric Light Co. in the southern district of New York, and marked "Complainant's Exhibit No. 21, Edison's Incandescent Electric Light, Timothy Griffeth, examiner, October 9, 1886," and which is understood to be identical with "Exhibit Defendant's Lamp" and referred to in interrogatory 4, to Franklin L. Pope herein, and will ask you to compare it with Exhibits 1 and 2, referred to in the last interrogatory, and say in what essential particulars, if any, the latter differs from the two former lamps? I do not refer to non-essential mechanical details, but only to such particulars as affect the character of the respective lamps, as consisting chiefly of fibrous, arc-shaped incandescing conductors in chambers wholly of glass and hermetically sealed.

1705 A. You wish me to leave out then all the mounting of the lamps and consider them simply as to the glass leading-in-conductors, atmosphere and carbon?

Counsel says "yes."

Witness continues:

The construction of the three lamps is very similar; a slight difference in the shapes of the globes, a difference in the support of the leading-in conductors and the carbon conductor; a difference between No. 2 exhibit and the Edison lamp in the attachment of the leading-in wires to the carbon conductor. I cannot tell how the attachment between the leading-in conductors and the carbon conductor is made in Sawyer-Man lamp, No. 1 exhibit. In the Edison lamp it is evidently electroplated with copper. In the Sawyer-Man lamp I do not know that I have ever seen one like it and don't know how it is connected.

X Q. 3496. What appears to be the material of the carbon in each case?

A. Carbonized fibrous material.

X Q. 3497. By what do you judge that it is fibrous material?

A. I know of no way by which such conductors as these appear to be can be made except from fibrous material. It is proper to remark that all the conductors appear to my eye to have been treated in some manner by deposit of carbon upon them.

X Q. 3498. From your experience in the making and inspection of lamps, do you doubt that these carbons are as stated in the question to Mr. Pope and to yourself, made from bamboo fibre?

A. I have no knowledge whether from bamboo fibre or some other fibre. I simply know that bamboo fibre would make such carbons, and if asked should say that they look like carbons made from bamboo fibre.

X Q. 3499. You have spoken in your recent re-examination-in-

chief of refitting and refilling and cleaning of lamps. Will
1706 you explain in a general way the occasions which occurred
in your experience, or were expected to occur in the use of
your lamps, for refitting or refilling a lamp, and how this would be
done?

A. All our lamps, while Mr. Sawyer and I were working together, were made so as to be readily taken apart, so that anything could be readily done to the interior work of the lamps, such as substituting carbon conductors, or restoring vitiated atmosphere or an atmosphere not suitable to the incandescent lamp. The word "filling," as used by me, covers exhaustion of the atmosphere filling with an inert gas, repeating the process of exhaustion and filling, heating up the walls of the lamp and heating up the interior of the lamp, and especially the incandescent conductor by an electric current, and finally leaving the lamp sealed up with an atmosphere of inert gas, or a vacuum of such gas. Perhaps it would be better to say, such a gas at different pressures from a little below atmospheric pressure to a substantial vacuum. The method of doing this, while Mr. Sawyer and I were working together, was to take out the screws holding the binding rings together, remove the sealing, open the stop-cocks to let the air in, in case there was an attenuated atmosphere in the lamps, then remove the glass plate to which was attached all the interior works of the lamp. If any purifying were required, clean the parts as attached to the glass base plate; if the carbon were a straight-pencil carbon, remove it, or any remains of it, and put another in its place, wash out the globe with alcohol, or ether or both; put the interior works of the lamp which were on or attached to the glass base plate into the globe proper, and screw the two parts together with the binding screws and rings. The refilling was done in the same manner as the original filling, all the lamps requiring to be filled or exhausted being connected together in one batch, and all done together. By refitting, I mean this, that we were frequently and often changing
the carbon-holders and their adjustments with the carbon
1707 incandescing conductor, and these changes I call refitting.
In the straight-pencil lamps the method of holding them in
the carbon clamps or holders was very frequently changed. This I called refitting. Again, the parts of the lamp above the diaphragm (which diaphragm is represented in the exhibits you have presented me to-day, by the glass support of the leading-in conductors) were frequently changed to use carbons for incandescent conductors of different shapes, or lengths, or sizes, such as the change from straight pencils to arch-shaped carbons of greater or less diameter, or the reverse, from arch-shaped to straight pencils of greater or less length. The occasion for doing this was to make a lamp which in all its parts, except the incandescent carbon conductor, would be permanent, and to make a lamp of such construction that a new incandescent conductor could be substituted in the lamp, which itself was permanent. The further occasion in our practice for the thing was like this: The testing of contacts between the holders and the incandescent conductor, the testing of the atmos-

phere of the lamp and the durability of the incandescent conductors of different shapes, forms and sizes, and of different methods of attachment to their holders. We almost continually took down good lamps to examine microscopically the incandescent carbons. We also frequently took down good lamps because, by reason of the formation of electric arcs at the points of contact, we found that such contact had not been made perfect electrically. We observed these arcs when the lamps were set up by means of a camera and screen by which a picture of the carbon while incandescent was thrown upon the screen of very large size, and when we found the least appearance of such an arc or defect, or the least appearance of the consumption of the carbon, or of defect in the carbon, such as unequal resistance at different parts of it, we usually took the lamps down, refitted or refilled them, or both, or sometimes ran them to light our shops, but not for exhibition In the
1708 straight-pencil lamps some of these lasted a very long time. Many of them were good lamps, but we thought them not reliable.

X Q. 3500. I understand then, Mr. Man, that you contemplated that in use the illuminating part or carbon might be subjected to injury or destruction, and the design of the lamp was to allow renewal or repairs without sacrificing the lamp chamber itself or any of the uninjured parts of the structure?

A. Yes, we did so contemplate and we did not know as we do now, the average life of the carbon conductor, and we thought it desirable to make a lamp in which a new carbon conductor could be substituted for one that should give out for any cause at any time.

X Q. 3501. You understand that we are speaking of the lamp of the patent in suit?

A. I mean the lamps made by Mr. Sawyer and myself, one of which is illustrated in the drawings of the patent in suit.

X Q. 3502. Look at figure 2, attached to the patent in suit, and say whether that is intended to illustrate a lamp upon the plan and to attain the purposes which you have explained.

A. The illustration, figure 2, is from the drawing accompanying the application for the patent in suit, and was made from an actual lamp given to the draughtsman from which to make it, which was one of the lamps made by Mr. Sawyer and myself, while at 94 Walker street, in our work for making a practical incandescent lamp, and is one of the plans used by us for that purpose. It is a lamp that may be readily taken apart and set up again, as I have described.

X Q. 3503. Is that lamp, as thus designed and constructed within, according to your understanding, the second and fourth claims of the patent in suit?

A. First, as to the second claim: I answer, yes, if the incandescent conductor is made of carbonized, fibrous material. Second: As to the fourth claim, I answer, yes.

1709 X Q. 3504. Please look again at Exhibits 1 and 2 of to-day and 21 of the New York case, referred to in a previous answer, and say whether their construction contemplates or permits the opportunities and advantages of repair or change which you have spoken of in your answer to interrogatory 3499 and subsequent questions.

A. They do not in any practical sense; that is, they cannot be readily taken down and set up again. I suppose, indeed I know, that a skillful glass-blower could take those lamps apart and a new carbon could be substituted or other change made in the interior of the lamp, and the lamp be again closed, refilled or exhausted, or both, and run again, but it would cost more than to make new glass parts for the lamp, preserving the metal parts.

X Q. 3505. Do you mean to say that it would be practical to do that with the lamp of the patent in suit, on the score of cost?

A. Yes, it could be readily taken down and a new carbon substituted, and the lamp be recharged or exhausted, and in many places to-day a lamp adapted for this purpose would be highly desirable. In referring to the lamp of the *the* patent in suit I simply refer to the type of lamp illustrated in the patent in suit, and do not mean to be understood that the invention sought to be covered by the patent in suit is limited to that type of lamp. If you refer to the cost of taking down a lamp and putting in new carbon conductors in lamps of the type of that illustrated in the patent in suit, the cost is entirely within the limits of practicability for many purposes for which incandescent lamps are or could be used to-day.

Adjourned till Wednesday, 3d inst., at 1 p. m.

1710 WEDNESDAY, *April 3d*, 1889.

Met pursuant to adjournment.

Present: Mr. Broadnax for complainant, and Mr. Lowrey for defendant, and the cross-examination of Mr. MAN proceeded as follows:

Mr. MAN here says: "I wish simply to say that in my answer to cross-question 3499, while I say that all the lamps made by Mr. Sawyer and myself were made so as to be readily taken down, &c., that my statement was intended by me as a general statement. The word 'all' is too broad, taken specifically, as a few lamps made by Mr. Sawyer, in which I did not participate, and one or two made by myself, were not intended to be taken down. If the word 'nearly' is put before the word 'all,' my answer would be correct."

X Q. 3506. Where are the one or two lamps which you have just spoken of as made by you; can you produce them, and will you?

A. I don't know. I at one time gave one of them to Mr. Broadnax, my counsel. They were made by Mr. Sharp and substantially illustrated by the drawing made by Mr. Sharp.

X Q. 3507. Do you now produce one of those lamps?

A. Yes, one of those made by Mr. Sharp, but not the one he illustrated.

X Q. 3508. Has this lamp which you now produce been in use?

A. Yes, I think so, only experimentally.

X Q. 3509. Please explain what was the arrangement of circuits and of incandescent conductors if there were to be more than one used in that lamp?

A. It was intended for two incandescent conductors.

1711 X Q. 3510. Where and for how long a time had you that is use?

A. At 43 Centre street while we were there. I should think in the month of March, 1878. The only use we made of it was simply a trial and not permanent use. The tubular conductors in the trial we made of it were covered at their ends with India-rubber tubing, and the tubing, after charging the interior of the lamp, was simply pinched together. The carbons were passed in through the tube and impinged upon the cross-piece hinged upon an upright held by a spiral spring in a central tube. The other lamp had lead tubing soldered to the ends of the tubular conductors after the carbon was put in, and had only one carbon, and after the lamp was charged the lead tubes were pinched together and melted to make them air tight. This lamp does not appear to have been run long enough to have determined any advantage in it, and so had not the means of permanently sealing it up attached.

X Q. 3511. There were two lamps similar in character, as I understand, one of which you produce, where is the other?

A. I don't know. It was at our shops. I don't know what became of it. It was never used after we left 43 Centre street.

X Q. 3512. Did you ever see it after leaving there?

A. No, sir.

X Q. 3513. You say the carbons were pushed up through the tubes in that lamp. Was it so in the lamp with the lead tubing?

A. Yes; there was only one carbon in the lamp, and the upper carbon piece was held rigidly instead of by a spring as in this case, and the carbon conductor was held up to it by a rod of carbon of the size of the bore of the tube, into which the end of a straight pencil carbon was inserted, and under the rod of carbon was a spiral spring to hold the carbon pencil up to the upper contact piece of the lamp. The holes through which the tubes pass are bored in the glass and sealed with binding screws. 1712

X Q. 3514. Did you insert the pencil or carbon before or after you had filled the lamp chamber with the atmosphere?

A. Before.

X Q. 3515. There are pieces here at the lower end of the tubular conductors which unscrew and come off. Were they removed for the insertion of the carbon and the filling of the lamp chamber?

A. They were removed for the insertion of the carbon, but were replaced and had lead tubes soldered to them before the charging of the lamp chamber. Not in this lamp, but in all glass lamps that Mr. Sharp illustrated.

X Q. 3516. What was the carbon material used in this lamp and the other?

A. Straight pencils of French carbon.

X Q. 3517. Do you mean of the Carre carbon?

A. Carre or some other French manufacture.

Said lamp put in evidence and marked "Defendant's Exhibit Experimental Lamp Produced by Man, April 3d, 1889."

X Q. 3518. How many types of lamps had you from the beginning of your work with Sawyer until its close in March, 1879?

A. I don't know that I could state. I have gone over that very fully, and it is only by going over from first to last all the work that we did that I could enumerate the different types. There were two general classes of the lamps, straight pencils and arched pencils, or V or other shaped, in which latter the incandescent conductor rose above or extended beyond both the holders or conductors leading to it.

X Q. 3519. I understand you to say that exhibit conductors put in evidence April 2d, 1889, are examples of part of the smaller forms of lamps?

1713 A. Yes, the shorter form of lamps. I think that they were used in the smallest form of lamps, but I can't be certain. I am sure they were used in the shorter form of lamps. They were conductors of this form that were used in the smallest form of lamps, perhaps of less size.

X Q. 3520. If I understand your recent testimony correctly, you made and set up between two and three hundred lamps of these various forms?

A. That is my estimate. I do not wish to be understood as swearing to positive numbers.

X Q. 3521. The lamps which you had were then made for your own use experimentally and otherwise?

A. It would be more accurate to say that they were not used, to my knowledge, except by ourselves and by Mr. Sawyer, after he separated from the Electro-Dynamic Light Co., unless they were used by some other people by direction of Mr. Sawyer in this later period. They were made, most of them, with a view of being sold.

X Q. 3522. Did you know in 1878 and 1879 of any rule by which you could have determined which was the better kind of fibrous material for your use without experiment?

A. One thing we took into consideration: The purity of the fibre to be carbonized. Our rule was to get as pure cellulose as possible, in which there was as little admixture of other things than gases and carbon (particularly metals or their bases), as possible. Another thing was to get a dense fibre, or one that was not too porous; another thing was to get a fibre that was uniform and that could be easily worked and put in shape before carbonizing. These rules, except the first, were learned by us very early by experiment. The first was determined when we determined to use carbon in our lamps. I do not know of any experience or rules of others at that time except the high resistance of pure carbon to heat, its high melting point, its infusibility.

X Q. 3523. By means of these experiments and the appli-
1714 cation of these rules, were you enabled within the range of

the materials which you examined to select the better and reject the worse natural fibres for your purpose?

A. We thought so, so far as our experiments extended, but it is proper to say our experiments and selection by means of them were limited to our then forms of lamps.

X Q. 3524. Did you make any experiments as to the kind of vegetable fibre most desirable, having in view standards of resistance in the incandesncing conductor, standards of size in main or distributing conductors, and other standard conditions of a business in which current is to be supplied from a central station for use in towns, cities, or villages? Did you assume conditions for this purpose?

A. We made experiments and calculations with reference to all things you mention.

X Q. 3525. Were there any of these conditions in respect to which you made these experiments and calculations in which you found willow carbon the best for the purpose?

A. I don't know or recollect.

X Q. 3526. Were there any of these conditions in respect to which you made these experiments in which you found carbonized paper the best for the purpose?

A. Confining myself to central station plant lighting, I do not know or recollect.

X Q. 3527. In your cross-examination you were asked (X Q. 964): "Now, if a person wanted to make a lamp under this patent with an incandescent conductor of fifty ohms resistance, what would he have to make the length or cross-section of his carbon?" and you answered: "I cannot tell without knowing the carbon that he was using and its resistance, and then only by experiment." Would not that be a correct answer in respect to any kind of carbon in any of the lamps which were made by you?

A. No, not in the sense that we could not or did not make carbons of any fixed or determined resistance which we desired.
1715 In the sense that I would have to know the elements I have mentioned there, of resistance in a particular case, before I could determine how to make the carbon, it is a correct answer. By "elements of resistance" in the conductor, I mean the specific resistance of the carbon to be used and its dimensions in either length or cross-section, which were not given to me in the question then asked.

X Q. 3528. Would the material of the carbon as to whether it was one vegetable or another vegetable fibre have anything to do with determining the question?

A. Yes, both the material and its treatment before carbonization.

X Q. 3529. Suppose in 1878 and 1879 you had wished to use incandescent lamps in multiple arc in the number of ten lamps of sixteen candles each for each horse power of current, and to attain the best duration of which you then had any experience, which one of the woods with which you were then familiar would you have selected as best for the purpose?

Obected to as not cross-examination and not material.

A. I speak from recollection that I think we should have selected willow, and treated the carbons.

X Q. 3530. Was that judgment the result of experiments which you tried on various kinds of wood?

Same objections.

A. It is a recollection only of what I think we would have done in looking back now upon the experiments we tried.

X Q. 3531. Are there any uses in electric lighting to which bamboo carbon would be applicable, and in which willow carbon would be either inapplicable, or less applicable?

Same objections.

A. I don't know; there may be, or may not.

X Q. 3532. Is willow carbon, to your knowledge, used anywhere at present in electric lighting?

1716 Same objections.

A. I have seen some lamps with willow carbon, a year or two ago. I don't know whether there is any use made of them now. I think it would be a good material to use now for some of the incandescent lamps.

X Q. 3533. Do you know whether there is any way of ascertaining if you are right in your last answer, except by experiment?

Same objections.

A. Yes; I know I could go to work and make good lamps of willow carbon, or, at least I think I could.

X Q. 3534. Do you mean that they would be commercial lamps in modern systems of lighting?

Same objections.

A. I mean that they would be good commercial lamps in some of the modern systems of electric lighting, in my opinion.

X Q. 3535. Have you any experimental experience, or are you answering according to your judgment merely?

Same objections.

A. I have not made any lamps since I quit working with Mr. Sawyer. I have advised in regard to the making of lamps at different times since then.

X Q. 3536. On page 48 of the minutes, on the eighth line from the bottom, I find the word "Sawyer's" between the word "his" and the word "judgment" interlined. Tell me if you know in whose handwriting is the interlineation.

A. In Mr. Sawyer's, I think.

X Q. 3537. Is the whole page in his handwriting?

A. Yes.

Adjourned till Thursday, the 4th inst., at 1 p. m.

1717 NEW YORK, *April* 4, 1889.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. MAN was continued as follows:

X Q. 3538. You have referred to Mr. Lowrey's visit to the shop of Sawyer & Man on the 30th of October, 1878, and have stated that you then exhibited to him your light. Please state whether you showed or communicated to Mr. Lowrey anything more than had been on the day previous communicated to the various representatives of the press?

A. I think that we exhibited to Mr. Lowrey about the same as was exhibited to the representatives of the press the day before, and in about the same manner. The lamps exhibited to him, according to my recollection, had straight-pencil incandescent conductors, and we told him that we made them of carbon. I do not recollect of anything being said of how our conductors were made or of any discussion of the carbon, except simply that we made them and they were of carbon; of course I cannot say at this length of time whether we told Mr. Lowrey some things that we did not tell the press representatives, or whether we told the press representatives some things that we did not tell Mr. Lowrey.

X Q. 3539. I hand to you what purports to be a letter signed by you and addressed to Charles A. Cheever, Esq., dated Dec. 12, 1880, and ask you to say whether that is your letter and whether it was sent to Mr. Cheever at or about its date?

A. Yes.

Said letter offered in evidence and marked "Defendant's Exhibit Man-Cheever Letter, April 4, 1889."

1718 Redirect examination:

R. D. Q. 3540. What, if any, profit have you made out of your enterprise in electric lighting entered into by you with Mr. Sawyer?

A. I have made none, and I have no prospect of making any, and on the contrary, have put in a great deal of money aside from my time, of which I see a prospect only of recovering a part.

R. D. Q. 3541. You have stated that Mr. Sawyer resigned the offices of secretary and trustee in the Electro-Dynamic Light Co. in the spring of 1879. State if you have refreshed your memory since as to the date of his resignation, and make such corrections as you wish to.

A. I think I stated when first examined in this case before Mr. Kitchen, examiner, that my impression was that Mr. Sawyer resigned in the spring or summer of 1879. I have not the means of referring to my testimony now, but that is the impression I have in regard to it. I have since refreshed my recollection by reference to the minute book of the Electro-Dynamic Light Co., which I had not then and had not for years before been able to examine. I find by the minutes of the meeting of the trustees of the Electro-Dynamic Light Co., in my own handwriting of Nov. 20, 1879, that Mr. Sawyer's resignation was accepted at the meeting of that day. I find by the minutes of the meeting of October 7th, 1879, at which Mr. Sawyer was also present and at which meeting no business was transacted except to adjourn, that I acted as secretary, although Mr. Sawyer was present. My recollection therefore is that Mr. Sawyer offered his resignation in the fall of 1879, and before or on October 7th.

R. D. Q. 3542. State whether or not you have recently furnished the Consolidated Electric Light Co., or the Sawyer-Man Electric
Company, its licensee, with parts of Sawyer-Man lamps, to
1719 be used by them in the construction of such lamps, to be
used as exhibits in this case, and if yea, please to state what
parts you furnished?

A. During the year last past I have furnished to them the parts of the Sawyer-Man lamps, enough for about from thirty to fifty lamps, made or caused to be made by Mr. Sawyer and myself (while we were working together) for the Electro-Dynamic Light Co. in 1878 and 1879, and which I have had in my possession ever since then. I delivered these to Mr. Robertson, Mr. Packard and Mr. Garden. The parts I think were complete for nearly all the lamps, except the carbon-holders, possibly some diaphragms and the carbon incandescing conductors. They were glass globes, glass base plates, binding rings, tubular binding screws, with stop-cocks, cups to cover the stop-cocks and binding screws, corrugated leading-in conductors, spun caps for covering the base of the lamps made of sheet metal. I have also given to Mr. Packard, Mr. Shallenberger and others instructions as to the making and purification of nitrogen gas and the details of work in setting up and sealing the lamps, and part of the material I furnished was sent to Mr. Shallenberger at Pittsburgh.

R. D. Q. 3543. Please to give the name of the person who put up for you at your Walker-street shop the water-exhausting apparatus referred to by you in your answer to question 3453.

A. David Hennessy.

R. D. Q. 3544. In the article taken from the New York Times of October 30, 1878, and put in evidence by defendant's counsel, it is stated:

"The pencil of carbon is heated by the electric current with a temperature of from 30,000 to 50,000 degrees Fahrenheit, in an atmosphere with which it cannot chemically combine."

State if you know what authority there is for that statement.

1720 A. Mr. Sawyer and I made experiments to ascertain what degree of heat carbon would endure without softening or becoming flexible. Our experiment was made in this way; we took different metals whose melting points were known, placed them in our lamps, passed through them currents of definite quantity and electro-motive force to heat them up to the melting point, turning in the electric current gradully. We took carbon conductors and turned into them currents of the same electro-motive force and quantity, or amperes, as those at which the different metals melted. We took into consideration the resistance of both the metals and the carbon conductors and their specific heats. From this we ascertained, or thought we did, in a rude way, approximately, the temperature of the carbon conductors at different degrees of luminosity. From this we deduced a rule of temperature of the carbon conductors as their luminosity increased. It was a rough and crude way of approaching the subject, but from it we came to the conclusion that pure carbon would soften and bend at a temperature of 30,000 to 50,000 degrees. Mr. Sawyer was in the habit of stating that we had found out that these carbons that we used would stand from 30,000 to 50,000 degrees Fahrenheit. I never heard him make the statement that we ran our lamps at such a temperature, and I think I certainly never made such a statement. I know of no other authority for its being stated in the newspapers than that I have given. I think the reporter must have got the idea from some statement of what degree of heat we thought carbon conductors would endure.

ALBON MAN.

Counsel for complainant offers in evidence a diagram made by the defendant's witness, Wm. Sharp, of the Walker-street shop, in answer to question 547 of his deposition and the same to be taken as part of his said deposition, the same is marked "Complainant's Exhibit Sharp's Diagram of Walker-street Shop, April 4, 1889."

Adjourned till Friday, April 5th, 1889, at 1 p. m.

1721 COMPLAINANT'S EXHIBIT CHEEVER AGREEMENT, W. T. F., S. E.

Agreement made by and between the Electro-Dynamic Light Company, organized under the laws of the State of New York, and having its principal place of business in New York city, party hereto of the first part, and Charles A. Cheever, of the city, county and State of New York, party hereto of the second part:

Witnesseth, that whereas, the party of the first part is the owner of a certain improvement in electric lights or lamps, consisting in the use of an incandescing arc of carbon, the joint invention of William E. Sawyer and Albon Man.

And whereas, the party of the second part is desirous of acquiring the ownership and control of said invention for the United States and of any letters patent of the United States granted therefor; to which end he desires time in which to negotiate with other parties in relation to the purchase of said invention and patent for the common benefit of the parties hereto:

Now, therefore, in consideration of the premises and of other good and valuable considerations, them thereunto moving, it is agreed and covenanted between the parties hereto as follows:

1. The party of the second part shall have the right or option of purchasing said invention, as described and claimed in that application, this day prepared and executed, and shown in the models and drawings thereof, and in any letters patent which may hereafter be granted in the United States therefor, thereon for the sum of one hundred thousand dollars in cash, during the coming week,

ending at midnight of Saturday, January seventeenth, eighteen hundred and eighty.

1722 2. The expense of preparing and soliciting the patent herein referred to, is to be borne by the party of the second part, as far as incurred during the existence of this option. In case he fails to purchase, he is to be liable for no further expense, but in case of a consummation of the purchase, all further expenses, costs and charges are to be borne by the party of the second part.

3. It is understood between the parties hereto that said party of the second part will complete his negotiation at the earliest practicable moment; but in case delays should occur, if matters are in such condition that further time can be given to complete such negotiations, without loss to the party of the first part, or complications of its affairs, such time may be given by mutual consent.

CHAS. A. CHEEVER.

Dated January 9th, 1880.

Witness to C. A. C.:
W. K. APPLEBAUGH.
WILLIAM D. BALDWIN.

1723 COMPLAINANT'S EXHIBIT LOWREY LETTER OF OCTOBER 30, 1878. March 28, 1889. W. T. F. E. E.

John K. Porter, Grosvenor P. Lowrey, Geo. Wales Soren, Ch. Francis Stone, George S. Hamlin.

Porter, Lowrey, Soren & Stone, attorneys and counsellors at law, No. 3 Broad street, Drexel building.
P. O. box 1836.

NEW YORK, *October 30th*, 1878.

DEAR SIR: Referring to my visit to 94 Walker street this morning, I think it desirable to repeat to you more deliberately than may be done in a hurried conversation that the field of electric lighting is so vast, and promises such great results that good business men would commit a great error if they should allow themselves to become, in the outset, involved in any uncalled-for struggle for the possession of the whole field, and a small part of it would be enough for all.

As I said to you this morning, the suggestions which passed between us, arising apparently in both our minds out of the same practical considerations, were not intended by me to express the opinion of my associates, for I had not seen any of them since reading in the morning paper the announcement of the Sawyer-Man light; nor do I understand what you said as in any way committing you, except to the general proposition that it was always in these matters wiser to unite strong parties than to divide them, and leave them to expend themselves in opposition.

I want to repeat, therefore, that I shall be at all times in favor of considering more carefully the general ideas which we mutually expressed, and that without any very great reference to the question, who would or who would not succeed in the final contest.

1724 As I understand it, you have not a correct idea of Mr. Edison's light; in fact, he has not allowed any one to know what his intention consists of, but I understand that you have what is apparently to me a very good light, and even if we were able to sustain both rival patents we should be competitors in business, which itself would be commercially a great mistake.

I have already described to one of the directors of our company what I saw of your light and I shall mention our conversation to others as I shall chance to meet them.

You will be glad to hear that a telegram from Menlo Park this morning informed me that Mr. Edison slept twelve hours last night without pain, and is therefore out of the difficulty which has prevented him *for* working for the last few days.

I presume that your foreign patents are taken out, and I think there is a much greater field over there than here, and also if there should be a practical union of these interests in any way, it would be enormously to the advantage of both, on the other side, to be represented by the same strong banking house or houses.

Very truly yours,

(S'd) G. P. LOWREY.

Albon Man, Esq., 94 Walker street, city.

1725 COMPLAINANT'S EXHIBIT MAN'S LETTER TO LOWREY OF OCTOBER 31, 1878. March 29, 1889. W. T. F., S. E.

NEW YORK, *October* 31, 1878.

DEAR SIR: I have to acknowledge the receipt this afternoon of your letter to me of Oct. 30th inst. We feel very confident of the success of our inventions and the stability of our patents. Some of your people, and if we are not mistaken, from Mr. Edison's own laboratory, have seen our light and can attest its excellence, as can also a vast number of people who have thronged to see it. Of course we have not made public all that we have done, nor do we suppose that Mr. Edison has done so, but we do distinctly claim that we are the inventors of all that we use, and that we can show our priority over Mr. Edison and every one else in these inventions, and we cannot but feel from what we see published that many of these inventions are essential to the successful working of Mr. Edison's light.

If we are right, Mr. Edison's light, if put in operation, must in the end pay tribute to us. At the same time, my dear sir, we do not claim to be all the world, nor to contain all the wisdom of it, nor to know in advance all that has been and will be found out about lighting by electricity. Permit me just here to pay what is but just tribute to the ability, skill and inventive talent of Mr. Edison, and to admit that his well-known character in this respect is a great advantage to those attempting to bring his inventions before a public whose confidence in him as an inventor is great. I admit at the same time the high character, standing and wealth of your associates, as you must that of those who are associated with us.

1726 I do not permit myself for a moment to think that either you, or those associated with you, would think of attempting to deprive us by litigation or otherwise of our just rights, notwithstanding any inference to the contrary that might be drawn from your letter. Having thus cleared the ground, I have to say that I can see no ground of objection to a union of interests that should do away with antagonism, if a fair basis for such union can be found. But on the contrary I can see, and I have no doubt the eminent business men who are associated with us in interest would also see, that great advantages might be derived to both companies from such a union.

If you will bring about the appointment of a proper committee from your company for the purpose, I will see to it that representatives from our company shall meet them as soon as you advise me, for the discussion of the subject. The matter may be informal if you desire it, at first.

I am happy to hear of Mr. Edison's improved health.

In the matter of foreign patents I believe we are all right.

Very respectfully yours, ALBON MAN.

G. P. Lowrey, Esq., Drexel building, cor. Wall and Broad streets, N. Y.

1727 COMPLAINANT'S EXHIBIT LOWREY LETTER OF NOVEMBER 6, 1878. March 29, 1889. W. T. F., S. E.

John K. Porter, Grosvenor P. Lowrey, Geo. Wales Soren, Ch. Francis Stone, George S. Hamlin.

Porter, Lowrey, Soren & Stone, attorneys and counsellors at law, No. 3 Broad street, Drexel building.

P. O. box 1836.

NEW YORK, *Nov. 6th*, 1878.

DEAR SIR: I received your letter of Oct. 31 inst. as I was leaving my office. I had time to glance at the first page of it hastily, and then, thinking I might not have another opportunity for several days, I dictated to my stenographer my letter to you of November 2d and left it to be written out and signed by him for me. I have just this morning returned to the city and take the first opportunity to make a more formal reply.

I adhere to the general ideas of policy which I expressed to you in conversation and in my former letter. I do not think the matter is in any situation, however, to require the present consideration of whether or not we are likely to be rivals, and as such, injurious to each other. That time may very likely come, and perhaps soon, and of one of those interested in Mr. Edison's patents, I shall be ready and disposed towards whatever may seem to be required by good business judgment.

1728 I should not allude to any possible contest between our patents, except from your having exppessed a belief (very proper from your standpoint) that "Mr. Edison's light, if put in operation, must in the end pay tribute" to you.

I am entirely satisfied that the most exhaustive search of what has been done others will show that Mr. Edison has produced a perfectly novel invention.

Very truly yours, G. P. LOWREY.

Albon Man, Esq., 3 Mercer St., city.

1729 Complainant's Exhibit Sawyer's Letter, Dated March 7, 1878. March 27, 1889. W. T. F., S. E.

Office of the United States Electric Engine Co. (74 & 75 Coal and Iron Exchange), 21 Cortlandt St.

New York, *Mar.* 7, 1878.

Dear Sir: I received your note too late to see you yesterday, having been very busy running round all day. Before receiving it I had made an important appointment for this morning, and could not therefore come round to-day.

There is no machine at Columbia college, but I have got hold of a Hochausen machine that answers the purpose. Shall have it all this week, but not next week. I have hired a room, this morning, at 43 Centre street, up one flight, and the wires are now being run. Expect to do something this afternoon. If you can come round between 2 and 4, I will meet you there. Ask the engineer in the basement for my location. The entrance is by an arched way from Centre street.

The difficulty seems to be vanquished, although the machine is not just what we want.

I tried the full power on a lamp yesterday, and you would have supposed a small sun was shining in the vicinity.

Truly yours, in haste, W. E. SAWYER.

1730 Complainant's Exhibit Lowrey Letter of Nov. 2, 1878. March 29, 1889. W. T. F., S. E.

New York, *Nov. 2d*, 1878.

Dear Sir: I have this moment received your letter, which, however, I have not time to read, as I am going out.

I was surprised this morning to hear that my letter to you was spoken of as an advance towards a consolidation of our company with yours. I am sure you cannot have made such a mistake. At any rate, if such an impression was derived from what I wrote, there was no such specific purpose in my mind, and I desire to correct it now and to add that I have not the slightest idea that the Edison Electric Light Co. would entertain any such proposition from you, and certainly they would not make it.

It is one of the dangers of private intercourse that it is liable to these misconstructions.

Very truly, G. P. LOWREY,
By K.

Albon Man, Esq., 94 Walker St.

1731 (Vol. II.)

United States Circuit Court, Western District of Pennsylvania.

No. 5, May Term, 1888.

In equity.

THE CONSOLIDATED ELECTRIC LIGHT COMPANY
vs.
MCKEESPORT LIGHT COMPANY.

Testimony on Part of Complainant in Reply, Taken before William T. Farnham, Special Examiner, under Order of Court Reopening the Testimony.

NEW YORK, *March 30th*, 1889.

Present: Thomas B. Kerr, counsel for complainant; and Richard N. Dyer and *and* Walter K. Griffin, of counsel for defendant.

1732 THOMAS B. STILLMAN, a witness on the part of the complainant, being duly sworn, deposes as follows in answer to interrogatories by Mr. KERR:

Int. 1. Please to state your name, age, residence and occupation.

Ans. Thomas B. Stillman; age, 37; residence, Hoboken, New Jersey; my profession, analytical chemist.

Int. 2. Were you acquainted with William E. Sawyer; and if so, when did you get to know him?

Ans. Yes, sir; in December, 1878.

Int. 3. Are you acquainted with Albon Man? If so, when did you get to know him?

Ans. Yes, sir; at the time that I became acquainted with Mr. Sawyer.

Int. 4. Under what circumstances did you become acquainted with Sawyer and Man?

Ans. I was consulted by them at that time in regard to the preparation of pure nitrogen gas

Int. 5. For what purpose?

Ans. The gas to be used in the filling of the Sawyer and Man electric lamps.

Int. 6. Did you do any work for them at that time; and if so, what?

Ans. I did. I arranged an apparatus for manufacturing and purifying nitrogen gas, and also filling the lamps with the same.

Int. 7. Where did you arrange this apparatus?

Ans. In the first place at 94 Walker street at their factory; and in the second place at my laboratory at 40 Broadway.

Int. 8. Did they have any apparatus for that purpose at 94 Walker street before you arranged the apparatus you have spoken of for them?

Ans. They did.

Int. 9. Please describe it.

Ans. It consisted of a large glass retort connected to a series of Wolff *pottles*. The Wolff bottles contained purifying agents, and a large rubber bag as a receiver.

1734 Int. 10. Will you please produce drawings of the apparatus for purifying nitrogen gas and for filling the lamps, which was arranged by you for them?

Ans. I now produce the drawings required, which I have marked "Stillman No. 1" and "Stillman No. 2;" drawing No. 1 representing the method of preparation of the gas, and drawing No. 2 the method of purification of the gas.

The drawings produced by the witness are offered in evidence as Complainant's Exhibits Stillman No. 1 and Stillman No. 2, W. T. F., examiner, March 30, 1889.

Int. 11. Please describe the apparatus shown in the drawing "Stillman No. 1."

(Here follows diagram marked p. 1733.)

Ans. It consists essentially of a retort marked "A," in which is placed a mixture of chloride of ammonium and nitrate of potassium, which, upon the application of heat and a sufficient quantity of water, generate nitrogen gas. This gas is then passed through a Wolff bottle marked "B," containing some oil of vitriol as a dryer, then through the Wolff bottle marked "C," containing a solution of sulphate of iron, then through the Wolff bottle marked "D," containing a solution of pyrogallate of sodium; then through the Wolff bottle marked "E," containing sulphuric acid; then through the Wolff bottle "F," containing raw cotton; thence to the receiving gas bag marked "G."

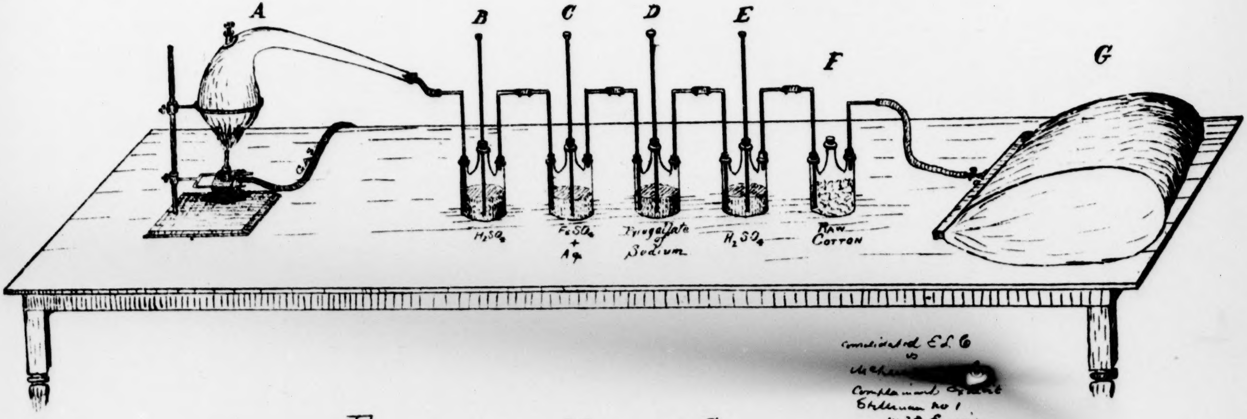
Int. 12. Please describe the apparatus shown in the drawing Stillman No. 2.

(Here follows diagram marked p. 1736.)

Ans. The gas bag full of the gas is put in connection with the following system of purifiers; first through Wolff bottle "H," containing solution of sulphate of iron; thence through a Wolff bottle marked "I," containing solution of pyrogallic of sodium; thence through the Wolff bottle marked "J," containing oil of vitriol into a series of long glass tubes marked 1 to 7 respectively, and shown in the drawing as "K." Tube No. 1 contains oil of vitriol;
1735 tube No. 2, broken pieces of caustic potash; tube No. 3, solution
of sulphate of iron; tube No. 4, sticks of caustic potash; tube No. 5, solution of sulphate of iron; tube No. 6, oil of vitriol; tube No. 7, containing phosphoric anhydride; thence into a wash bottle containing cotton; thence into an iron tube containing metallic sodium, the metallic sodium being kept melted by means of a Bunsen combustion burner, through which the tube passes; this tube is marked No. 8 in the drawing. From thence the gas passes

STILLMAN No. 1.

No. 286.
C.E. Light Co.
v.
McK. Light Co. } p. 1733


A
B
C
D
E
F
G
GAS
H_2SO_4
$FeSO_4$ + Aq
Pyrogallate of Sodium
H_2SO_4
RAW COTTON

Consolidated E. L. Co
vs
McChe[illegible]
Complainant's Exhibit
Stillman No 1
W.J.B. Guinis.
March 30 1889

PREPARATION OF NITROGEN GAS.

$NH_4Cl + KNO_2 = KCl + 2H_2O + N_2$

through two bulbs containing phosphoric anhydride; thence into a Wolff bottle filled with cotton, and thence to the lamps.

Int. 13. Did you make any use of this apparatus at 94 Walker street?

Ans. I did. For preparing nitrogen gas to be used in the Sawyer-Man electric lamps, and I filled the lamps by the process and the apparatus just described.

Ans. 14. Please describe those lamps which were filled by you?

Ans. These lamps were the lamps being made by the Sawyer-Man people at 94 Walker street. They were all incandescent electric lamps, the light being given by a small piece of incandescent carbon in each instance. The carbons used were of various forms and material. There was the straight willow carbon, treated and untreated. There was the straight Carré carbon. There was the horseshoe paper carbon, treated and untreated; also the willow carbon, hollow and treated. Various names were given in the shop to these different forms of carbon, for instance, we had the straight-pencil carbon which was called the hammer and anvil. There was the plain arch, and the straight willow. Those were the three principal ones made at the time I was at the factory. The lamp consisted essentially — two metallic electrodes of various forms; but usually of two pieces of brass conductors passing through the base of the lamp, one to about three-quarters of the distance up, the other paralle*l* to it, and extending*s* some distance further up the globe. The ends of the brass rods or tubes were connected to large pieces of carbon which 1737 acted as the receiver for the pencils of carbon used as an illuminant. Various devices were made use of to maintain the contact of these larger pieces of carbon perfect with the carbon used as the illuminant. In the straight-pencil lamp a long and delicate spring extending from the upper portion of the brass conductor connected with the upper end of the pencil, extended to the base of the lamp, retaining the pressure of the carbon uniform when in a heated cond*d*ition. In the arch lamp, however, no use was made of the spring for this purpose, as it was found by experiment that the passage of the current through the carbon arch did not rupture the carbon and that the arch itself relieved the carbon of the strain. In filling the lamps with nitrogen gas, the gas was passed through a tube to the upper end of the globe and the air displaced by the nitrogen passing out through an aperture at the base in the other side. When the air had been displaced a current of electricity was turned onto the lamp and the carbon maintained in a state of incandescence from one-half hour to an hour to drive out any occluded gases that might be present. The filling tube was then withdrawn, valves turned, and the lamps closed. Lamps standing this test were passed by me and sent to the factory or office for exhibition. The base of the lamp consisted of two glass plates attached to the end of the globe by means of screws running up through the plates. The plates were joined together by means of Canada balsam, when the lamps were filled, sealing wax was then placed around the base, securing the interior of the globe from admixture with the air from the outside. A short time after my working in the factory at 94 Walker street, I ordered a sealing mixture for the base of the lamp, as the wax at times became soft. To overcome this a mixture containing caoutchouc was used, which when cold adhered firmly to the glass and made a tight joint. The globe of the lamp was a long cylindrical one about two inches in diameter, and from six to ten inches in length.

Int. 15. About how many lamps did you fill at 94 Walker street?

1738 Ans. Forty or fifty lamps.

Int. 16. Can you tell what proportion of these had arch-shaped paper carbons?

Ans. I should judge about a third.

Int. 17. You spoke about putting up a purifying and filling apparatus at your laboratory No. 40 Broadway. Please state when you did this and why.

Ans. The latter part of December, '78 or first of January, '79, I transferred the apparatus from the Walker-street shop to my laboratory at 40 Broadway, as I could not devote all my time at the factory.

Int. 18. Did you fill any lamps at No. 40 Broadway for Sawyer and Man?

Ans. I did.

Int. 19. About how many?

Ans. There were a good many lamps. I couldn't tell you how many; over a hundred to a hundred and fifty.

Int. 20. What was the character of the carbons in these lamps?

Ans. The same as I have previously described—straight-pencil carbons and arch carbons.

Int. 21. What was the material of the arch carbon?

Ans. Paper carbon.

Int. 22. About what proportion of the lamps which you filled at 40 Broadway were provided with arch-shaped paper carbons?

Ans. I think the proportion was smaller than that at the Walker-street shop, probably a quarter instead of a third.

Int. 23. Was there any test applied to the lamps you filled at 40 Broadway?

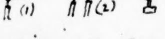
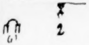
Ans. Each lamp was subjected to the current of electricity and the carbon kept incandescent from one-half hour to an hour. No further test was made at my laboratory, but if the lamps maintained this incandescence without break or change in the carbon the lamps were returned to the factory as properly charged.

1739 Adjourned until 2 p. m.

Met pursuant to adjournment.

Int. 24. Have you any record of any tests made with those lamps at 40 Broadway, and if so, please produce it and explain it.

Ans. I have, and now produce a record of some lamps tested January, 1879. This record shows the test made of some lamps sent to my laboratory from the Walker-street factory to be charged with nitrogen gas. The first date is January 6th, 1879, on which

Date	Number of Lamps filled	Kind of Lamps	Remarks
Jan'y 6th	3	1 H.A. plain 1 H.A. S.P. 1 arc.	H.A ~~plain~~ S.P. poor contact (II) H.A. plain ~~good~~ fair carbon but the anvil & hammer carbons appear short and poor. The arc in fair condition but contacts not very secure. The arc gives a light of about 4 candles with 10 Lalande cells. If properly secured it will doubtless be the most economical and rational form yet devised -
Jan 8th	1	large willow carbon.	
" 9th	3		No 1, anvil, No 2 crescent, both good. No 3 burned 8 minutes.
" 10th	1	Willow c. large	- burned 8 minutes.
" 12	3		No 1, Arch lamp formed arc in current of battery.
" ~~13~~	~~4~~		No 2 Twisted wood c. good 15 m.
			" 3 W.C. not " 4 "
" 13	4		Of the lamps (7) sent up Jan 12 & 13 - 4 burned good.
" 14	3		
" 16th	4	Filled at	

Complainants Exhibit
Stillman record of lamp
tests. W.J.F. Examiner.
March 30. 1889

No. 286.
C.E. Light Co.
v.
McK Light Co.
p. 1745

Cons E L Co
v.
McKeesport Co

date three lamps were sent down to be filled by me, one being a hammer-and-anvil plain carbon, one hammer-and-anvil specially prepared or treated, and one arch lamp, the latter being a paper carbon. The entry of January 6th contains the following remarks:

"The hammer-and-anvil specially prepared—poor contact. The hammer-and-anvil plain—good fair carbon, but the hammer-and-anvil carbons appear short and poor. The arch in fair condition, but not very secure. It gives a light of about four candles with ten Ladd cells. If contacts are properly secured it will doubtless be the most economical and rational form yet devised."

This entry was made in the handwriting of my partner, Mr. William H. Fuller. January 8th is a record of one lamp marked "large willow carbon" with no remarks. January 9th three lamps were sent down, as follows: No. 1, anvil; No. 2, Crescent; No. 3, straight carbon. Under the head of remarks, No. 1, anvil, and No. 2, Crescent, both good. That is to say, they stood the test required by me, and were returned to the shop as satisfactory. No. 3, straight carbon, burned eight minutes. On January 10th one lamp was sent down marked "willow carbon, large." The remarks under this show that it burned eight minutes. On January 12th three lamps were sent down for me to fill, No. 1 being an arch lamp, No. 2 hammer-and-anvil, and No. 3 willow carbon. Under head of remarks, "arch lamp formed arc in current of battery."
1741 No. 2, treated-wood carbon, hammer-and-anvil, stood the test fifteen minutes; marked "good fifteen minutes." No. 3, willow carbon, "not good, four minutes." On the 13th of January four lamps were sent up. On the 14th, three lamps. On the 16th, four lamps. Under remarks it states "Of the lamps (7) sent up January 12th and 13th four burned good."

Paper offered in evidence as Complainant's Exhibit Stillman Record of Lamp Tests, W. T. F., examiner, March 30th, 1889.

(Here follows lithograph marked p. 1745.)

Int. 25. You state that the entry of January 6th, 1879, on this exhibit, is in the handwriting of your partner Mr. Fuller. Is he still your partner?

Ans. He is not. We dissolved partnership in 1880.

Int. 26. Do you know where he is now?

Ans. No; I do not.

Int. 27. In whose handwriting are the other entries on this exhibit?

Ans. In my own handwriting.

Int. 28. When were they made?

Ans. At the dates set forth on the exhibit.

Int. 29. Where has that exhibit been since 1879?

Ans. In my desk at my office, 40 Broadway.

Int. 30. Does this record show all the lamps which were filled and tested by you at 40 Broadway?

Ans. No, sir.

Int. 31. Have you any other record showing the tests of the other lamps?

Ans. Not that I know of. I have looked but could not succeed in finding any.

Int. 32. Was it your custom to keep a record of all the tests you made of those lamps?

Ans. It was not.

Int. 33. How did this record happen to be made?

Ans. It was started by Mr. Fuller, and I carried it along for a few days, later the lamps came more at a time and I had not the time to devote to it, and another reason was that no check record was kept at the factory of the lamps that I checked off at the laboratory.

1742 Int. 34. Did you ever see any of these arch-shaped paper-carbon lamps in use at 94 Walker street?

Ans. Yes, sir.

Int. 35. Please state how they burned.

Ans. Some burned well and some poorly.

Int. 36. Do you know what was the cause of the difference in the operation of those lamps?

Ans. My impression is that it was a mere mechanical difficulty, a failure to make proper contact between the carbon. Some lamps sent down to be filled, plainly showed this, as the record in the last exhibit also shows.

Adjourned until Monday, April 1st, 1889, at 11 a. m.

NEW YORK, *April 1st*—11 a. m.

Met pursuant to adjournment.

Present: Thomas B. Kerr, of counsel for complainant, and Walter K. Griffin, of counsel for defendant.

Int. 37. What does the part marked " L " in the drawing Stillman No. 2, indicate?

Ans. It indicates the rack for holding the lamps during filling, the lamps being indicated in position by the letter " M."

Int. 38. Was there any other apparatus used in filling the lamps which is not shown in the drawing Stillman No. 2?

Ans. There was. It consisted of dryers and a large aspirator, the dryers being used to prevent any contamination of moisture, and so forth, from the air, which might possibly come from this end of the apparatus, and a stop-cock to shut off the apparatus when completed.

Int. 39. Will you please make a drawing illustrating this additional apparatus and produce it at the meeting to-morrow morning?

Ans. I will.

Int. 40. Please state whether you made any exhaustion of the lamp globes.

1743 Ans. Yes, sir, I did.

Int. 41. Please describe the apparatus you used for that purpose.

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Vol. II.

TRANSCRIPT OF RECORD.

SUPREME COURT OF THE UNITED STATES.

OCTOBER TERM, 1893.

No. ~~286~~. 44

THE CONSOLIDATED ELECTRIC LIGHT COMPANY,
APPELLANT,

vs.

THE McKEESPORT LIGHT COMPANY.

APPEAL FROM THE CIRCUIT COURT OF THE UNITED STATES FOR THE WESTERN DISTRICT OF PENNSYLVANIA.

FILED OCTOBER 17, 1890.

(14,326.)

Ans. It was a simple water exhaust at use at 94 Walker street. A large number of the lamps were exhausted there and sent to me in an exhausted condition at 40 Broadway. I also exhausted some in my laboratory at the suggestion of Mr. Man, before charging the lamps with nitrogen. In my laboratory I made use of the mercury vacuum. In a few of the lamps the air was displaced by coal gas, and the coal gas displaced by nitrogen, and then the lamps sealed. The mercury vacuum consisted of a glass globe, two openings at the top, with stop-cocks, the lower portion of the globe being drawn down to a tube, in which tube was also a stop-cock. This globe was connected by rubber tubing to a large bottle, similar in shape to a Wolff bottle, but having a stop-cock at its base. The method of using it was as follows: Mercury was placed in the glass bottle, the stop-cocks in the glass globe opened and the bottle containing the mercury placed upon a shelf some two or three feet above the height*h* of the glass globe. When the mercury had filled the glass globe up to the stop-cocks they were closed, the stop-cock connecting with the apparatus was opened, the glass bottle removed from the shelf to the floor, the stop-cock at the base of the glass globe opened, allowing the mercury to descend from the glass globe to the bottle, thereby filling the glass globe full of air which was formerly in the apparatus—in the lamps to be charged. This operation was repeated until we were satisfied that the air had been taken out of the lamps.

Int. 42. You have spoken of the conductors in the lamps as being of unequal length. Was that the case with all the lamps?

Ans. No, sir. I referred to the hammer-and-anvil lamps—straight carbon. In the arch lamp of paper carbon they were of the same height.

Int. 43. You have given the size of lamps filled by you, were they all of the same size?

1744 Ans. No, sir, they varied in length and breadth.

Int. 44. In the first entry on Complainant's Exhibit Stillman Record of Lamp Tests, namely, that of January 6th, in the handwriting of Mr. Fuller, one of the lamps is referred to as an arc lamp. Was that what is commonly known as an arc lamp?

Ans. It is not. It refers to an incandescent arch lamp.

Int. 45. Referring now to the filling tubes, did all these lamps have a *long* filling tube reaching to the top?

Ans. Some of the lamps required a tube to be placed in during the process of filling, while in others the metallic conductor reaching to the top of the lamps was hollow, and served the purpose of a filling tube.

Int. 46. Have you any recollection of the life of any of the Sawyer-Man lamps filled by you?

Ans. I have. Several of the lamps burned finely for a number of days, while one in particular burned several weeks in the shop at Walker street, and was in good condition when broken accidentally by one of the workmen in hammering something on the wall.

Int. 47. Where was this lamp placed when in use?

A. Part of the time in the shop and part of the time in the office at 94 Walker street.

Int. 48. In what part of the shop?

A. Over the workmen's bench.

Int. 49. Please state what kind of a carbon that lamp had.

A. It was a straight treated carbon, and when the lamp was broken the carbon appeared of a silvery white color without any apparent break to it.

Int. 50. What was the atmosphere in that lamp?

A. Nitrogen gas.

Int. 51. What was its mechanical construction?

A. The construction was the same as the hammer-and-anvil lamps I have already described.

Adjourned to meet on Tuesday, April 2d, at 10 a. m.

1746 New York, *April 2d*, 1889—10 a. m.

Met pursuant to adjournment. Present counsel as before.

The examination of Mr. Thomas B. Stillman was resumed:

Int. 52. To what in your opinion was the durability of this particular lamp due?

(Objected to as incompetent.)

A. To proper contact between the carbons, and proper filling with nitrogen gas.

Int. 53. Do you remember anything about the subsequent history of that lamp?

A. Yes, sir. The same lamp was set up with the same carbon and filled with nitrogen gas and run for a few hours when an arc formed in the carbon, caused by poor contact, and the carbon was soon destroyed.

Int. 54. You speak in question 46 of several of the lamps burning finely for a number of days. What kind of carbons did these lamps have?

A. They were of all the various forms of carbon sent down to the laboratory to be filled—straight pencil, arch paper carbon.

Int. 55. How did you come to know about the lives of these lamps?

A. By being in the shop off and on from day to day, meeting people there who were interested in the lights, and who were carefully watching them and who were very much interested in the existence of the lamps.

Int. 56. Was it any part of your business to take records of the lives of the lamps?

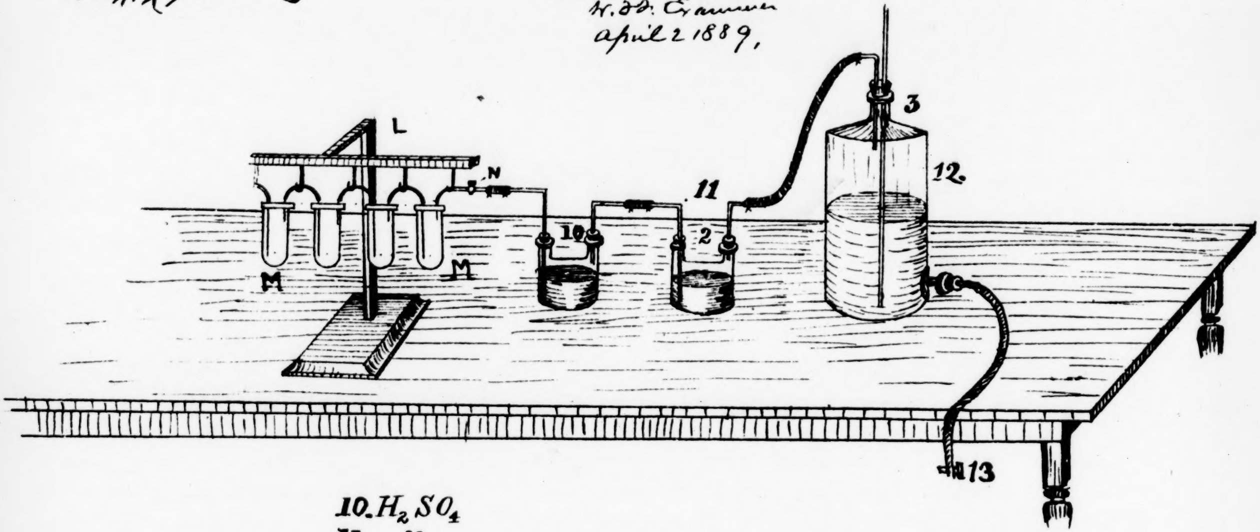
Ans. No, sir.

Int. 57. Can you produce any letters from William E. Sawyer in regard to the filling of lamps, and if so, please produce the same.

Ans. Yes, sir. I produce a letter written to me by Mr. Sawyer March 5th, 1879, regarding the filling of some lamps by me with nitrogen gas.

No. 286.
C. E. Light Co.
v
McK. Light Co.
} N. 1740

Cons & Co
vs.
McKeesport Co
} Complainants exhibit
[illegible] 403
W. D. D. Examiner
April 2 1889.



L
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M
M
10
2
11
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12.
13

10. H_2SO_4
11. ”
12. Aspirator.

1747 (The letter is offered in evidence as Complainant's Exhibit Sawyer-Stillman Letter of March 5, 1879, W. T. F., examiner.)

Int. 58. I notice that the year is not given on that letter. What makes you say it was written in 1879?

Ans. I identify it by means of the composition of the letter, and from the fact that at that time the base of some of the lamps was sealed up with sealing wax.

Int. 59. Where has that letter been ever since it was received by you?

Ans. In my office desk at 40 Broadway.

Int. 60. Are you familiar with the handwriting of William E. Sawyer?

Ans. Yes, sir.

Int. 61. Is this letter in William E. Sawyer's handwriting?

A. Yes, sir; it is.

Int. 62. In question 39, during yesterday's examination, I asked you to produce a drawing showing the additional apparatus used in filling the lamps. Have you made *made* and will you now produce such drawing?

Ans. I have, and now produce it.

(The drawing is offered in evidence as Complainant's Exhibit Stillman No. 3, W. T. F., examiner.)

(Here follows diagram marked p. 1740.)

Int. 63. Please describe the apparatus shown by the drawing and its operation.

Ans. The last lamp in the series marked "M" is connected with a straight glass tube containing the stop-cock "N." This tube is connected with another passing through a wash-bottle containing sulphuric acid marked "10" in the drawing, then through another wash-bottle containing sulphuric acid marked "11." This is connected with a large aspirator in which there is a safety glass tube passing through the liquid and out through the top of the aspirator. This safety tube indicating by the rise and fall of water in the tube the pressure of the gas passing. The fall of the water from the aspirator is regulated by a stop-cock, marked "13." When 1748 the air is displaced out of the lamps by the nitrogen, the gas is shut off from the bag "G" and the water allowed to run from the aspirator 12 until the safety valve in the aspirator shows a slight exhaust existing through the system. The stop-cock marked "N" is now turned off and the lamps sealed in the usual manner. The gas is shut off from the bag G by the stop cock shown in the figure at the neck of the bag.

Int. 64. What was the object of the slight exhaust you have spoken about in your last answer?

Ans. The object was to have the amount of gas in the globes that when the lamps were burning the gas being expanded by the heat generated by the incandescent carbon would be under normal atmospheric pressure.

Cross-examination by Walter K. Griffin, Esq., counsel for defendant:

X Int. 65. Up to what time did you continue to fill lamps for Mr. Sawyer?

Ans. Until the company moved to Ansonia, Connecticut.

X Int. 68. What was the date of this?

Ans. I think in the spring of 1879.

X Int. 67. Have you any books or papers which enable you to fix the date?

Ans. No papers relating directly to the moving of the company to Ansonia, but I have one or two letters from Mr. Sawyer written from Ansonia to me in the summer of 1879 in regard to the use of bisulphide of carbon in prisms. He was then with Wallace & Co., of Ansonia, Conn.

X Int. 68. Were you acquainted with the lamp called by Mr. Sawyer the feeder lamp?

(Objected to as incompetent and irrelevant.)

Ans. I was.

X Int. 69. Did you fill any of these feeder lamps for Mr. Sawyer?

1749 Ans. My impression is I filled a few. These lamps were much larger than the Sawyer-Man lamp and were made at his factory on Fulton street, over McKeson & Robbin's drug store, city, Mr. Sawyer then acting for the Eastern Electric Manufacturing Co.

X Int. 70. Have you any books or papers showing your charges for services rendered Messrs. Sawyer & Man during the period you have mentioned?

Ans. No, sir.

X Int. 71. Did you ever have any?

Ans. In my partnership with Mr. Fuller at that time an account was kept of disbursements and receipts of matter belonging to firm work but not of individual work, that is to say, our partnership was of such a nature that all work brought into the office from parties unknown to us was considered firm work; but through our friends, individual work. In this way I considered that the work brought to me by the Sawyer-Man people, through Mr. Edwin L. Myers, who was a former student of mine, belonged to me exclusively. I have no record, so far as I know, of the amounts paid me by Sawyer and Man, nor at the present moment have I any idea what it was.

X Int. 72. Will you please look and see if you can find any such record?

Ans. I will; but I can state in a general way that payments were made by check, and I think those amounts could be obtained from the treasurer of the company.

X Int. 73. When were you last at the shop, 94 Walker street?

Ans. In the spring of 1879.

X Int. 74. How late in the spring?

Ans. My impression is that it was about April.

X Int. 75. Do you remember seeing at any time at Walker street certain feeder lamps, that is to say, lamps in which a pencil of carbon was capable of being fed up so as to compensate for its destruction by the current?

Ans. No, sir, not at 94 Walker street.

1750 X Int. 76. Have you no recollection of any such lamps at 94 Walker street?

Ans. No, sir.

X Int. 77. Have you no knowledge of their use there in any way?

Ans. No, sir.

— Int. 78. And never heard of their being used there?

Ans. No, sir.

— Int. 79. After the time you began to fill lamps at 40 Broadway how frequently were you at 49 Walker street?

Ans. Quite frequently; that is to say, in one week I might be up there a dozen times, and another week three or four times.

X Int. 80. What would take you up there?

Ans. In some instances my desire to see how the lamps were progressing and burning, and in other cases Mr. Man and Mr. Sawyer would sometimes send for me.

X Int. 81. How long would you remain there?

Ans. Various lengths of time, from a few minutes to sometimes two or three hours.

X Int. 82. How many times are you certain you remained there as long as two or three hours?

Ans. It is impossible to state positively. Probably fifteen times.

X Int. 83. Are you certain that you filled any lamps for Mr. Sawyer after March 20th, '79? I mean as to Walker street.

Ans. I am not positive in regard to that particular date. It was about that time, or a little later, my impression is, they moved to Ansonia.

X Int. 84. In what condition were the lamps brought to you for filling at 40 Broadway?

Ans. All ready to set up in the circuit for filling with nitrogen gas. A few at times being exhausted at the Walker-street shop, and others not exhausted.

X Int. 85. By exhausted, what do you mean?

Ans. The air being taken out from the lamps.

1751 X Int. 86. Do I understand you that you would arrange these lamps on the stand L, in connection with your apparatus shown in your sketches, and fill them with nitrogen gas?

Ans. Yes, sir.

X Int. 87. And the general principle of your apparatus was by means of a suitable water suction to draw nitrogen gas through a series of tubes or bottles containing chemicals, thereby purifying the gas, or depriving it of moisture. Is that so?

Ans. It is.

X Int. 88. You have mentioned that in certain lamps you had to insert tubes into the lamps for the purpose of filling the same with nitrogen gas in such manner that one of the tubes should extend to the upper end of the lamp globe while the other should be shorter, terminating near the base of the globe. Please state the object of this so that the court may understand it.

Ans. The extension of the tube to the end of the lamp was for the purpose of allowing the nitrogen to more thoroughly permeate every part of the lamp while the latter was being filled.

X Int. 89. If the tubes had been short, terminating near the base of the lamp would it not have been almost impossible in tubes of the diameter and length you described as used for the lamps to have got rid of the air at the end furthest removed from the base?

Ans. I think not, but there would be a much longer time occupied in making this displacement.

X Int. 90. And with an ordinary aspirator such as you used very much longer time, would it not?

Ans. The length of time is dependant upon the rapidity of the gas.

X Int. 91. Putting it in another way, the consumption of nitrogen gas in order to arrive at the filling of the globe with nitrogen would be very much greater with the *the* short tubes, would it not?

1752 Ans. It would.

X Int. 92. In those lamps in which the metal conductors or radiators were tubular, I understood you to say that some provision was made so that the tubular conductor *the* acted instead of the long tube you otherwise inserted in the lamp. What arrangement was made?

Ans. One of the conductors was hollow from the bsse to the top, passing through the bottom of the lamp and containing at its lower end a cock turned by means of a screw-driver. Rubber tubing connecting the lamp with the system for purifying nitrogen gas was attached to the base of this tube and securely fastened, but not far enough up on the tube to cover the cock which was turned by the screw-driver. By this arrangement the lamp could be securely shut off without being taken out of the system.

X Int. 93. And when this hollow conductor did not exist, how did you insert the long glass tube for the purpose of filling the globe with nitrogen gas?

Ans. The metallic tube was passed up through the base of the lamp, fitting the tube in which the cock was placed loosely, the lower end of this tube passing into the rubber tubing, the rubber tubing itself being joined to the metal-ic tube which held the stop-cock at the base of the lamp. When the lamps were filled with nitrogen this tube was withdrawn from the lamp, and allowed to pass down through the aperture at the base of the lamp into the rubber tube, and the instant it passed the stop-cock, that was turned. The rubber tube was larger than the inner metal tube so that I could work the metal tube down into the rubber.

X Int. 94. What sort of a stop-cock was there to the base of the lamp?

Ans. It was a metallic cock: Further than that I have forgotten the details of construction.

X Int. 95. How far were the lamps put together which you received at 40 Broadway?

1753 Ans. The interior of the lamp was in complete order for running, so that no further change was necessary after the lamps were filled.

X Int. 96. Were the globes fastened to the base? If so, how?

Ans. The globes were fastened to the base first by having the surfaces of the glass plate evenly ground and Canada balsam placed between to fasten them together, and then long screws running from the upper flange of the base of the globe through to the lower glass plate and there secured.

X Int. 97. Were metal rings or flanges used above or below the base of the lamp?

Ans. I think there were—yes, sir.

X Int. 98. In other words the lamps were intended to be ready for filling. Is that so?

Ans. Yes, sir.

X Int. 99. And this was the case with all lamps sent to you at 40 Broadway, was it not?

Ans. That was the condition of all lamps sent down to 40 Broadway to be filled. There were a few lamps sent down to me, however, to examine the carbons, generally by Mr. Man, who claimed that the lamps were not properly filled. That is to say, taking two lamps from one set which had been filled at the same time, two of any particular kind, as straight pencil or arch carbon, one lamp would burn well and the other poorly when tested with several hours' run at the shop, and yet no apparent difference could have been noticed in those lamps when filled.

X Int. 100. In filling the lamps, did you ever open them, or were they kept closed?

Ans. They were always kept closed.

X Int. 101. After the lamps were filled by you, what did you do to them?

Ans. After turning the stop-cocks I soldered the stop-cocks, some of them with solder and some with sealing wax, as required by Mr. Sawyer.

X Int. 102. Did you put the lamps into their cups?

1754 Ans. Not at 40 Broadway. I have no recollection of doing it.

X Int. 103. So that all you had was the globe, the base fastenings, and the interior works. Is that so?

Ans. In a few instances I sealed the lamps besides the stop-cocks by pouring a mixture of sealing-wax, ca-utchouc around the base of the lamp, but did not set it in the metal cup.

X Int. 104. In testing the lamps, how many battery cells did you employ?

Ans. I had a large three-cell, bichromate dip battery, sufficient to bring each lamp in circuit to low incandescence.

X Int. 105. Was this bichromate battery what you have called a Ladd cell?

Ans. It is not. Mr. Fuller had a few Ladd cells there, which were used on a few of the lamps first sent down. But the battery did not work satisfactorily being an old one, and I purchased us a new one.

X Int. 106. What degree of incandescence did you raise the lamps to?

Ans. Till the carbon became at a low red-heat not sufficient to give any light.

X Int. 107. Was this the case when you used the Ladd cells and the bichromate battery?

Ans. We had difficulty with the Ladd cells, and for that reason did not use them, except in the few instances stated.

X Int. 108. Do you mean that the Ladd cells were not so powerful as the bichromate battery?

Ans. No, I mean that at times the Ladd cells would operate and not operate, without apparent reason.

X Int. 109. When the lamps were filled and tested by you, what was done to them by you?

Ans. They were laid carefully aside, and either sent up to the factory or they sent down for them; generally, however, they sent down for the lamps.

1755 X Int. 110. Why were they laid carefully aside?

Ans. For the reason that they were made of glass, required careful handling.

X Int. 111. Except as you visited 94 Walker street, had you any personal knowledge as to what was done to these lamps after they left your hands?

Ans. No, sir.

X Int. 112. When a lamp or carbon proved defective under your test, what did you do, if anything, to it?

Ans. I returned it to the factory as unfit for trial at the factory.

Adjourned to meet on Wednesday, April 3d, at 10 o'clock, a. m.

New York, *April 3rd*, 1889.

Met pursuant to adjournment.

Present: Thomas B. Kerr, of counsel for complainant, and Walter K. Griffin, of counsel for defendant.

X Int. 113. Am I right in understanding by your answer to question 41, that when you used the mercury tubes there mentioned, it was for the purpose of exhausting the air, preparatory to filling the lamps with nitrogen?

Ans. Yes, sir.

X Int. 114. When you exhausted the lamps slightly so as to allow for the expansion of the gas when the carbon was rendered incandescent, did you have any uniform gauge or test, or did you make simply a slight exhaustion without definite accuracy?

Ans. The safety tube in the aspirator at the end of the apparatus I used as an indicator for a slight exhaust, the lowering or falling of the column of water in the tube indicating whether the gas was under pressure or under a slight exhaust. The meniscus of the water in the safety tube, which at normal pressure is slightly above the pressure in the aspirator, I would bring down to the level of the water in the aspirator.

1756 X Int. 115. As I understand you, the exhaust was a very slight one, was it not?

Ans. Yes, sir.

X Int. 116. In sending the lamps to 94 Walker street, did you put any tag or marks upon the lamps?

Ans. Only in the case of lamps which failed to stand the test of incandescence. I had no uniform tag; in some instances a note was sent describing the lamp which worked unsatisfactorily, the description in the note being sufficient to enable the parties at the factory to recognize the lamp spoken of.

X Int. 117. When a carbon proved defective, what, to your knowledge, was the practice of the factory? was the lamp thrown away, or the lamp taken apart and a new carbon substituted?

Ans. Generally speaking the lamp was taken apart and a new carbon inserted. In some instances, however, some of the lamps were not set up again.

X Int. 118. When the carbon was replaced were the lamps refilled before being again used?

Ans. Yes, sir, the lamps were brought down to be filled under the same conditions as before, unless the carbon of a different form than the former one had been inserted.

X Int. 119. And if the carbon had been changed the lamp so changed was sent to be filled, was it not?

Ans. It was, and the lamp might be considered as an entirely new lamp so far as the carbon was concerned.

X Int. 120. What means, of your own knowledge, had you of knowing whether, for example, a lamp sent January 14 was the same or a different lamp from a similar appearing lamp sent, say, two weeks before?

Ans. In the case of lamps which I had filled and sent to the factory and which ran there but a short time and then broke, it is probable my attention was not called to the matter; but whenever
a lamp made an especially long run the lamp after breaking
1757 would be fitted with a similar carbon to the one which make
the long run, and in some instances a note to that effect from
Mr. Sawyer would be sent to me.

X Int. 121. As I understand you, as a general rule, you did not then know whether the lamps sent to you for filling were the old lamps with new carbons or fresh lamps which had not been before filled?

Ans. In some instances where a carbon had been consumed at the factory in running the lamp an apparent change would take place in the appearance of the metallic conductor; that is to say, the upper portions of the conductors would have a different appearance in color than the lower portions.

X Int. 122. That is to say that in some instances the discoloration of the metal conductors showed to you that the lamp had been in use before?

Ans. Yes, sir.

X Int. 123. Where this discoloration did not exist, or where, for example, it may have been removed by cleaning the conductors, had you any means of identifying a particular lamp with a similar appearing lamp previously sent to you?

Ans. Two lamps of the same size, construction and appearance, would give me no indication to distinguish between a new lamp and an old one. That is to say, if the lamp which had been previously filled had been thoroughly cleaned and the wax or sealing material used at the base of the lamps entirely removed, there would be no distinction; but, in nearly every instance, portions of the sealing material on the outside of the lamp would be left upon the base of the globe, these proportions being very small as a rule.

X Int. 126. And these remains of the sealing wax existing, as you say, in nearly every instance enable you to say that the lamp had been used before. Is that so?

Ans. Yes, sir.

X Int. 127. Do I understand you rightly that in nearly every instance the lamps sent to you showed such traces of sealing wax?

1758 Ans. Traces of sealing wax or of the other material they used for sealing the outside of the lamps.

X Int. 127½. Do you remember what your charge was for filling lamps at 40 Broadway?

Ans. No, sir, I do not.

X Int. 128. Do you think it was in the neighborhood of eighty cents per lamp?

Ans. It would be impossible to answer that question, as I have no memoranda or recollection about it.

X Int. 129. You presented a record kept by Mr. Fuller and yourself of some twenty-two lamps. In your recollection is that record a fair illustration of your experience with the lamps you filled at 40 Broadway?

Ans. I do not think so for the reason that these were the lamps first filled at my laboratory, and later on with experience the work was more satisfactory.

X Int. 130. As I understand you, you had been filling lamps at 94 Walker street with the same apparatus you used at 40 Broadway?

Ans. Yes, practically the same apparatus. I took the apparatus down to 40 Broadway, but it was returned before the company went to Ansonia. I duplicated the apparatus at my laboratory.

X Int. 131. How did your apparatus differ from the apparatus at Walker street prior to the use of your method?

Ans. The improvements that I made after going to the factory consisted in the use of phosphoric anhydride as a drying agent, and in the use of metallic sodium kept in a melted condition to absorb all traces of oxygen from the gas. I also inserted the drying tubes marked "K" in Stillman Exhibit No. 2.

X Int. 132. State what means were used prior to your method for preparing and purifying the gas.

Ans. The method used was by heating a mixture of chloride of am-onium and potassium nitrite with sufficient water, and passing the volume of nitrogen gas through the system of purifiers
1759 marked Stillman No. 1. The reason that I introduced phosphoric anhydride was because I was under the impression that the gas made by the process described in Stillman No. 1 was not sufficiently free from moisture and air.

X Int. 133. Do I understand you that your figure 1 represents the entire apparatus used at Walker street before your improvement?

Ans. Yes, sir.

X Int. 134. And the only substance in that apparatus tending to free the nitrogen from oxygen existing in the original air of the retort or entering by any leak was the bottle of pyrogallate of sodium?

Ans. Yes.

X Int. 135. The use of the cotton was simply to prevent the mechanical transportation of particles of dust or solid matter, was it not?

Ans. Yes.

X Int. 136. The sulphuric acid tending to absorb moisture?

Ans. Yes, sir; and the ferrous sulphate to absorb any traces of oxide of nitrogen which might have been formed by overheating the retort.

X Int. 137. After the gas was so prepared what means, if any, were used for purifying it before it was passed into the lamps?

Ans. The nitrogen gas was passed through another set of Wolff bottles containing a solution of sulphate of iron, then solution of caustic potash, then oil of vitr-ol, each solution being in two different Wolff bottles joined consecutively.

X Int. 138. What was the trouble, if any, with this apparatus which resulted in the use of your apparatus?

Ans. The original cause of the trouble I never was made conversant with except that Mr. Sawyer and Mr. Man were under the impression that trace of moisture was in the nitrogen gas after it was in the lamps, and the problem as stated to me was to
1760 deprive this nitrogen gas of all traces of moisture. This, I found, could be done by the use of phosphoric anhydride which, if I recollect right, I took out a patent for.

X Int. 139. What, from your experience, would be the effect upon the life of the lamp of the presence of traces of moisture in the nitrogen gas?

Ans. I think that moisture in the nitrogen gas in the globe when brought in contact with the incandescent carbon at a white heat, would be converted into oxygen and hydrogen. This dissociation if once taken place the oxygen would be free to unite with the carbon to form carbonic acid and the pencil speedily destroyed.

X Int. 140. And this it was the object of your invention or use of the phosphoric anhydride to prevent?

Ans. Yes, sir; the phosphoric anhydride was used to prevent the presence of moisture in the lamps in conjunction with the other dryers.

X Int. 141. You stated that after you began filling at 40 Broadway that later on with experience the work was more satisfactory. What do you mean by that?

Ans. I mean, first, that the experience showed that speed in filling was an essential, and also the experience of working in the shop producing a better contact of the carbons.

X Int. 142. Do I understand that you mean by speed in filling that the lamps had to be filled and sealed very quickly, or that you had to have a very rapid flow of nitrogen throuh the lamps in order to sweep out the air?

Ans. No, sir. The speed spoken of refers to the passage of the gas through the purifying apparatus, the absorption of impu-ties being more perfect at a slow rate of speed than fast. I would say right here that when I substituted a cylindrical glass vessel for holding the sodium, the latter being placed on a sand bath, if the rate of flow of the gas was too fast, or if the gas had not been properly purified from oxygen the metallic sodium would catch fire. 1761 Of course this would only take place when there happened to be oxygen in the gas.

X Int. 143. Is it a matter of easy practice or a matter requiring considerable experience to prepare and purify nitrogen gas so as to deprive it of oxygen, either alone or in combination, and from moisture?

Ans. Taking the text books on chemistry as a standard, the process is a simple one and not difficult; but to deprive the nitrogen of the last traces of oxygen the use of sodium, as above indicated, is essential in my mind, which does not necessarily complicate the apparatus materially, and in a chemist's hands a simple operation.

X Int. 144. In your answer to question 14 you mentioned the straight Carré carbon as used by Sawyer and Man. What kind of a carbon was that and in what shape was it used?

Ans. It was a carbon called the Carré carbon, imported from Paris, and was used in all the different forms of the carbon pencils, except the arch, which was a paper carbon. It was retort carbon. I knew they ran out of it once and had to cable over.

X Int. 145. What kind of a carbon was the hollow willow carbon mentioned by you in the same answer to question 14.

Ans. It was a straight cylindrical hollow carbon made from willow.

X Int. 146. You state that the carbon was hollow. What had been removed to make the carbon hollow.

Ans. The interior carbon had been removed by mechanical means.

X Int. 147. I ask you to read on page- 70 and 71 of Sawyer's book on electric lighting, already in evidence, beginning on page 70 where the description of boat-shaped carbons is commenced, and state whether the hollow willow carbons mentioned by you are the same or different from the carbons there mentioned in the book?

Ans. They are different. The hollow willow carbon
1762 being a hollow cylinder, whereas the boat-shaped carbon
is a straight pencil, concavo-convex in cross-section, the
centre of the carben being slightly larger than the base.

X Int. 148. How much, if any, of the original willow was left in these hollow willow carbons as you call them?

Ans. I could not answer that. I didn't make the carbons.

X Int. 149. How did you know that they were hollow willow carbons?

Ans. Nearly every lamp sent down to be filled was sent with a note describing the lamp. At the factory, before I filled the lamps at 40 Broadway, the lamps when running after being filled with the gas were subject to close examination by Mr. Sawyer and Mr. Man, myself and others who were interested, and the proficiency of the lamp always made a discussion as to the different forms of carbon which would be described at that particular time while the lamp was running.

X Int. 149½. What do you mean by the expression "treated" in your answer to question 14?

Ans. Mr. Sawyer had a process of depositing carbon in a very fine state of division upon pencils of coarser material by decomposition of hydrocarbon, this coating being very hard and uniform. The term "treated" referred to a carbon which had thus been exposed to this process.

X Int. 150. What do you mean by the expression "pencils of coarser material" in your last answer?

Ans. I mean carbon, the particles of which were coarser than the carbon deposited by the process.

Adjourned until April 4th, 1889, at 10 o'clock a. m.

NEW YORK, *April 4th*, 1889—10 a. m.

Met pursuant to adjournment.

Present: Thomas B. Kerr, of counsel for complainant, and Walter K. Griffin, of counsel for defendant.

1763 X Int. 151. What do you mean by the term "plain arch"
in your answer to question 14?

Ans. That simply refers to the arch-shaped carbon which was plain in its appearance. My impression is that there were a very few carbons made of the arch form from hard carbon, by one of the men in the shop; but by the plain arch I understand the paper carbon.

X Int. 152. Is there any difference between your use of the term "plain arch" and your use of the term "horseshoe paper carbon" in question 14?

Ans. No, sir.

X Int. 153. In your record of lamp tests under date of January 9th there is an entry of one lamp as No. 2 crescent. What form do you recollect as indicated by that term?

Ans. The same form as the arch, that being a term of my own used at that time.

X Int. 154. In the hammer-and-anvil lamps, what class of carbon was used?

Ans. Straight-pencil carbon, both treated and untreated. The kind of carbon was both hard carbon and willow carbon, so far as I recollect. I am positive these two materials were used.

X Int. 155. In your answer to question 46 you state that several of the lamps burned finely for a number of days. Do you know of your own knowledge what was the material of the carbon in these several lamps?

Ans. My knowledge concerning the carbon in these lamps is the same as of the others.

X Int. 156. Are you able to swear that any one of the several lamps mentioned by you in your 46th answer were paper carbons?

Ans. My knowledge relating to the paper carbon would be the same as that relating to the other carbon, and the lamps could not burn successfully at the factory without being filled with nitrogen gas by me at that time. I was therefore cognizant of all the 1764 forms of carbon in the lamps which were filled. Some of the lamps which burned successfully were of paper arch form.

X Int. 157. Do I understand that you substantially filled all the lamps during the period you were employed to fill the lamps?

Ans. Yes, sir.

X Int. 158. How old a man was Mr. Myers at this time?

Ans. About twenty years, I should judge—about twenty or twenty-one.

X Int. 159. How did you come to testify in this suit?

Ans. President Morton of the Stevens institute told me that the Westinghouse Company desired me to fill some of the old form of Sawyer lamps with nitrogen gas and that I should get ready to do the same by getting the apparatus together, as the lamps would be ready for charging in a few days, and in the course of a conversation which I had with him, it appeared to him that my former work in this line would be of interest to the company.

X Int. 160. Were the lamps brought to you to be filled?

Ans. They were not; I expect them any moment at the institute.

X Int. 161. Were you in any way retained by the Westinghouse Company?

Ans. President Morton secured my services for the Westinghouse people as expert in the filling of the globes with nitrogen.

X Int. 162. Do you expect to be called in this suit as an expert?

Ans. I do.

X Int. 163. How long ago was it Professor Morton spoke to you?

Ans. Ten days or two weeks, about, I should say.

1765 Redirect examination by Mr. KERR:

R. D. Int. 164. Please state where the chemical apparatus was placed in the Walker-street shop?

Ans. It was placed on the bench—a portion of it—and the dryers and purifiers on the partition in the shop between the front and back rooms. There was a table against the partition, and sometimes the generating apparatus was placed on the table and sometimes it was upon the adjacent end of the workmen's bench.

THOMAS B. STILLMAN.

Examination closed.

COMPLAINANT'S EXHIBIT SAWYER-STILLMAN LETTER OF MARCH 5, 1879. W. T. F., Examiner, April 2, 1889.

MARCH 5.

Friend STILLMAN:

I send you 5 lamps which please have ready for us by 9 to-morrow. To-morrow will send you 4 more.

Seal these as before excepting the stop-cocks. With these fill the cups with melted sealing wax or shellac and screw on, instead of soldering. Be careful when you put the sealing wax originally on the base not to have it come up in way of the cups for the stop-cocks.

Be sure to run these lamps long enough to get a good filling.

Yours truly, W. E. SAWYER.

Shall I send down for the lamps to-morrow morning, or will you bring them up?

1766 NEW YORK, *April 1st*, 1889.

Met pursuant to arrangement of counsel.

Present: Amos Broadnax, Esq., for complainant and Mr. Man; and Mr. Walter K. Griffin, for defendant.

IDA MAN IVES, being called on behalf of complainant and duly sworn, testifies as follows:

Int. 1. What is your name, age, residence and occupation?

Ans. Ida Man Ives. 33 years of age. I reside with my husband and father at 118 Putnam avenue, Brooklyn. My father's name is Mr. Albon Man. My husband's name is Edward M. Ives.

Int. 2. Where were you residing in the winter, spring, summer, fall of 1878 and winter of 1879?

Ans. With my father at his residence, 118 Putnam avenue, Brooklyn.

Int. 3. During that time do you recollect of Mr. Wm. E. Sawyer's visiting your father at his residence?

Ans. I do.

Int. 4. When first did he visit your father there?

Ans. In the latter part of the winter or spring of 1878.

Int. 5. Did he visit your father any time during the summer or fall of 1878?

Ans. He was there during the fall of 1878.

Int. 6. State, if you recollect, how often he called to visit your father?

Ans. I don't recollect how often. He was there a number of times, and I recollect his dining there once.

Int. 7. State whether or not you recollect of your father's making any carbons in his house there at any time during the time mentioned by you?

Ans. Yes, I recollect seeing him in the spring of 1878 making some carbons. That is what he said he was making.

Int. 8. State what, if anything, you saw him do towards the making of such carbons?

1767 Ans. I saw him put in little sticks and also pieces of paper in strips and rings—put them in a crucible and place that in the fire.

Int. 9. What fire did he put them in?

Ans. In the range fire in the kitchen, and also in the laundry stove.

Int. 10. State what, if anything, he put into the crucibles besides the paper and sticks?

Ans. Some black-looking powder.

Int. 11. Do you know what the black-looking powder was?

Ans. I do not.

Int. 12. How often did you see your father do this?

Ans. As near as I recollect, twenty or thirty times.

Int. 13. What, if any part, did you take in assisting him to prepare the paper and sticks that he put in the crucible?

Ans. I cut out the papers for him, and I saw him filing the sticks fine, smoothing them down.

Int. 14. Did you assist him in that?

Ans. I didn't do it—simply saw him.

Int. 15. What shape were the papers that you cut out for your father?

Ans. In strips about an eighth of a yard long—different widths and in rings.

Int. 16. What kind of paper was it that you cut up for your father in those shapes?

Ans. Blotting paper.

Int. 17. What kind of blotting paper was it?

Ans. Ordinary white blotting paper, as I remember it.

Int. 18. Do you recollect of cutting up any other kind of paper?

Ans. No, sir.

Int. 19. About how wide were the strips of white blotting paper that you cut up for your father?

1768 Ans. Very narrow little fine strips perhaps about an eighth or a quarter of an inch.

Int. 20. About what size were the rings of paper that you cut out for your father?

Ans. About the size of an ordinary spool of thread—the end of it.

Int. 21. How long did these experiments of your father continue from the time he began?

Ans. Several weeks.

Int. 22. What was the crucible like that he put the carbons in that he put in the furnace of the range?

Ans. I did not examine it. I think it might have been metal of some kind.

Int. 23. Was it square or round? By round I mean cylindrical or conical.

Ans. Round.

Int. 24. Do you recollect of seeing him use a square crucible or box? If so, please to state whether it had a lid or how it was fastened.

Ans. Yes, I recollect of his using a square box of sheet iron or something of that kind, and he fastened the lid on by winding a wire or something of that kind, as I recollect.

Int. 25. State, if you know, what these carbons were being made for by your father.

Ans. For his electric light.

Int. 26. Did your father tell you that at the time, or did you see them used in electric lamps?

Ans. He said he was making carbons. I saw the lights afterwards.

Int. 27. Where did you see the lights?

Ans. At his shop in Walker street, New York.

Int. 28. How many of the lights did you see there?

Ans. Five or six.

Int. 29. All burning at one time?

Ans. Yes, they were all burning at one time and turned on to different degrees of brightness.

1769 Int. 30. What shape were the carbons that were in those lamps that you saw?

Ans. A little longer than a half circle.

Int. 31. Do you know whether or not any of these carbons were made of paper or sticks of wood such as you made for your father? State what your recollection of it is.

Ans. I do not know what they were, positively. I simply know what I was told.

Int. 32. State what your father told you about it at the time.

Ans. All I know is that he told me the carbons were the same in the lamps as those that he made.

Int 33. State, if you recollect, whether or not you saw your father tie up any of the sticks that you or he prepared in the form of a bow or loop before he carbonized them?

Objected to as distinctly leading. Question withdrawn.

Int. 34. State, if you recollect, in what form your father put the sticks before putting them in the crucible that had been previously prepared by you or him?

Ans. They were straight, as I recollect.

Int. 35. How did you happen to visit your father's shop in Walker street?

Ans. He took me there with a party of friends to show us the lamp.

Int. 36. With whom was your father working at that time on electric lights?

Ans. With Mr. Sawyer.

Int. 37. What time was it that you visited the shop in Walker street? When was it?

Ans. In the fall of 1878.

Int. 38. Who went with you besides your father?

Ans. My aunt, Miss Watkins, and Mr. and Mrs. Greenough, of northern New York.

Cross-examination:

X Int. 39. Can you state any more distinctly when you visited the Walker-street shop?

1770 Ans. I can't remember exactly. It was early in the fall.

X Int. 40. How long was it after you had assisted your father as to the carbons?

Ans. It must have been four months, perhaps. It was early in the spring, March or April, when I assisted him. It was certainly September when I went to the shop, or later.

X Int. 41. What other shapes did you see at the shop, if any, besides the half circles?

Ans. I do not recollect any.

X Int. 42. Did you not see straight carbons?

Ans. I do not recollect.

X Int. 43. How long were you in the shop?

Ans. About half an hour, I think, perhaps longer. I don't know the exact time.

X Int. 44. And you think you saw about a half dozen lamps?

Ans. Yes.

X Int. 45. And you didn't see any straight carbons?

Ans. I do not recollect any.

X Int. 46. How do you come to recollect the shape of the carbons at all?

Ans. Same as I recollect anything. I recollect it, that they were of that shape.

X Int. 47. What part of the shop were you in?

Ans. In the reception-room and in the workshop.

X Int. 48. What kind of lamps were those that you saw at the shop?

Ans. They were a little glass globe—oblong globe—little fine-looking wire inside the globe so far as I could see, with a band around the small end of the globe, and they were mounted on a bracket of some kind, I don't know exactly what.

X Int. 49. What did your father say to you, exactly, so near as you can now remember, as to the carbons?

Ans. Nothing that I recollect, except that he was making carbons.

1771 X Int. 50. That was at your house, was it not?

A. Yes.

X Int. 51. Who was in charge of the kitchen at the time?

Ans. My aunt, Miss Watkins.

X Int. 52. Who was the cook?

Ans. I can't recollect exactly. We changed girls several times. There was a girl there.

X Int. 53. Did not the same girl who was there in 1878 remain there for several years afterwards?

Ans. No.

X Int. 54. How did you come to testify here? I mean who first spoke to you as to the matter?

A. I spoke first to my father.

IDA MAN IVES.

1772 *Testimony of Alice J. Watkins.*

ALICE J. WATKINS being called in behalf of complainant, and duly sworn, testifies as follows:

Int. 1. What is your name, age, residence, and occupation?

Ans. Alice J. Watkins, 44 years of age. I reside at 118 Putnam avenue, Brooklyn, in the family of Mr. Albon Man. His wife is my sister.

Int. 2. Have you been present and listened to the testimony of your niece, Mrs. Ives, here this afternoon?

Ans. Yes.

Int. 3. Please to state what, if anything, you recollect about the experiments of Mr. Man in making carbons at his house, and when it was that such carbons were made?

Ans. It was in the winter and spring of 1878, he worked in the kitchen, and I remember his using a dish he called a crucible. It was a rough-looking vessel, I thought of iron. In it I saw him put bits of paper, pieces of sticks, a blackened powdered substance. That is all I can recall. I saw him cover it and place it in the fire in the range. I don't know that I can recall any more in regard to it.

Int. 4. What was the shape of the crucible, as near as you can recollect it?

Ans. Round.

Int. 5. How long did he leave it in the furnace of the range or other stove?

Ans. I don't recollect.

Int. 6. Did you see him have more than one crucible?

Ans. I think so.

Int. 7. How many do you recollect of his having?

Ans. Not more than two.

Int. 8. Were they both of the same shape?

Ans. The other was square.

Int. 9. Did they both look like iron or clay?

Ans. I think so.

1773 Int. 10. State if you recollect what the shape of the paper and sticks were that he put in the crucible?

Ans. The paper was in narrow strips an eighth of a yard long.

Int. 11. Were there any shapes of the paper?

Ans. I think in round rings.

Int. 12. Can you give the size of the rings as near as you can recollect?

Ans. No, I can't.

Int. 13. What was the shape of the sticks?

Ans. As I remember, they were straight—of different lengths.

Int. 14. How often did you see him prepare these papers and put them in the crucibles?

Ans. Twenty or thirty times. I have a distinct recollection of his cutting the sticks, I meant to say preparing them.

Int. 15. What makes you recollect the fact of his making these carbons?

Ans. The amount of dirt and refuse I had to clean.

Int. 16. Did you have charge of the housekeeping or kitchen department then?

Ans. Mostly.

Int. 17. Did you visit the shop in Walker street along with Mrs. Ives and Mr. Man?

Ans. I did.

Int. 18. What did you see there?

Ans. I saw the electric lamp.

Int. 19. How many do you recollect of seeing on that occasion?

Ans. Five or six.

Int. 20. Did you notice the form of the carbon burners in the lamp? If so, please to state what the form of the carbon burners was?

Ans. A little longer than half a circle, as I recall it.

Int. 21. Did you notice whether any of the burners in those lamps were made of straight sticks of carbon?

Ans. I do not recall it.

1774 Int. 22. Do you recollect of Mr. Sawyer visiting Mr. Man's house?

Ans. I do.

Int. 23. State, if you recollect when his visits occurred.

Ans. The early spring, I think, and then in the summer, of 1878.

Int. 25. How often did he visit there?

Ans. I can't remember, maybe six times.

Int. 26. Can you recollect what time in the year it was in 1878 that you visited the shop in Walker street?

Ans. In the fall; it may have been September, somewhere about that.

Int. 27. These carbons that you saw in the lamps—I mean the carbon burners you saw in the lamps in the Walker-street shop, how did they differ, if at all, from the paper carbons you saw Mr. Man make at his house?

(Objected to as leading and suggestive.)

Ans. I should think as near as I can recall it they were the same shape.

Cross-examination:

X Int. 28. Were these lamps lit when you saw them?

Ans. They were.

X Int. 29. Who lit them for you to see?

Ans. I think they were lighted when we went there.

X Int. 30. Were they kept lit?

Ans. Yes.

X Int. 31. All the while you were there?

Ans. They were turned up and down to show different degrees of light.

X Int. 32. As I understand you they remained lighted all the time you were there?

Ans. Yes.

X Int. 33. Are you sure your visit was made before October, 1878?

1775 Ans. I think so.

X Int. 34. Are you sure you did not see lamps with straight pencils?

Ans. I said I did not recall them.

X Int. 35. You simply do not recollect them, if they were there. Is that so?

Ans. Just as I said, I do not recall them.

ALICE J. WATKINS.

The further examination of the witnesses herein adjourned till Tuesday, 2d inst., at 1 p. m.

1776 NEW YORK, *April 5th*, 1889—10 a. m.

Met pursuant to adjournment.

Present: Thomas B. Kerr, of counsel for complainant, and Walter K. Griffin, of counsel for defendant.

Testimony of Hans J. Muller.

HANS J. MULLER, a witness on the part of the complainant, being duly sworn, deposes as follows in answer to interrogatories by Mr. KERR:

Int. 1. State your name, age, residence, and occupation.

Ans. Hans J. Muller; age, 51; residence, 553 West 53rd street; electrician.

Int. 2. Were you acquainted with William E. Sawyer, and if so, when did you become acquainted with him?

Ans. I was. I met him first in Arnoux & Hochhausen's shop, on the corner of Reade and Centre street, in the earlier part of 1878.

Int. 3. Were you connected with Arnoux & Hochhausen in any way?

Ans. Yes. I was foreman in the firm at that time.

Int. 4. Under what circumstances did you meet Sawyer?

Ans. He came to Hochhausen's office to order a machine, special wound, for a test of incandescent lights.

Int. 5. Of whose manufacture was that machine, and who made the special winding?

Ans. The machine was Hochhausen's manufacture of the old Siemens type, and I personally did the winding.

Int. 6. Was that machine used by Sawyer?

Ans. Yes, sir.

Int. 7. Where?

Ans. In a room at 41 or 43 Centre street.

Int. 8. Did you ever see any of the lamps which he tested with that machine?

1777 Ans. I have seen some of them a number of times. The first that I have seen was in 41 or 43 Centre street.

Int. 9. Please state at what time you saw the lamp at 41 or 43 Centre street and describe the lamp which you saw there.

Ans. It was in March or April, I rather think in March. The lamp consisted of a glass globe about six inches high, and an inch and a half diameter, mounted on a metallic base. As far as I could see from the distance that I was away from the lamp, there was a round carbon about three-quarters of an inch long and about a sixteenth of an inch thick mounted on two brass rods running up from the base to the upper part of the globe.

Int. 11. Was this carbon straight or curved?

Ans. It was straight and in a horizontal direction from one rod to the other.

Int. 12. How often were you at Sawyer's room at Center street?

Ans. I was there only one time to my recollection.

Int. 13. Did you ever see any of these lamps at any other place? and if so, where?

Ans. I have seen some on corner of Howard and Centre streets, in the period between May and earlier part of August, 1878.

Int. 14. Please describe the lamps you saw at Howard and Centre streets.

Ans. They had about the same shape as the one before described, with the exception that some had semicircular carbons, and in others the carbons were straight. They were placed vertically from one rod to the other.

Int. 15. Did you ever see these lamps in use at Howard and Center streets?

Ans. Yes, sir; I have seen two burning at the time on several occasions.

Int. 16. What was the form of the carbons in the lamps you saw burning?

Ans. Sometimes the form was semicircular, and sometimes the horizontal straight. Vertical-placed carbons I have not seen burning.

1778 Int. 17. How did those lamps you saw burning seem to operate?

Ans. They gave a very steady light as long as I saw them.

Int. 18. How was it as to brightness?

Ans. I judged they must have been about 12 to 16 candles.

Int. 19. How did you come to be at Howard and Centre streets?

Ans. Arnoux & Hochhausen had moved their shop on the 1st of May to that place, and I, of course, went with them.

Int. 20. Where was Sawyer's shop with relation to Arnoux & Hochhausen's shop at Howard and Center streets?

Ans. It was on the floor below—that occupied by Arnoux & Hochhausen, in a room occupied by a party named Mueller & Neumann.

Int. 21. Are you acquainted with Albon Man, and if so, when did you first become acquainted with him?

Ans. I am. I met him first in the earlier part of 1879, at 138 Center street, where he collected rent for a room occupied by Kaschau Brothers and myself.

Int. 22. Did you do any work for Sawyer when he was at Howard and Centre streets?

Ans. I did. One time I made a submarine lamp for them; another time I made a commutator, and another time I drilled brass rods to form cylinders, as he said, for the purpose of making certain lamps.

Int. 23. Was any work done for him by Arnoux & Hochhausen at Howard and Center streets besides this work you have spoken of in your last answer?

Ans. Yes, sir; but to my knowledge, the year previous. Whether there was any work done by them at that time I cannot say.

Witness here states that he misunderstood questions 22
1779 and 23; thought they referred to when Sawyer came to me
at 138 Center street, was in 1879.

Int. 24. I now will repeat my question 22, in view of your explanation; did you do any work for Sawyer when he was at Howard and Center streets?

Ans. Yes, sir. I connected the machine that I have spoken of before, and which was located in Hochhausen's shop, to Sawyer's little office on the floor below, to transmit electricity from the machine to there. I personally did not do much else. They gave me a number of orders, which I turned over to men that were working under my supervision, although I made a few small parts for lamps for them.

Int. 25. What were these orders which you turned over to other men for?

Ans. They were, as far as I know, all for lamps. Closer explanation was never given to me. They gave me simply pencil sketches showing how the piece should look when done, but did not explain what purpose it was intended for.

Int. 26. Were they in the habit of explaining to you what they were doing?

Ans. No, sir; on the contrary, they kept all their ideas as secretly as possible, and all I have seen was on occasions which they could not control.

Int. 27. Do you know anything about any manufacture of carbons for electric lamps done by them?

Ans. They sawed carbon pencils out of retort carbon and filed them down, sometimes round and sometimes square, until they had the desired shape. One time I have seen old Sawyer turning a piece of carbon round and boring a hole in, and then he cut a piece of it down to form a ring which he then cut in two parts; one of them he mounted on one of the lamps. That's all I know that they did.

Int. 28. Were you ever consulted in regard to the manufacture of carbons for the lamps by any of them?

Ans. Yes, sir. Old Sawyer one time asked me if I know
1780 of any device to cut retort carbons to pencils in a cheaper
manner than they did at that time. I answered, the only way of which I knew would be to mount a number of copper discs on a mandril and set it on a lathe and cut with them the carbons by means of applying water and sand; but I also stated, that this would be a rather expensive way, because a great number of them would break and become useless.

Int. 29. What did old Sawyer say to that?

Ans. He said that this would be only to use these carbons for experiment. They intended to make carbons out of paper by cutting them out into the desired shape and carbonizing them.

Int. 30. What did you understand he meant by carbonizing paper?

Ans. I understood the usual way of carbonizing vegetables; that is, to close them in a hermetically closed vessel and bring them into a white heat.

Int. 31. Had you at that time any knowledge or experience in carbonizing vegetable materials?

Ans. Yes, sir. Some years before I made carbons for batteries in turning wood into a cylinder which I then put in a retort, surrounded by a carbon dust and brought it to a white heat, by which it carbonized to my satisfaction.

Int. 32. Did Sawyer run the machine at Howard and Centre streets constantly?

Ans. No, sir; it was only running from time to time, when they wanted to try lights.

Int. 33. How did they get the machine started and stopped when they wanted to use or discontinue its use?

Ans. While I was there they came up to me telling me to start it or to stop it, and sometimes they started and stopped it themselves.

Int. 34. Can you state how many lamps you saw altogether at Howard and Centre streets?

Ans. I don't think I saw more than six in a finished shape.
1781 Int. 35. Did you make parts for any more than that num-
ber of lamps?

Ans. There were parts made for more under my supervision, and old Sawyer had a few men working for himself at Hochhausen's floor to make parts of lamps.

Cross-examination:

X Int. 36. The work you refer to in your answer to question 22nd, was done by you in 1879, after you had moved to 138 Centre street; was it not?

Ans. Yes, sir.

X Int. 37. Where was Mr. Sawyer's office then, if you know?

Ans. At the corner of Elm and Walker streets.

X Int. 38. How large a room had Sawyer on Howard street?

Ans. About ten feet square to my recollection.

X Int. 39. Was there any machinery in it?

Ans. Outside of an air pump I don't know of any.

X Int. 40. Did any shafting run through it so as to apply power?

Ans. No, sir; not that I know of.

X Int. 41. In your answer to question 35 you state that old Sawyer had a few men working for himself at Hockhausen's floor. Was there more than one man working for him?

Ans. There was to my recollection three or four—sometimes three and sometimes four. One man named Sharp was engaged permanently at that time by Sawyer, and the rest were taken to help whenever he was in want of them.

X Int. 42. Do you remember the names of these men?

Ans. The name of one is Zagg, and the other Rector. A Frenchman did some work for him—I can't recollect his name.

1782 X Int. 43. How soon before Sawyer left Howard street did you have your conversation with old man Sawyer as to making carbons?

A. I don't know the time when Sawyer left Howard street, because I left before him. Old man Sawyer told me about making paper carbons in June or July, '78. I cannot locate the time any closer.

X Int. 44. In your answer to question 27, you say you saw old Sawyer turning a piece of carbon round and boring a hole in it. That was a piece of retort carbon, was it not?

Ans. Yes, sir.

X Int. 45. Did you see Mr. Man at Howard and Centre street-?

Ans. I cannot say, because I did not know him at that time, and if he has been there, my attention not being called to him personally.

X Int. 46. When work was being done for Sawyer it was done in Hochhausen's shop amongst the other men, was it not?

Ans. Yes; but not all, for as I already stated, one man was permanently engaged by Sawyer.

X Int. 47. But he worked in the same shop as the other man, did he not?

A. Yes, sir.

X Int. 48. How did you come to testify in this suit?

A. About 14 days *any* a gentleman, who introduced himself as being connected with Mr. Curtis, came up to our office, corner of 11th avenue acd 16th street, asking me if I had any knowledge about Mr. Sawyer and his doings at Howard and Centre streets. I answered yes, and then Mr. Curtis asked me to testify.

X Int. 49. How many times have you seen either Mr. Curtis or any one else as to the subject of your testimony?

Ans. I have seen Mr. Curtis only once, and the other gentleman twice; one time at our office and the other time at Mr. Curtis' office.

1783 X Int. 50. Were you ever at Sawyer's place at Elm and Walker streets?

A. Yes, sir; in the summer of 1879. It was at the time I did the work mentioned in my 22d answer.

(Signed) H. J. MUELLER.

Examination closed.

1784 New York, *April 5th*, 1889.

Met at 1 p. m., pursuant to adjournment.

Present: Mr. Broadnax for complainant, and W. K. Griffin, Esq., for defendant.

Deposition of Edwin L. Hayes.

Edwin L. Hayes, being called on behalf of complainant, and duly sworn, testifies as follows:

Int. 1. What is your name, age, residence and occupation?

Ans. Edwin L. Hayes; 69 years of age; I reside at Bloomfield, New Jersey; I am a general broker in lands, stocks and bonds.

Int. 2. Are you acquainted with Albon Man?

Ans. I am.

Int. 3. How long have you known him?

Ans. More than twenty years.

Int. 4. Have you ever been a neighbor of Mr. Man's?

Ans. Yes, sir. I lived next door but one to him in Putnam avenue, Brooklyn, for a number of years.

Int. 5. Were you a neighbor of his in the year 1878?

Ans. I was.

Int. 6. What, if anything, do you recollect of Mr. Man's telling you about carbons for electric lamps in 1878?

Ans. The conversation on carbons came up more particularly after I had introduced Mr. Sawyer to Mr. Man.

Int. 7. When was that?

Ans. That was in February or March, 1878.

Int. 8. When did you make the acquaintance of Mr. Sawyer?

Ans. In the latter part of December, 1877.

Int. 9. How did you make his acquaintance?

Ans. I was introduced to Mr. Sawyer by a gentleman of the name of Church.

Int. 10. What was the occasion of Mr. Church's introducing Mr. Sawyer to you?

1785 Ans. Mr. Church called upon me to know if I had any facilities for getting capital in to work upon electric lighting business.

Int. 11. What did you say to him in reply?

Ans. I said that I thought perhaps I had the means of getting capital in; that I had a friend in Brooklyn who had been giving attention to electric matters of various kinds, and thought perhaps I might interest him, I referred to Mr. Man.

Int. 12. Had you and Mr. Man previously talked together about the subject of electricity?

Ans. We had.

Int. 13. Did you then introduce Mr. Church or Mr. Sawyer to Mr. Man?

Ans. I made an appointment with Mr. Church to go with me that evening to go to Mr. Man's house in Brooklyn?

Int. 14. Did you keep the appointment?

Ans. Mr. Church called at my house that evening and I went with him to Mr. Man's house, and gave him an introduction. Mr. Sawyer was not with me at that time.

Int. 15. Did you subsequently introduce Mr. Sawyer to Mr. Man?

Ans. I did, the next evening.

Int 16. Were you present at the interview with Mr. Sawyer and Mr. Man that evening?

Ans. I was, and also Mr. Church.

Int. 17. What was the general subject of conversation between yourself and Mr. Sawyer and Mr. Man on that occasion?

Ans. The principal subject was electricity, and to devise a plan to get capital in to develop Mr. Sawyer's inventions.

Int. 18. Inventions appertaining to electric lighting?

Ans. Yes.

Int. 19. Did that interview result in an arrangement between Mr. Sawyer and Mr. Man to undertake the development of electric lighting?

1786 Ans. It did. There was an appointment made that they should meet the fore part of the week, I think Tuesday, and consider the subject-matter.

Int. 20. State, if you know, what steps they took towards the making of electric lamps.

Ans. Of my personal knowledge, I don't know as I can say anything more than Mr. Sawyer informed me that Mr. Man had agreed to furnish some capital to make some experiments in electric lighting.

Int. 21. Did you subsequently see any electric lamps made by Sawyer and Man?

Ans. I did.

Int. 28. Where and when did you see them?

Ans. I don't know as I can state the time exactly. Some days after I was invited to go up to Centre street.

Int. 23. Do you recollect the number in Centre street?

Ans. No, sir.

Int. 24. Did you go there with Mr. Sawyer or Mr. Man?

Ans. I went up with Mr. Church.

Int. 25. Who did you see there, and what did you see there in the way of any electric lamp?

Ans. I saw Mr. Sawyer and Mr. Man and an old gentleman who seemed to be a mechanic, who was said to be Mr. Sawyer's father.

I saw an electric lamp there. I don't know that I can describe the form of it now.

Int. 26. Did you see more than one?

Ans. I cannot say at that time whether I saw more than one or not.

Int. 27. Did you subsequently see any of the Sawyer-Man lamps at that place?

Ans. I cannot say that I did. It was a very short time after that I saw the Sawyer-Man lamps, but whether it was at that place or at Howard street I am not certain.

1787 Int. 28. What, if anything, did Mr. Man or Mr. Sawyer say to you about carbons to be used as illuminating conductors for those lamps either at that time or at any time subsequently?

Ans. Mr. Man stated to me that, I think, they had sent to France to get some carbons, and that they had not proved very satisfactory—Paris, I think. Some little time subsequent to this conversation I was coming down in the cars; at Franklin street Mr. Man stepped onto the car and showed me some carbons—paper carbons—that he said he had made himself.

Int. 29. How many were there?

Ans. I couldn't say; he had quite a number of them—different shapes, in an envelope.

Int. 30. Did he state where he had made those carbons?

Ans. He did; he said he made them at home.

Int. 31. Did he say he had carbonized them himself?

Ans. He did.

Int. 32. How did he say he had carbonized them?

Ans. I don't think I can tell. He said he had carbonized them in his laboratory.

Int. 33. Did he say in what fire or furnace he had carbonized them?

Objected to as leading and suggestive to the witness.

Ans. He said he had carbonized them in his little cupola furnace. I forgot it exactly. I have been in his little place there where he worked.

Int. 34. What was the shape of the carbons he showed you?

A. There were some circles—half circles—some straight. I don't recollect now all the shapes.

Int. 35. Did you take them in your hands and look at them?

Ans. I couldn't say whether I took them in my hands or not. I saw them when he took them out of the envelope.

1788 Int. 36. When was this that he showed you these carbons?

Ans. I cannot state definitely the time. It was several weeks after they commenced working at this business.

Int. 37. Can you state what year it was?

Ans. In 1878. I think March or April. It was early in the spring.

Int. 38. Did you subsequently see any carbons like those you have mentioned in the Sawyer-Man lamps, and if so, please to state where?

Ans. I did. I noticed the half-circle carbon particularly when that was on exhibition. I think that was on Howard street. I am not positive, but I think it was.

Int. 39. Are you clear that it was in Howard or Centre street?

Ans. It was after they left Centre street, I think.

Int. 40. Who took you to see them on that occasion, or did you go by yourself?

Ans. Mr. Church gave me notice that they would make an exhibition in the afternoon of the morning he came to see me, and I went up.

Int. 41. Was Mr. Sawyer or Mr. Man there or both of them?

Ans. They were both of them there.

Int. 42. In how many lamps did you see these half-circular carbons?

Ans. I cannot say how many. They exhibited several lights at the same time. They had several lights strung around the room, I don't know how many of them had circular carbons.

Int. 43. Was there more than one that had circular carbons?

A. I can't say positively. There were several lights around. I didn't notice particularly whether they were all circular carbons or not.

Int. 44. What did Sawyer or Man say to you about these carbons at that time, if anything?

1789 Ans. Not to me directly. There were several gentlemen there; they explained the carbons and they were all listening at the same time.

Int. 45. Did you hear them say what the carbons were made of, and if so, please state.

Ans. I don't know as there was anything particular said at that time any more than that they were said to be paper carbons the same as Mr. Man showed me some time previous.

Int. 46. Were you interested in any way in the Electro-Dynamic Light Co. at that time?

Ans. Only as a broker in introducing parties. I was a stockholder.

Int. 47. Were other stockholders of the Electro-Dynamic Light Co. present at that time?

Ans. I think there were several of them.

Int. 48. Did you subsequently see these lights at any other place; if so, please state where.

Ans. I saw subsequently, at this same place, and I think I saw them when they were moved to Walker and Elm streets.

Cross-examination by Mr. GRIFFIN:

X Int. 49. At the close of your last answer you asked whether the Walker and Elm street place was where Hochhausen was, did you not?

Ans. Yes; I wasn't clear whether they were on the corner of Walker and Elm or on Howard street.

X Int. 50. How was it that you were not clear on this point?

Ans. I was frequently at their place of business at both places and I couldn't call to mind now whether they were at Howard or on the corner of Walker and Elm.

X Int. 51. Do you mean to say you are not certain whether Hochhausen was at Howard street or at Walker and Elm?

1790 Ans. No, I meant to be understood that when this exhibition was made I was not certain whether it was on Howard street where Hochhausen was or whether it was the corner of Elm and Howard.

X Int. 52. Can you describe the lamp which you saw at Centre street when you went there with Mr. Church?

Ans. I don't think I can describe the lamp at all; they had so many different forms of lamps there to experiment on.

X Int. 53. I mean the lamp that you first saw at Centre street. Can you describe that?

Ans. No, I don't know that I can. I don't recollect exactly what the lamp was.

X Int. 54. Are you certain that you ever saw that same lamp again?

Ans. I saw an exhibit of all the different lamps that they had made several months after they commenced operations, commencing at No. 1. I couldn't see how many lamps there were. There were several of them that they had been experimenting with.

X Int. 55. Are you certain that you ever saw the Centre-street lamp again?

Ans. I am.

X Int. 56. Where did you see it?

Ans. I saw it in their shop after they moved to the corner of Elm and Howard. That is the time I saw the several lamps they were experimenting with.

X Int. 57. Are you sure it was the same lamp?

Ans. Yes, sir; I should think it was the same lamp.

X Int. 58. Can you describe it?

Ans. I cannot describe it.

X Int. 59. When did Mr. Man state to you that he had sent to France to get carbons?

Ans. A short time after they commenced operations at Centre street.

X Int. 60. What kind of carbons had to be sent for?

1791 Ans. He said they had sent for French carbon, that is all I know about it. I don't know what kind he sent for.

X Int. 61. Do you know whether they used any French carbons?

Ans. I do not.

X Int. 62. Did you ever have any lamps called to your attention which were said to have French carbons in them?

Ans. Not to my recollection.

X Int. 63. You never heard of them so far as you remember?

Ans. I do not recollect of hearing of their using them.

X Int. 64. When did you see Mr. Man's cupola furnace?

Ans. I couldn't tell when. I have seen it a number of times when I have been in his little shop that he worked in.

X Int. 65. Where was that shop?

Ans. In his house, 118 Putnam avenue, Brooklyn.

X Int. 66. Did Mr. Man tell you he had carbonized what he showed you in his cupola furnace?

Ans. I don't know that he mentioned the furnace. He said he had carbonized the samples he showed me.

X Int. 67. He didn't tell you how he had carbonized them?

Ans. I think he did, but I don't recollect now what the process was.

X Int. 68. Did he tell you the material of the carbons?

Ans. He explained it all very particularly at the time, but I don't recollect—he called them paper carbons.

X Int. 69. That is about all you remember?

Ans. That is about all I remember about the carbons.

X Int. 70. When Mr. Church took you to the exhibition which you think was in Howard street, who were there to your knowledge?

Ans. Mr. Man, the two Sawyers, Wm. E. and his father, Mr. Myers—I don't recollect his given name. Mr. Church was there and several others whose names I do not now recall to mind.

1792 X Int. 71. Were they members of the Electro-Dynamic Co.?

Ans. That was my understanding at the time—that they were members of the company who came up to see the exhibition.

X Int. 72. Are you positive that at that exhibition there was more than one lamp with a circular carbon?

Ans. There were several lamps there on exhibition. I suppose they were all with circular carbons.

X Int. 73. What makes you suppose that?

Ans. I was examining the light and I remarked to Mr. Man—I asked him whether that was his paper carbon. That was the question I put to him. I supposed the lights were all similar. I didn't examine particularly but the one.

X Int. 74. And you have no recollection of any other shapes?

Ans. I have no recollection of seeing any other shapes that day—any other form of carbon.

X Int. 75. Have you any recollection of seeing any other shapes any other day at Howard street?

Ans. Previous to this exhibition I saw them using the wood carbon they called it. That was a straight carbon.

X Int. 76. Was that the only time you remember seeing a straight carbon?

Ans. I don't recollect of seeing any straight carbons after this exhibition, though I may have done it.

X Int. 77. You can't say whether you did or not?

Ans. Not of their production.

X Int. 78. What do you mean by that?

Ans. I have no recollection of seeing any straight carbons used by them after that.

X Int. 79. Who first spoke to you as to testifying in this suit?

Ans. Mr. Man.

X Int. 80. How many conversations did you have with him?

1793 Ans. Never had any extended conversation. He said he might have to call on me to establish the time that Mr. Sawyer was introduced to him.

X Int. 81. Did he talk to you about the paper carbons?

Ans. Yes, he asked me what my recollection was in the matter of paper carbon.

X Int. 82. Did he talk over what had occurred?

Ans. No, sir.

X Int. 83. Whom besides Mr. Man have you seen as to your testimony?

Ans. I have not seen any one except the gentleman to whom I gave my recollections as to the introduction—Mr. Kerr, I believe.

X Int. 84. Did he talk to you about paper carbons?

Ans. No, sir.

EDWIN L. HAYES.

1794 *Deposition of David Hennessy.*

David Hennessy being called on behalf of complainant and duly sworn testifies as follows:

Int. 1. What is your name, age, residence and occupation?

Ans. David Hennessy, 57 years of age, I reside 205 West 48th street, New York city. I am a plumber.

Int. 2. Are you acquainted with Albon Man, and if so, how long have you known him?

Ans. I am. I have known him twenty years, or thereabouts.

Int. 3. Did you do any plumbing work for Mr. Man at 94 Walker street?

A. I don't know the number, but I did at the corner of Elm and Walker streets, if that was the number.

Int. 4. Do you recollect when you did that work?

Ans. I done it October, 1878, or thereabouts, I think.

Int. 5. Have you a memorandum of the work you did for him at that time? If you have please produce it?

A. I have, and I produce it.

Int. 6. From what did you make this memorandum, and when?

Ans. From my books, I made it recently.

Int. 7. Do you mean within a week or ten days?

Ans. Yes, sir.

Int. 8. Does this memorandum represent when the work was done; the dates?

Ans. Yes, sir.

Int. 9. Have you visited the premises lately?

Ans. Yes, sir.

Int. 10. Within a week or ten days?

Ans. Yes, about ten days.

Int. 11. Do you remember a light hole in the northwest corner of the building?

Ans. Yes, sir.

Int. 12. Did you put any of this work in that light hole, and if so, what?

1795 Ans. Yes, sir, I put three pipes there.

Int. 13. What part of this work was at the top next to the roof of the building there?

Ans. A large air chamber.

Int. 14. What parts ran down from that air chamber?

Ans. There was an exhaust went down to the basement; something I didn't understand.

Int. 15. Under whose direction did you put that work up?

Ans. Mr. Albon Man.

Int. 16. At the time you put it up did he tell you what it was for?

Ans. No, sir.

Int. 17. All that you know of it, as I understand, is that you put it up under his directions?

Ans. Yes, sir.

Int. 18. Did any of the pipes lead into the shop?

Ans. Yes, that small tube pipe led into the shop and also downstairs.

Int. 19. State, if you know, what was at the end of the pipe that led into the shop.

Ans. Two small little air cocks on it.

Int. 20. Was there a pipe led from the top down to the basement or street?

Ans. Yes. It led down to the basement.

Int. 21. Were any of these pipes supplied with water connected to the Croton water?

Ans. Yes, sir.

Int. 22. What did the Croton water pipe lead into?

Ans. It led into this vessel upstairs, this chamber up under the roof.

Int. 23. Does this memorandum which you have produced—a copy from your books—contain a true copy of items for the work done there by you?

Ans. Yes, sir.

Memorandum offered in evidence and marked Complainant's Exhibit Hennessy Memorandum, April 5, 1889.

(Signed) DAVID HENNESSY.

1796 COMPLAINANT'S EXHIBIT HENNESSY MEMORANDUM. April 5, 1889. W. T. F., S. E.

NEW YORK, *October*, 1878.

Mr. Albon Man to David Henessy, Dr., practical plumber and gas-fitter, 1597 Broadway, bet. 48th and 49th Sts.

Oct. 17.	To	115 lbs. lead pipe.
	"	40 ft. ¼ lead tubing.
	"	2⅝ stops and wastes finished.
	"	37 ft. ½-inch gas pipe.
	"	1½-inch soldering nipple.
	"	5 prs. tacks and screws.
	"	18 pipe hooks.
Oct. 18.	"	7 lbs. 2-inch lead.
	"	4 ft. ⅛-inch gas pipe.
	"	2 brass ¼-inch gas cocks.
	"	cartage, charcoal, candles and screws.
	"	1½ day plumber and assistant.
	"	8 lbs. solder.
Oct. 19.	"	2½ ft. ⅛ gas pipe.
	"	1 ft. ⅛ elbow.
	"	1 ft. ⅛ tee.
	"	2 ft. ⅛ nipples.
	"	1 ft. ⅛ coupling.
	"	1 ft. ⅛ air cock.
	"	2 ft. ½ unions.
Oct. 29.	"	73 ft. ⅜ gas pipe.
	"	1 day gas-fitter and assistant.
Oct. 30.	"	17 ft. ⅜ gas pipe.
	"	18 fittings.
	"	12 straps.
	"	2 ft. ½-inch lead pipe.
	"	2 lbs. solder.
	"	2⅜ stop-cocks.
	"	1 large bracket.
	"	3 small brackets.
	"	coal, candles and screws.
	"	¼ day plumber and assistant.

1797 *Deposition of Edward Rowe.*

EDWARD ROWE being called on behalf of complainant and duly sworn testifies as follows:

Int. 1. What is your name, age, residence and occupation?

Ans. Edward Rowe, 74 years of age, I reside in the city of Brooklyn on the corner of Franklin and Fulton avenues, I am United States assistant appraiser at the New York custom-house.

Int. 2. Are you acquainted with Albon Man?

Ans. I am, sir.

Int. 3. Were you acquainted with him in 1878?

Ans. Yes, I have been acquainted with him over twenty years. I have lived a neighbor to him in Brooklyn during all that time. I have been a member of the board of education of Brooklyn for the past twenty-five years.

Int. 4. Please to state generally what information you have regarding an electric lamp or light from Mr. Albon Man?

Ans. Coming in the car with me one morning we were talking on the subject of electricity, and he asked me if I would like to see anything of that kind, and accepting his invitation he took me to a building that seemed to be devoted to mechanical purposes and I accompanied him to this place, and he found he was not able to show me what he wanted on account of the workmen not being there, and invited me to come some other time. Shortly after, I accompanied him to the same place and he then showed and explained to me this new invention, electric light produced I believe by what he called an incandescent burner which they were then to work on. After satisfying my curiosity and explanations I left and went to my business.

Int. 5. What, if anything, did Mr. Man say to you while you were there about the incandescing carbons? Did he tell you what they were made of?

1798 Ans. Yes, he told me—he showed them to me—he said they were made of paper and I expressed my surprise that they didn't burn up.

Int. 6. When was this?

Ans. In the early part of 1878.

Int. 7. How many lamps did you see there—incandescing lamps?

Ans. He showed me a number. How many I can't say.

Int. 8. How long were you there on that occasion?

Ans. I suppose from half to three-quarters of an hour, explaining to me things.

Int. 9. Have you any knowledge of the subject except as explained to you by Mr. Man?

Ans. No, sir, and no mechanical genius. It is all Greek to me.

Int. 10. How do you fix the date?

Ans. Because my business then was on Grand street near Broadway, New York, and I moved from that location that year.

(Signed) EDWARD ROWE.

Adjourned till Saturday, the 6th inst., at 11 a. m.

1799 NEW YORK, *April 9th*, 1889—11 a. m.

Met pursuant to adjournment.

Present: Thomas B. Kerr, of counsel for complainant, and Walter K. Griffin, of counsel for defendant.

Testimony of George S. Beith.

GEORGE S. BEITH, a witness on the part of the complainant, being duly sworn, testifies as follows in answer to interrogatories by Mr. KERR:

Int. 1. State your name, age, residence and occupation.

Ans. My name is George S. Beith, my age is 50 years, residence New York city; I am a machinist and engineer.

Int. 2. Where are you now employed?

Ans. At the New York Lumber and Wood Working Co., at 134 Alexander avenue, New York.

Int. 3. When did you enter the employment of that company?

Ans. On the 9th of April, 1883.

Int. 4. Have you continued in its employment ever since?

Ans. Yes, sir.

Int. 5. Please state whether that company has a Sawyer-Man electric lighting plant, and if so, when it purchased the same?

Ans. It has such a plant. It was put in by the Consolidated Electric Light Co., in November, 1883.

Int. 7. What was the size of that plant?

Ans. It was 250 lights.

Int. 8. Has it since been increased?

Ans. Yes, sir. It is now 400.

Int. 9. Has that plant been in use ever since November, 1883?

Ans. We have used it every winter until the winter of '87 and
'88, when it was not in use. This past winter it has been in
1800 use. During the winter of '87 and '88 they removed the
business to Batavia, so they had no need of the lights.

Int. 10. Can you produce one of the lamps which was in use in November of 1883?

Ans. Yes, sir, this is one.

Witness produces a lamp which is offered in evidence as Complainant's Exhibit New York Lumber Co. Lamp, W. T. F., examiner.

Int. 11. Please state how those lamps burned.

Ans. The lamps gave satisfaction, seemingly, there were no complaints.

Int. 12. How long was that particular form of lamp used by the lumber company?

Ans. They were used that winter, '83 and '84, all winter.

Int. 13. What was their guaranteed life?

Ans. Twelve hundred hours.

Int. 14. What was their candle power?

Ans. Sixteen candle power.

Int. 15. What was their percentage of loss during that winter?

Ans. Out of the number of lamps which we got when the plant was first put in, there was about 10 per cent. loss.

Int. 16. What period of time was covered by this 10 per cent. less?

Ans. Our rate of ten per cent. was for that winter, from about November to about April.

Int. 17. You have spoken of the use of the lamps in the winters, weren't they used in the summers, and if not, why not?

Ans. We have used them in the summer, but it was on a rare occasion, during a thunder storm when it got dark for fifteen or twenty minutes. Other than that there was no occasion to use them.

Int. 18. How did those lamps used in the fall and winter
1801 of '83 compare with the lamps which you now use?

Ans. Well, perhaps the percentage of loss might be a little greater during that fall. The lamps that we then used would get a little more smoky than they do now, and we would take them out and replace them with others. I might also state that those which were kept there were brilliant and gave good light.

Int. 19. Does the lamp which you have produced show the smokiness you have spoken of?

Ans. Yes, sir, a little of it.

Int. 20. Do you know whether this lamp you have produced is still in working order?

Ans. I tried that last night; it was. You can't see that smoke when it is lit, as much as you do now.

Int. 21. Where has that lamp been since '83?

Ans. It has been in the factory of the wood-working company, in my charge.

Int. 22. Do you know how long it was in use?

Ans. Only that winter of '83 and '84.

Cross-examination:

X Int. 23. What were the working hours of the lumber Co.?

Ans. Ten hours a day. They commenced at seven o'clock in the morning, and stopped at half past five.

X Int. 24. How were the rooms of the lumber company lit during the daytime?

Ans. In clear weather they were lit by daylight. In very dark weather some of the rooms had to be lit by electricity.

X Int. 25. What was the hour for lighting up?

Ans. Ten minutes to seven in the morning for starting till about about half past eight and sometimes nine; from half past four in the afternoon until a quarter to six.

X Int. 26. What personal knowledge have you as to whether the lights were lit at that time each day?

1802 Ans. They were not all lit at the same time.

X Int. 27. What is the greatest number of lamps you know to have been lit during ordinary working hours?

Ans. We had eighty on one floor.

X Int. 28. In what part of the works was your position while on duty?

Ans. At the engine, boilers, dynamo and lamps—the plant right through.

X Int. 29. When you gave the hours of lighting up, do you mean that was the time when the dynamo was set in operation?

Ans. Yes, sir.

X Int. 30. And during the hours the dynamo was running, such of the lamps were lit as were necessary, according to circumstances?

Ans. Yes, sir; that's right.

X Int. 31. And that number would vary according to the weather and other things, would it not?

Ans. The weather was the principal cause of any variance in the time of lighting or the use of the lamps.

X Int. 32. It depended altogether upon how dark it happened to be?

Ans. Yes, sir, exactly.

X Int. 33. You produced a lamp this morning; after those lamps were changed, what was the shape of the globes used?

Ans. Pear-shaped.

X Int. 34. When were these pear-shaped lamps put in?

Ans. I can't say positively whether we had any of those that winter; I think we had them the following winter.

X Int. 35. That was the second winter of use, was it not?

Ans. Yes, sir, the second winter, '85 and '86.

1803 X Int. 36. Did you ever test the lamps to ascertain their exact candle power, or when you stated their candle power in your direct examination, did you simply mean that they were bought as sixteen-candle lamps?

Ans. Exactly. I had no means of testing them.

GEO. S. BEITH.

Adjourned to April 10th, 1889, at 11 a. m.

NEW YORK, *April 10th*, 1889.

Met pursuant to adjournment.

Present: Thomas B. Kerr, of counsel for complainant, and Walter K. Griffin of counsel for defendant.

Counsel for complainant offers in evidence the paper book shown to the witness Thomas A. Edison at questions 516 and 517 of his examination in this case, and marked by the examiner for identification at that time as Complainant's Exhibit Edison, Swan and Maxim Record, the same containing the deposition of said Thomas A. Edison in said interference case on pages 1 to 13 inclusive, and 154 to 262 inclusive, and the same is marked "Complainant's Exhibit Edison, Maxim and Swan Interference Record, testimony on behalf of Edison, W. T. F., examiner, April 10, 1889."

Objected to as incompetent, immaterial and irrelevant.

Complainant's counsel also offers in evidence a certified copy of the file-wrapper and contents in the matter of the application of Thomas A. Edison, filed December 11, 1879, serial No. 146–30, for improvements in electric lamps and method of making the same.

1804 Said copy being certified by Benton J. Hall, Commissioner of Patents, on March 28th, 1889, as shown by the certificate thereto annexed, and the same is marked "Complainant's

Exhibit Edison File-wrapper and Contents, W. T. F., examiner, April 10, 1889."

Complainant's counsel also offers in evidence a certified copy from the records of the Patent Office of a letter from Dyer & Wilber, attorneys for Edison, dated October 4th, 1880, ordering copy of file-wrapper, contents and drawing of the application of Sawyer and Man, filed January 9th, 1880, for improvement in electric lights, and a certificate of the furnishing of said copy on October 16, 1880, the said copy being certified by C. E. Mitchell, Commissioner of Patents, on April 2d, 1889, and the same is marked "Complainant's Exhibit Certified Copy of Dyer & Wilber Letter of October 4th, 1880, W. T. F., examiner, April 10, 1889."

Objected to as incompetent, immaterial and irrelevant.

Testimony of Hugh R. Garden.

Hugh R. Garden, a witness on the part of the complainant, being duly called and sworn, testifies as follows in answer to interrogatories propounded to him by Thomas B. Kerr:

1 Q. State your name, age, residence and occupation, and what connection you have, if any, with the complainant company.

A. Hugh R. Garden, 48, New York city, lawyer and president of the complainant company.

2 Q. How long have you been connected with the complainant company, and in what capacities?

A. I have been connected with the complainant company since its organization in September, 1882, and was vice-president of the company from the date of its organization until some time early in
the spring of 1885 when I was president of the company for
1805 a few weeks, I was thereafter vice-president of the company
until the autumn of 1888, when I became president of the
company, and have continued as president of the company until the present time.

3 Q. What connection have you had ever since the organization of the company with its active business management?

A. From the date of its organization until the spring of 1885 I was compelled, much against my inclination and education, to take an active part in its business management.

4 Q. What familiarity have you acquired with the manufacture of incandescent electric lamps?

A. Very soon after the organization of the company I found that as the official head of the legal department, it was necessary for me to familiarize myself with the methods and processes of manufacture of the incandescent electric lamp, and for many months I made it my business to spend a few hours almost every day at the manufactory of the company studying the details of such manufacture, and I thus became familiar with the manufacture of incandescent electric lamps.

5 Q. Are you acquainted with Henry E. Vineing, and if so, how did you make his acquaintance?

A. I know a man named Vineing, his Christian name I am not familiar with. The man I refer to was employed in the manufactory of the complainant company, my recollection being that he was an Englishman who came to us recommended by some people connected with the Lane Fox Company, who were manufacturers of incandescent lamps in England, and he was employed by our superintendent, because he stated that he could make an incandescent electric lamp better than anybody else.

6 Q. What was your experience with him in regard to his ability to make incandescent electric lamps?

A. Very unsatisfactory. He was an ingenious mechanic but was evidently not familiar with the methods and processes 1806 used by the manufacturers of incandescent electric lamps, and devoted most of his time to unnecessary and useless experiments which he claimed at the time would be beneficial, but which proved to be absolutely injurious to the lamps then being manufactured by the company.

7 Q. Had the company prior to that time been manufacturing and selling incandescent electric lamps?

A. It had, but its resources being limited, its manufacturing facilities were not very extensive. I recall now amongst the places where its lamps were in use by purchasers the building at the corner of Wall street and Broadway in the city of New York, owned jointly by the First National bank and the National Bank of the Republic, and called the United Bank building; also an establishment on Union square in New York, owned and occupied, I think, by William H. Jackson & Co.; also a manufacturing establishment in Harlem, styled, I think, the New York Wood-Turning Company, and at that time the company was under contract — the incandescent plant for the new Mutual Life building then being erected in the city of New York, the contract calling, I think, for some 1,600 lights.

8 Q. What satisfaction did the lamps give, which you were making prior to Vineing's employment by the company?

A. I never heard of any unusual complaints about the quality or life of the lamps, and the purchasers always paid their bills for lamps promptly.

9 Q. How long did Vineing continue in the employment of the company, and what was the cause of his leaving?

A. I do not remember how long he was in the employment of the company. He was discharged at a time when the force was being reduced, he being one of those who could best be spared, as ranked among the least efficient.

10 Q. Vineing again obtained employment from the company. 1807 Can you state the circumstances of his re-employment and the termination of that re-employment?

A. As I stated, Vineing was an ingenious mechanic and I think in the summer of 1885, Mr. Henry C. Davis being then the manager of the commercial affairs of the company, Vineing was employed by him, I believe, directly to assist in fitting up the factory for an increased output. During that period also much of his time was occupied in carbonizing and in subjecting to the hydrocarbon process invented by Sawyer and Man of many kinds of fibrous material, including paper, bamboo, various kinds of woods, split to size, grasses, jute, manilla, threads of various kinds woven and twisted. This was done during a period of several weeks, perhaps months, under orders from the office of the legal department, for the use of the experts and the lawyers for the complainant to enable them to decide by comparison with the carbons manufactured by the Edison Electric Light Co. which had been stipulated into a case then and now pending in the circuit court of the United States for the southern district of New York between the complainant corporation and the Edison Electric Light Co. whether or not a stipulation on the part of the Edison Company that the carbons manufactured by them were not subjected to the hydrocarbon treatment, was true. The result of the experiments and tests made of the carbons manufactured in various ways and of various materials above referred to, satisfied the experts and the counsel of the complainant company that the carbons of the defendant company were subjected to more or less of such treatment, and thereupon witnesses were summoned by the complainant from the factory of the Edison Company, who proved it.

11 Q. Were these experiments, the carbonization of various materials mentioned by you, which were done by Vineing, designed for the production of filaments for use in commercial lamps to be manufactured by the complainant?

A. No; but at the same time that these series of experi-
1808 ments upon various materials, as above referred to, were
being made, the company was manufacturing its usual
standard lamp.

12 Q. During the time of Vineing's first employment did he carbonize any other materials than those the company was using in the manufacture of its commercial lamps, and if so, under what circumstances?

A. Prior to the employment of Vineing the company had been using for the most part, carbonized bamboo filaments in its lamps. Vineing insisted that he knew of valuable material used by Lane-Fox, and of other material discovered by himself, which with improved methods of manufacture to be explained by himself, would produce a better carbon than we were then using. It very soon developed, however, that he was merely experimenting and that the use of those materials or those methods of manufacture did not produce a better carbon or a better lamp, but in reality seriously interfered with the uniformity of the manufactured product, which uniformity is one of the essentials in successful incandescent electric lighting. His persistence in continuing these experiments, and not abiding by results already obtained by the company, was the chief reason for his discharge.

13 Q. Under what circumstances did Vineing's second employment with the company terminate?

A. The company had leased a new factory in Brooklyn for the enlargement of its works and Mr. John M. Robertson, the superintendent, reported that he could get no satisfactory work out of Mr.

Vineing in the mechanical department in which he was employed, and asked that he be discharged. Mr. Vineing was given the opportunity "to resign," and he "resigned."

15 Q. Please give the title of the suit on the treating patent to which you have referred to.

A. U. S. circuit court, southern district of New York, between The
Consolidated Electric Light Company complainant, and The
1809 Edison Electric Light Company, defendant. In equity on
bill, etc., G, 3406. On patent 211,262.

15 Q. Please state what the attitude of the Edison Electric Light Company towards the Consolidated Electric Light Company has been ever since the date of the organization of the latter.

A. The attitude of the Edison Company toward the Consolidated Electric Light Company has been one of continuous and extreme hostility, and all the resources that apparently unlimited means, great power and wide-spread reputation could exert, were used to break down the organization and prevent its commercial success. Every effort was made to intimidate would-be purchasers from the Consolidated Electric Light Company by threats of suits to be brought for infringement, and through the press and by private circulars, the commercial world was constantly urged to remember that the Edison Company would not permit any other company to enter a field which they alleged belonged to the Edison Company exclusively. During this period an interference was pending in the United States Patent Office between the Edison Company and the Consolidated Electric Light Company, the successor of the Electro-Dynamic Light Company, which resulted, after a contest of about five years in the success of the Consolidated Electric Light Company, and the issue of a patent to it on the 12th of May, 1885, the same being the patent in suit. The Consolidated Electric Light Company for its own protection and the protection of its purchasers, was compelled to bring several suits upon patents granted to Sawyer and Man and owned by it, against the Edison Electric Light Company, and in addition to an enormous amount of money expended in endeavoring to overcome the commercial strength and financial power of its antagonist, it has been compelled to expend more than $100,000 in these legal controversies. At the outset, the Consolidated Electric Light Company was poor financially, but had confidence in its pat-
ents and in its ability to attain commercial success. This
1810 confidence is now shared with it by the vast number of con-
sumers who are now using the Sawyer-Man incandescent
electric lamps.

16 Q. Please state what the attitude of the other electric lighting companies engaged in incandescent lighting, toward the complainant company, is.

A. The only companies in this country other than the complainant company who are largely engaged in the manufacture and sale of incandescent electric lamps, are the defendant company, the Westinghouse Electric Co., the United States Electric Lighting Co., and the Thomson-Houston Electric Co. All of these companies, with the exception of the defendant company, are manufacturing and selling incandescent electric lamps under contracts of license with the Consolidated Electric Light Co., and a large number of lamps manufactured by these companies under the Sawyer-Man patents are being sold to local plants and stations originally erected by the Edison Electric Light Co.

Direct examination closed.

Adjourned to April 11th, 1889, at 11 a. m.

NEW YORK, *April* 11*th*, 1889.

17 X Q. Was not a suit in equity brought against your company by the Edison Electric Light Co., May 2nd, 1885, upon the Edison bamboo filament patent?

A. A suit was brought by the Edison Company against the Consolidated Electric Light Co., upon the bamboo filament patent, the date of which suit I do not remember. I only remember that it was brought some time after several suits had been instituted by the Consolidated Electric Light Co. against the Edison Electric Light Co. for infringement of several of the Sawyer-Man patents.

1811 18 X Q. Can you not ascertain from your papers whether the date of beginning that suit was not as I stated?

A. I find that I have sent all my papers in that case over to Mr. Broadnax.

It is stipulated that the suit on the Edison bamboo filament patent was commenced May 2d, 1885, the bill being sworn to as of that date.

19 X Q. In addition to the concerns mentioned in your seventh answer, who else, if anybody, was employing your lamps?

A. I do not think the company was prepared to sell dynamos and install electric lighting plants prior to the summer or early in the fall of 1883, and they therefore did not have many such plants in operation. Those referred to in answer seven are impressed upon my mind because they were in New York. I do not recall any others at this moment.

20 X Q. Are not the concerns mentioned in your seventh answer substantially all the concerns who at that time were using your lamps?

A. I do not think they were, cannot say positively but am sure there were not many others.

21 X Q. The lamps sold to all these concerns had bamboo carbons, had they not?

A. A large majority were bamboo carbons.

22 X Q. What other materials do you know them to have used in those lamps sold to any of the concerns you have mentioned?

A. Thread and grass of some kind, the name of which I have forgotten.

23 X Q. Subsequently did you not adopt bamboo for the filament in all your commercial lamps?

A. In the lamps manufactured at the factory of the Consolidated Electric Light Co. we did.

24 X Q. That was the only factory over which your company had control, was it not?

1812 A. Up to the spring of 1885, yes. After that period companies not controlled by us manufactured lamps under license from us for which they paid us a royalty. From August 23rd, 1887, to October 1st, 1888, the Consolidated Electric Light Co. operated a factory at Pittsburgh, making many thousand lamps *per diem*, in which the carbonized filament used was made of silk thread.

25 X Q. During the year 1885 what material did you understand was used by the Edison Company in its lamps?

Objected to as immaterial.

A. The stipulation in the suit referred to by me in my examination-in-chief made by the Edison Company recited that their carbon filaments were made of bamboo, and such was the general opinion.

26 X Q. In any of the Edison lamps which you or the experts examined during the year 1885, did you find the material to be anything else than bamboo?

A. They were certainly all made of fibrous material and I don't remember seeing any that were not of bamboo.

27 X Q. Is not the means of telling whether a carbon has been treated or not, an optical examination either by the eye or by the microscope?

A. It is the only means I know of.

28 X Q. Were not the various materials carbonized by Vineing tried in lamps at your works?

A. Some of them were and some were not.

29 X Q. Do you know any of the classes of material which he carbonized which were not actually tried in lamps? I do not refer to single specimens, but to classes of material.

A. It may be possible that Vineing attempted to make lamps, or rather incandescent conductors for lamps, out of every class of material that he carbonized. My objection to Vineing's course at the factory was that he spent his time in useless experiments, instead of using the material which we had theretofore found to be good, bamboo, for instance, and using such as an incandescent conductor.

1813 30 X Q. In your 16th answer you mentioned several electric light companies, with the exception of the Edison Company are not all those companies either owned or commercially controlled by contract or lease by the Westinghouse Electric Co.

A. I do not know the relations between the United States Company, and the Westinghouse Company: the Thomson-Houston Company is not under contract of lease or, as far as I am aware, any other contract relating to lamps with the Westinghouse Company. The commercial assets of the Consolidated Company were leased by the Westinghouse Electric Company, on the 1st day of October, 1888, and the lamp factories of the Consolidated Company are now being operated by the Westinghouse Company.

31 X Q. How long under a microscope does it take you or an expert to tell whether a carbon has been treated or not?

A. The time taken for examination would depend upon the amount of the treatment; a very slight or delicate treatment requiring a more careful investigation, than one where the filament is heavily coated by the treatment.

32 X Q. If I gave you a filament to ascertain whether it had been treated, all that would require to be done would be to pass that filament throughout its entire length under the microscope and attentively note the appearance, is that not so?

A. No, that is not all; I have seen cases in which filaments had to be examined with the rays of light falling upon the filament at different angles and with different degrees of intensity before it could be determined whether or not they were treated.

33 X Q. In other words you had to use the proper light for the illumination of opaque objects under the microscope, was that not so?

1814 A. Yes, you had to obtain the proper light and a proper microscope.

34 X Q. And that is all there is to it?

A. Not being an expert I cannot say, but that's all I know about it.

HUGH R. GARDEN.

NEW YORK, *April* 11, 1889.

Met pursuant to adjournment.

Present: Mr. Broadnax for complainant and Mr. Griffin for defendant.

Testimony of Edward R. Knowles.

EDWARD R. KNOWLES, being called on behalf of complainant, and duly sworn, testifies as follows:

1 Q. What is your name, age, residence and occupation?

A. Edward R. Knowles, 37 years of age. I reside at 439 A, Waverly avenue, Brooklyn. I am an electrical engineer.

2 Q. State whether or not you are the same Edward R. Knowles that testified in the interference between Wm. E. Sawyer and Albon Man on one side and Thomas A. Edison on the other, on or about the 23d day of November, 1882.

A. I am.

3 Q. I place in your hands a book containing a certified copy of your deposition in that case, the same being a part of the printed record of the testimony in that interference. Please to look at the book and state on what pages it begins and terminates.

A. It begins on the 84th page and terminates on the 92d.

1815 4 Q. How recently have you read this deposition?

A. Yesterday.

5 Q. Assuming the questions of that deposition to be propounded to you now, would you make the same answers to them?

A. I should, or substantially the same.

6 Q. Are the answers to those questions true, as you now recollect the facts inquired about?

A. They are to the best of my recollection.

7 Q. Where are you now employed?

A. By the Mutual Electric Manufacturing Company.

8 Q. How long since you left the employ of the Consolidated Electric Light Company?

A. I left them on the 12th of February, 1884.

The deposition of the witness in the interference in now offered in evidence under the stipulation between counsel as to such depositions already of record, and the examiner is requested to write said deposition into this record as a part of the same, and the same is as follows: (it being stipulated between counsel that the examiner may compare the same with a certified copy of said deposition and certify the same as correct.)

COUNSEL'S NOTE.—The deposition of Edward R. Knowles in the interference case above referred to, is printed in volume 3 of this record, on pages 622 to 630 inclusive.

Cross-examination by Mr. GRIFFIN:

9 X Q. In your answer to question 43 on interference, you state that you used the carbons there mentioned in the lamp known as the Sawyer and Man lamp. Can you describe that lamp generally, if so, do so?

1816 A. I can. The lamp consisted of a long glass tube cemented into a metallic cup, this forming one part of the lamp. One of the electrodes for the lamp was hermetically sealed through and insulated from the metallic base. The other electrode was in metallic connection with the metal base. The two electrodes were furnished with a small carbon clamp at their extremeties, into which a U-shaped carbon was inserted and firmly held. This formed the other part of the lamp. The cup with its attached globe was passed over the carbon and electrodes of the lamp and united to the metallic base and soldered thereto, forming a tight joint. That is a description of the lamp.

10 X Q. When you went into the employment of the Consolidated Electric Light Company what lamps were they manufacturing?

A. They were not manufacturing any. They commenced the manufacture of the lamp of which I was the inventor.

11 X Q. At what time was this?

A. They commenced it when I went there, which was somewhere about the 12th of October, 1882, when I first began my work there. This was on the corner of Front and Adams streets, Brooklyn.

12 X Q. What was the carbon used in that lamp?

A. Quite a variety of carbons. They were made from paper, kittoal, tampico, istle, patent fibre, bast and bamboo.

13 X Q. What was the material for the carbon adopted for the commercial lamp of the company?

A. Bamboo.

14 X Q. When was this adopted?

A. It was finally decided to use bamboo the 28th of March, 1883.

15 X Q. When were the first commercial lamps put on the market to your recollection?

A. The first lamps we put on the market were put in the United Bank building, corner of Wall and Broadway. I can't give the exact date. I have got it but not here.

16 X Q. These were bamboo lamps, were they not?

A. Bamboo.

1817 17 X Q. How did the bamboo carbons in your lamps differ from the bamboo carbons used in the Edison lamps?

A. They had no lugs on the extremities and were much heavier and lower in resistance, and were treated loops—treated carbons.

18 X Q. Later on, how did the carbons used by you differ from the Edison bamboo carbons?

A. They never had any terminal lugs, were round in section, treated and of a lower resistance than the Edison carbon.

19 X Q. The treatment lowered the resistance, did it not?

A. It did, more or less. The carbons when carbonized and before treatment were always of quite low resistance, comparatively speaking. The treating process was principally used to equalize the resistance of the carbons and make them uniform.

20 X Q. How did you come to leave the employment of the Consolidated Company?

A. They got through with my services and didn't need me any longer.

21 X Q. What do you mean by saying they "got through" with your services?

A. There were several of us that could not agree very well and it was decided that we had better part.

22 X Q. Wasn't there quite a row?

A. Not particularly. They informed me that they did not need my services any longer. I tendered my resignation, which was accepted.

23 X Q. Have you been retained as an expert in this suit?

A. I have.

24 X Q. How long ago were you retained?

A. I don't remember exactly. About a month ago.

25 X Q. Do you expect to testify again in this suit?

A. I shall, if I am asked so to do.

1818 26 X Q. You have no knowledge of any intention to call you again, have you?

A. I don't know anything about it.

27 X Q. Do you remember my calling at your office in Brooklyn in company with Mr. Vineing?

A. I do.

28 X Q. Did you not then state to me in substance that in consequence of your retainer you must refuse to give me information as to the matters of which I inquired?

A. Not knowing who you were I did. It is not my habit to give information to anybody I am not acquainted with, unless for some special reason.

29 X Q. You recognized Mr. Vineing, did you not?

A. I did.

30 X Q. And I informed you that I was attorney for the Edison Electric Light Company, did I not?

A. I did not so understand you. I understood that you were connected with the Edison Company in some capacity, from what Mr. Vineing said when he introduced you.

31 X Q. And you told us that the Edison Company couldn't get anything out of you, substantially, wasn't that it?

A. Not substantially. I had just been retained by the Westinghouse people, and I did not consider that I was at liberty to converse with other people on the subject for which they had retained me.

32 X Q. For what subject had they retained you?

A. For general electrical work, I suppose, but more especially on incandescent lamps and kindred subjects.

33 X Q. Have you done any general electric work further since your retainer?

A. Not any.

34 X Q. Have you done any work especially on electric lamps and kindred subjects since your retainer?

A. Nothing. This is my first appearance in their interest to-day.

1819 Redirect:

35 R. D. Q. Do you consider yourself qualified to testify as an expert on the general subject of electric lighting and especially of incandescent electric lamps?

A. I do.

36 R. D. Q. Since you were retained in this case, have you had any conferences with Mr. Broadnax on the subject of incandescent electric lamps, in making such lamps and especially carbons?

A. I have.

E. R. KNOWLES.

NEW YORK, *April 13th*, 1889.

Met pursuant to adjournment.

Present: Thomas B. Kerr of counsel for complainant, and Walter K. Griffin of counsel for defendant.

Testimony of James A. Vandegrift.

JAMES A. VANDEGRIFT a witness on the part of complainant being duly sworn testifies as follows in answer to interrogatories propounded to him by Mr. KERR:

1 Q. State your name, age, residence and occupation.

A. James A. Vandegrift, 27, my place of residence, Newark, N. J.; I am a manufacturer of incandescent electric lamps.

2 Q. Please state the name of the company you are connected with, and how long you have been connected with it?

A. United States Electric Lighting Company, since January 20th of 1880.

1820 3 Q. Have you been engaged in the manufacture of lamps for that company ever since that date?

A. With the exception of two years.

4 Q. What two years?

A. 1882 and 1883.

5 Q. Please state what kind of lamps the United States Company was manufacturing, if any, at the time you were there, namely, January 20th, 1880?

A. The lamp contained a carbon composed of paper treated with a hydrocarbon vapor.

6 Q. Please state what kind of lamps so far as the carbon is concerned, the United States Company has been making and selling since January 20th, 1880?

A. Two kinds, one with a carbon composed of paper and the other kind with a carbon of tamadine.

7 Q. Please state when the United States Company began to manufacture lamps from tamadine?

A. Some time during the year 1883.

8 Q. To what extent has the manufacture of paper-carbon lamps been carried on, to your knowledge, by the United States Company since January 20th, 1880?

A. They manufactured since 1883 in the neighborhood of eight hundred thousand. From 1880 until 1883 they were making between two and three hundred a day as an average.

9 Q. State whether the United States Company is still making and selling lamps with paper carbons.

A. It is.

10 Q. Please produce specimens of paper-carbon lamps made by the United States Company during the period from January 20th, 1880, to the present time?

A. I now produce two lamps, having carbons of different forms, one with a letter M carbon and one with a zigzag carbon, which are samples of the two types of paper-carbon lamps made by the United States Company during that period.

1821 The two lamps produced by witness are offered in evidence and marked "Complainant's Exhibit U. S. Zigzag Lamp," and "Complainant's Exhibit U. S. M-shaped Lamp, W. T. F., special examiner, April 13, 1889."

11 Q. Is the United States Company at present manufacturing and selling both of these forms of paper-carbon lamps?

A. They are.

12 Q. State whether these are practical and commercial lamps.

A. They are.

Cross-examination by Mr. GRIFFIN:

13 X Q. What experience had you in the manufacture of incandescent electric lamps prior to January 20th, 1880?

A. None.

14 X Q. Or as to the manufacture of carbons prior to that date?

A. None.

15 X Q. You were about 20 years of age when you went to the factory, were you not?

A. Yes.

16 X Q. What have been your successive positions in the factory?

A. Assistant to Mr. Maxim; in charge of the incandescent department; erecting plants; again in charge of the incandescent department.

17 X Q. In the M-shaped lamp you have presented, is not the shape of carbon covered by letters patent to Mr. Maxim?

A. I believe it is.

18 X Q. Is not the zigzag shape in the second lamp presented by you, also patented to Mr. Maxim in this country?

A. My understanding is that it was patented by Mr. Weston.

1822 19 X Q. What kind of paper originally before carbonization were the conductors of these two lamps formed of?

A. Called parchment deed paper.

20 X Q. Is not the use of parchment paper patented by Mr. Weston in the United States?

A. I have no knowledge of such a patent.

21 X Q. Are the paper conductors in the two lamps treated or non-treated?

A. They are treated.

22 X Q. By whose process?

A. Mr. Maxim's.

23 X Q. Patented to him in the United States, is it not?

A. Yes, sir.

24 X Q. What is the difference in the weight of those paper conductors before and after treatment?

A. I should say 10 per cent. heavier after treatment.

25 X Q. Is the paper prepared or treated prior to carbonization?

A. Only very slightly charred, for the purpose of punching better.

26 X Q. What do you mean by very slightly charred?

A. Heated between copper plates, and raised to a temperature to slightly brown the paper.

27 X Q. This has the effect of charring or consuming all loose, exterior fibres, has it not?

A. No; it is simply for the purpose of allowing the punch to make a clean cut.

28 X Q. You mean by making a clean cut making a cut without dragging out or teazing out the fibres on the edge of the filament, do you not?

A. Yes.

29 X Q. What temperature are these copper plates heated to for the process of partial carbonization?

A. About 250 degrees Farenheit.

30 X Q. Who invented this process?

1823 A. Mr. Maxim.

31 X Q. And it is patented to him in the United States?

A. I don't remember a patent issued to him for this.

32 X Q. By what means are the papers carbonized? I mean who invented the process used by the United States Company?

A. Mr. Maxim.

33 X Q. Has he any letters patent of the United States for any of the processes or means of carbonization?

A. He has.

34 X Q. And these processes invented by and patented to Mr. Maxim are used by the United States Company?

A. They are.

35 X Q. In the M lamp I notice a special means for attaching the ends of the carbon to the twisted electrodes consisting of miniature nuts, bolts and washers. Whose invention is this?

A. Mr. Maxim's.

36 X Q. And the twisted electrodes, whose invention are those?

A. I don't know.

37 X Q. How many letters patent of the United States upon the method of sealing lamps do you know?

A. I know of four.

38 X Q. How many of those patented processes are made use of in sealing the M lamp? I mean by sealing and so forth, the processes or means of fixing the electrodes in the inner bulb and the means of fusing or attaching the inner bulb to the outer bulb.

A. Two processes.

39 X Q. How many patents has the United States Company, so far as you know, on the methods of procuring a vacuum and sealing or fusing the outer globe to secure the vacuum?

A. I am aware of only one.

1824 40 X Q. Do you know whether there is only one patent or is there only one patent of which you are now aware?

A. I only remember one patent.

41 X Q. There may be more patents for all you know?

A. Yes, sir.

42 X Q. In the zigzag lamp presented by you, the method of supporting the electrodes is different from the methods shown in the M lamp. How many patents, if any are there upon this method of sealing the electrodes in the zigzag lamp?

A. One.

43 X Q. Have you any definite knowledge as to the number of patents, or of inventions made since January 20th, 1880, used by the United States Company in connection with the system of manufacture and use of these paper-carbon lamps?

A. I have no definite knowledge.

44 X Q. Before carbonization, is the paper submitted to pressure of any kind?

A. Yes.

45 X Q. Describe the means by which that pressure is applied.

A. An ordinary screw-press with a hand wheel.

46 X Q. Have you any idea of the number of pounds pressure to the square inch they applied?

A. I have not; but it is only to keep the paper from wrinkling during the process of charring. This pressure is applied during the process of charring.

47 X Q. How many paper lamps of this size do the United States Company now manufacture?

A. Between seven and eight hundred per day.

48 X Q. How does this compare with the number of tamadine lamps?

A. About one-quarter.

Cross-examination closed.

JAMES A. VANDEGRIFT.

1825 Boston, *April 1st*, 1889.

Testimony Taken on Behalf of Complainant, Before H. C. Merwin, Special Examiner, Pursuant to Agreement of Counsel.

Present: L. E. Curtis, Esq., for complainant; R. N. Dyer, Esq., for defendant.

It is stipulated and agreed that proofs may be taken on behalf of complainant before H. C. Merwin, notary public, with the same force and effect as if taken before one of the standing examiners of the court, and that an order may be entered *nunc pro tunc* at any time, without notice, appointing said H. C. Merwin a special examiner herein.

Adjourned to April 2, at 11 a. m.

Boston, *April* 2, 1889.

Met pursuant to adjournment.
Present: Counsel as before.

Testimony of Charles R. Cross.

The witness, Prof. Charles R. Cross, a witness produced on behalf of complainant, being duly sworn and interrogated by counsel for complainant, deposes and says as follows:

1826 Int. 1. What is your name, age, residence and occupation?

Ans. Charles R. Cross; 41 years of age; I live in Boston, Mass., and am Thayer professor of physics in the Massachusetts Institute of Technology.

Int. 2. What knowledge have you of the science of electricity and of the various applications of electricity to the useful arts, and particularly the art of electric lighting?

Ans. During the past nineteen years, in the position which I have occupied at the Massachusetts Institute of Technology, I have constantly been required to give extended instruction in the study of electricity, both theoretical and applied. I have, during a large portion of that time, given special courses of lectures relating to applied electricity, and particularly to the theory and practice of electric lighting, both to my own classes and in public. I am director of the Rogers laboratory of physics in the institute of tech-

nology, and have under my care the large collection of apparatus for electrical measurement and testing belonging to that laboratory, and have the direction and superintendence of the work of instruction and research which is constantly carried on in that laboratory. About six years ago, at my suggestion, a course in electrical engineering, the first to be established in this country, was instituted in the institute of technology, and since that time, by far the greater part of my time has been occupied in the development of that course. In this connection, I have immediately under my care the instruction of students, both in the lecture-room and laboratory, in the study of technical electricity, and a very great portion of that instruction is devoted to different branches of electric lighting, which I am accustomed to treat with minuteness. I have personally, and in connection with my advanced students, made numerous researches in electricity, and especially in its application to the telephone and to electric lighting, and have published a number of papers thereon. I have several times served upon juries
1827 called to decide upon the relative merits of electric lamps,
dynamo machines and other devices used in electric lighting, and have become familiar with the various systems of electric lighting which have been proposed or used. I have frequently, during the last eleven years, given testimony in the United States courts regarding electrical inventions, and have testified in almost all of the principal suits relating to the electric speaking telephone, and also in numerous suits relating to electric lamps and electric lighting. I have kept myself informed as to the development of the incandescent electric lamp and its employment for electric illumination, and am familiar with the history of this branch of the art. I am acquainted with the various devices which have been proposed or used for this purpose.

Int. 3. Have you read and examined the complainant's patent in suit, U. S. letters patent No. 317,676, granted May 12, 1885, to Electro-Dynamic Light Co., of New York, assignee of William E. Sawyer and Albon Man, and do you understand the same?

Ans. I have read the patent referred to, and believe that I understand it.

Int. 4. What were the principal kinds of electric lamps known in the art prior to 1880, and which of these, if any, had been used for any industrial purpose?

Ans. There were three kinds of electric lamps which had been described prior to the date mentioned in the question. These lamps were, first, the arc lamp; second, the arc incandescent, or semi-incandescent lamp; and, third, the incandescent lamp.

The first of these makes use of the voltaic arc, which is produced when a current from a voltaic battery or dynamo machine of proper construction is caused to pass between two pencils of hard carbon, first brought into contact and then separated from each other by a short distance. The current of electricity leaps across the gap between the two carbons, producing an intensely brilliant light,
1828 the most brilliant artificial light known. The greater part
of this light comes from the ends of the pencils themselves,

which become heated to an intense whiteness, and glow with great brilliancy.

A description of this phenomenon, together with a picture of the voltaic arc, will be found on page 4 of a book entitled "Electric Lighting" by H. Fontaine, translated by Paget Higgs, published in London in 1878.

In the arc incandescent, or semi-incandescent lamp, one piece of carbon, generally brought to a point, is allowed to rest lightly upon a second piece of carbon. Owing to the higher resistance at and near the point of contact, the carbon becomes incandescent, and emits a continuous light. A gentle pressure is exerted between the two carbons, so that the contact is still kept up, notwithstanding the wasting away which occurs from ordinary combustion and other causes. The lamp of Shepard, shown in British patent No. 13302, of 1850, Defendant's Exhibit No. 20, is a lamp of this kind, as is also the well-known Werdermann lamp.

The incandescent lamp is a lamp in which a piece of platinum, iridium, carbon, or other refractory-conducting material, is brought to incandescence by the passage through it of a current of electricity, which causes it to emit a steady glow. Of this character is the lamp described by King in British patent No. 10919 of 1845, Defendant's Exhibit No. 17.

A picture of this lamp is shown in Fig. 45, page 170, of Higgs' book already cited.

The arc lamp is the only one of these which had been used for any industrial purpose at the date referred to in the question. It had, however, been so used for many years, being especially well known in connection with light-house illumination; so that the term "electric lighting" was always understood as referring to illumination by means of the arc light. A picture of one of the best
known electric lamps which had been used prior to 1880, the
1832 Serrin regulator, is shown in Fig. 9, page 31, of the Higgs
publication. It was especially employed in some of the
French light-houses, though its use was by no means limited to this.

Adjourned to 2.15 p. m.

Resumed after adjournment at 2.15.

Complainant's counsel offers in evidence the cuts referred to in the preceding answer, and the same are marked, respectively, Complainant's Exhibit Cut of Voltaic Arc; Complainant's Exhibit Cut of Serrin Arc Lamp; Complainant's Exhibit Cut of Werdermann Arc Incandescent Lamp; and Complainant's Exhibit Cut of King Lamp; H. C. M., spe. ex.

(Here follow diagrams marked pp. 1829, 1830, and 1831.)

Int. 5. Did the term "charcoal," prior to 1880, have any different signification in the art of electric lighting, from its popular signification of wood charcoal prepared by the ordinary methods of

No. 286.
C. E. Light Co. } p. 1829.
v.
McK. Light Co.

Complainant's Exhibit, Cut of Voltaic Arc.

No. 286.
C. E. Light Co
v
McK. Light Co.
p. 1830

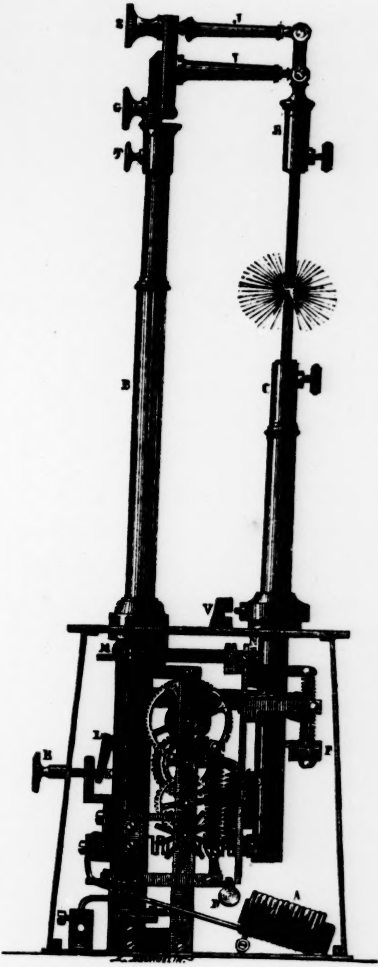
S
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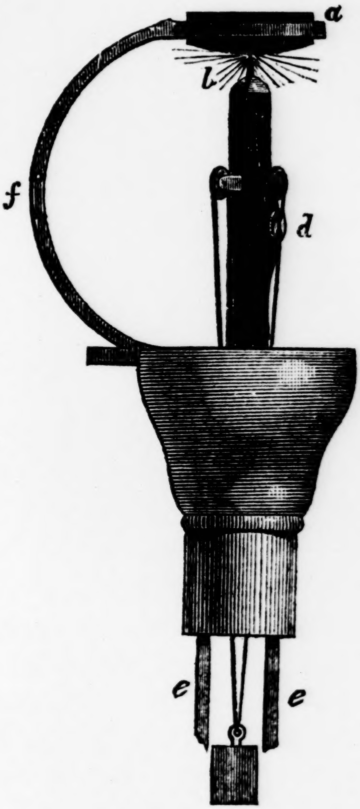
Fig. 9. Serrin's Regulator.

Complainant's Exhibit, Cut of Serrin Arc Lamp.

No. 286.
C. E. Light Co.
v.
MCK. Light Co.
} p. 1831



Complainant's Exhibit, Cut of Werdermann Arc-Incandescent Lamp.

[illegible] urner; and if so, please state what such different [illegible], and how it arose.

[illegible] he date referred to in the question the word char- [illegible] monly used in the art of electric lighting with a [illegible] rent from that in which it is popularly used. [illegible] designate the hard gas-retort carbon out of which [illegible] ons pencils used in the production of the electric [illegible]

[illegible] rm arose, apparently, in some such manner as [illegible] en the electric light was produced by Davy and [illegible] rimenters, they made use of hard charcoal, gen- [illegible] arcoal, which they shaped into pencils of proper [illegible] never satisfactory, since they were very rapidly [illegible] d, largely owing to this peculiarity, no use was made [illegible] arc, except as a lecture-room experiment, for many [illegible] But about 1845, Foucault suggested the employment [illegible] encils made from the hard carbon which is formed on the [illegible] terior of gas retorts, which is like graphite, very dense, and [illegible] wastes away very slowly, when used for the material of the pencils between which the arc is formed. For this, in later times, was substituted artificially prepared pencils made by pulverizing coke or gas-retort carbon, mixing it with some suitable material, such as tar, which would cement the particles together, forming them into a pencil shape in moulds, and heating them so as to consolidate the whole into a hard pencil.

The term charcoal, originally applied to the pencils of ordinary boxwood or similar charcoal used by Davy and others, not unnaturally came to be applied to the material of the carbon pencils employed in the arc light, without regard to the particular kind of carbon employed, the term charcoal being used in a generic rather than in a specific sense; and hence continuing to be applied to the material of the pencils for arc lighting long after the ordinary form of charcoal had ceased to be used for that purpose.

There is also still another way in which apparently the word charcoal has come to be used as, in general, identical in meaning with the word carbon, and especially as applied to the hard gas-retort carbon employed in arc lighting. There are many cases in which descriptions of pencils of carbon of this kind have been originally described in patents or other publications written in the French language and which have subsequently been translated into English. In many of these, the French term "charbon" has been rendered in English as "charcoal."

I will proceed to give a number of illustrations of the use of the term charcoal, to which I have referred.

In a paper by Violette (Defendant's Exhibit No. 11, Violette Paper), find this statement.

"Charcoal made at 1,500 degrees centigrade conducts much better than the charcoal of gas retorts and serves perfectly for electric illumination."

1834 In the English patent to Shepard, No. 13302 of 1850 put in evidence by defendant, page 9, I find the following descrip-

tion, which refers to a form of arc incandescent or se
lamp presented by the patentee as the inventio
Nollet of Brussels."

"6. Apparatus for lighting in a va

When it is desired to light by means of t
charcoal, I employ an arrangement of appara
which is represented in Fig. 10. A is a globe
if desired, be ground or obscured on the inside,
and soften the intensity of the light. The stop
is very carefully luted and two insulated polar
about 2 millimetres in diameter, are passed th
these wires is soldered to the side and towards the
copper tube C, of about 1 decimetre (4 inches) in leng
is intended to hold a little cylinder of *charcoal*, which
stantly pushed down from above by a small cylinder of
is of a weight adjusted to the purpose. The other polar wi
out under the lower end of this tube at about 1 centimetre (
inch) distance from its extremity, and terminates in a little cone
of prepared *charcoal* or coke, and against the top of which the little *charcoal* cylinder E rests, which, when the current is established, becomes incandescent, and remains in that state a very long time, because the small portions which are consumed are continually replaced by a portion of the cylinder, which the metal presser forces on to the top of the cone."

The italics in the preceding quotation are my own, and do not occur in the original.

There is also a Belgian patent to F. Nollet, filed May 5, 1851, and granted Nov. 4, 1852, which covers the same ground as the Shepard English patent just referred to, and of which the
1835 latter is substantially a translation. In this Belgian patent
I find the following paragraph, which corresponds to the one which I have quoted from the English patent:

"Lorsque je veux éclairer au moyen de l' incándescence du charbon, je dispose l' appareil qui est représenté Fig. 8 et qui se compose d' un ballon de verre dépoli si on le veut à l' intérieure pour adoucir la trop grande intensité de la lumiére. Le bouchon de ce ballon très soliditement luté est traversé par les deux fils polaires P. N. isolés d' environ deux millimètres de diametre. Un de ces fils est soudé à la paroi latérale et vers l extremité supérieure d' un tube de cuivre d' environ un dècimétre de lengueux et d' environ trois millimètres de diamètre. Ce tube est destiné à recevoir un petit cylindre de *charbon* comme il est dit cidessus, et constamment poussé de haut en bas par un petit cylindre de plomb qui a le poids nécessaire pour pousser suffisamment le *charbon*. L' autre fil polaire se présente sous l' extremite inférieure de ce tube et a environ un centimètre de son extrèmité. Il se termine par un petit cône *b* de *charbon* préparé de quatre à cinq millimétres de base et au sommet duquel vieut appayer légèrement le petit cylindre de *charbon* ou coke qui lorsque le courant est établi devient incandes-

[illegible] nt dans cet état très longtemps puisque les petites
[illegible] ent se consommer sont constamment remplaceés
[illegible] cylindre que le metal presseur pousse constam-
[illegible] t du cone."

[illegible] e above quotation from the Belgian patent are
[illegible] observed that the word "charbon" in the Bel-
[illegible] ted "charcoal" in the English patent. Fig. 8
[illegible] e Belgian patent is substantially the same as
[illegible] English patent.

[illegible] ish patent to Binks, No. 119 of 1853, put in evi-
[illegible] defendant, the electrodes employed in arc lamps
[illegible] rods or pencils of solid charcoal;" and through-
[illegible] se arc-light carbons are referred to as made of
[illegible] n the ordinary gas carbon is undoubtedly intended,
[illegible] years prior to 1853 it was well recognized that com-
[illegible] was unfitted for such purposes, and could not prac-
[illegible] ed. In the same patent Binks describes the employ-
[illegible] carbonized lignite, and speaks of this product as a
[illegible] al.

Binks also at the very beginning of his patent uses the term charcoal to denote the form of carbon used in ordinary electric arc lighting. He says:

"In the ordinary arrangements of the carbon electrodes for producing light by a current of voltaic electricity, two rods or pencils of solid charcoal are used."

In the English patent to Way, No. 2547 of 1856, put in evidence by defendant, the patentee refers to the ordinary hard-carbon electrodes as "electrodes of charcoal." He says: "Heretofore in obtaining light by means of electricity, electrodes of charcoal have usually been employed," and goes on to describe a use of mercury in connection with his lamp.

The same Way, in British patent 2841 of 1857, also put in evidence by defendant, throughout this patent constantly refers to the carbon electrodes described in his earlier patent, just referred to by me, as made of charcoal, although hard carbon is unquestionably the substance intended.

In Harrison's English patent, No. 588 of 1857, in both the provisional and complete specification-, the patentee employs the term charcoal with reference to gas carbon. Thus he says: "It is well known that condensed gas carbon, from its great purity and density, is the best and most durable form of charcoal for the display
1837 of electric light." This paragraph occurs alike in both the provisional and complete specification-. In another case, when the patentee desires to refer specifically to charcoal made by carbonizing ordinary wood, he refers to it as "wood charcoal." The statement is as follows: "I form pencils or solid carbon electrodes, by suspending small rods or pencils of wood charcoal upon a frame of iron:" and goes on to describe his special process of carbonizing.

Burleigh and Danchell, in British patent No. 3164 of 1857, also use the term charcoal in the same sense as referring to the pencils

used in electric arc lighting, and describe a proces
carbon pencils are made from various forms of
gas carbon, by a process of moulding.

In Ure's Dictionary of Arts, Manufactures and
published in New York in 1866, on page 486,
"Electric Light," I find this statement:

"The voltaic battery has been employed a
tricity, and in nearly all the arrangements
lights produced between the poles, from the
charcoal, has been the illuminating source. O
culties in applying this agent arises from the
there is a transference of the charcoal from one
and consequently an alteration in the distance be

The "hardest charcoal" referred to is gas carb
use at that time for the purpose in question.

In the translation of the Gauduin French patent,
evidence by the defendant, it is stated that certain ch
sils, as well as the pencils used in arc lighting, should be
chemically pure carbon, and goes on to say, "Now the dust of
carbon, though containing but a small proportion of foreign matte
is not sufficiently pure for these uses." The translator has
1838 written in the margin opposite "retort carbon," the words
"retort charcoal," as explanatory of the meaning of the
French terms translated as "retort carbon."

From these illustrations I think it is clear that the term "charcoal" was in common use in the art of electric lighting as denoting other forms of carbon than that which is popularly known as charcoal, and especially as denoting the hard carbon used for the purposes of arc lighting.

Int. 6. Is the substance lignite mentioned in the Binks English patent, to which you have referred, a vegetable or a mineral substance?

Ans. It is a mineral substance.

Int. 7. Professor Brackett, defendant's expert, says in substance in his answer to question 5, "that in view of the prior patents and publications, put in evidence by the defendant, there is not, in his opinion, any novelty in the use of vegetable fibrous carbon as the incandescent conductor of the lamp of the patent in suit;" and Prof. Barker in his answer to question 9, agrees with him in the opinion so expressed.

Do you agree with this opinion of defendant's expert? Please read in addition to the questions and answers I have referred to, Prof. Brackett's answers to cross-questions 41, 42 and 43, and Prof. Barker's answers to question 47 and cross-questions 51–55 inclusive, and to cross-question 63, and give your reasons for any opinion you may express.

Adjourned till April 3d, 9.30 a. m.

April 3d—9.30 a. m.

Ans. I do not agree with the statements of defendant's experts referred to in the question. I have considered very carefully

s prior patents and publications put in evidence by
and neither in these nor in any other publica-
am acquainted do I find the use of vegetable
scribed in the Sawyer and Man patent in suit

ling the views which I entertain in opposition
ndant's experts can best be made clear by a
arious patents and publications which the de-
idence. It will simplify matters if I group to-
and publications in evidence.
bits Nos. 1–14 inclusive, comprehending the
n the Philosophical Transactions, the collected
phrey Davy, the articles from the American Jour-
ndus, and Watt's Dictionary of Chemistry, are sim-
s of interesting and important scientific investiga-
periments, but which neither describe electric lamps
to do this. Many of them have no relation whatever
descent lighting, and some have no relation to any kind of
g whatever, the object of the experiments described therein
eing in some cases of purely theoretical interest, and in others relating to arts which are widely different from electric lighting.

Several of these papers relate solely to processes of carbonization, and merely show the state of the art so far as carbonization in general is concerned, but without regard to the bearing of this subject on electric lighting by incandescence.

A second group of the exhibits relates only to arc lighting and to the preparation of carbons for this purpose. Such are the patents to Slater and Watson (Defendant's Exhibit No. 21), an English patent; Binks' English patent (Defendant's Exhibit No. 23); Harrison's English patent (Defendant's Exhibit No. 25); Burleigh and Danchell's English patent (Defendant's Exhibit No. 26); Le Molt's French patent (Defendant's Exhibit No. 37); and the Gauduin
1840 French patent with certificates of addition (Defendant's Exhibit No. 40). These throw absolutely no light upon the selection or use of fibrous carbon for incandescent lighting. On the contrary, so far as they have any effect whatever, they tend to lead one in precisely the wrong direction. The requisites of carbon suitable for arc lighting are quite the reverse of the requisites for carbon to be employed in incandescent lighting. The carbon pencils for arc lighting should be exceedingly hard and very incombustible, so that they may wear away but slowly in the air; and they should moreover have as slight a resistance as possible, in order that it may not interfere with the passage of electricity along their length. In arc lighting the work should all be done in the arc itself, and whatever resistance is offered to the passage of electricity through the pencils is a dead loss; and this is by no means a matter only of theoretical interest. On the contrary, it is practically very important, so that the custom is almost universal of electroplating carbons for arc lighting with copper, in order to diminish the resistance which is offered to the passage of the current through the length of the conductor. Such is evidently not the

case with the incandescent light, since the incan
ment or pencil is to be rendered incandescent th
length, and must therefore offer a high rather t
to the passage of the current throughout its w

A third set of patents and publications rela
descent or similar lamps, which are not, pro
descent lamps. These exhibits are Defend
Pinkus English patent; No. 6, De Moleyn's E
Greener & Staite's English patent; No. 20, S
ent; No. 24, Way's English patent; No. 27, W
No. 29, Konn's English patent of 1873; No. 32,
lish patent; No. 33, Varley's English pa
1841 ties for an arc incandescent light, or for an
ferred to in these patents, are very diffe
arising in incandescent lighting, and there is not
these patents which in any way directs the attention
towards the matters set forth and described in the Sawy
patent in suit.

A fourth group of devices comprehends those described
fendant's Exhibit No. 19, Staite's English patent, and No. 34, Ga
diner and Blossom's U. S. patent. These relate to incandescent lamps, but not to incandescent lamps employing carbon conductors, since both of the patents in question set forth the use of conductors of metal only.

The only exhibits introduced in evidence by the defendant which refer to incandescent lamps with a carbon incandescing conductor, are the following: No. 17, King's English patent; No. 22, Robert's English patent; No. 28, Konn's English patent of 1872; No. 30, Kosloff's English patent; No. 31, Jensen's English patent; No. 35, Kosloff's U. S. patent; No. 38, Mechanics' Magazine article, describing the King lamp; No. 39, Journal of the Society of Arts article, referring to the Lodyguine lamp. Among all of these lamps there are three only which are alleged by defendant's experts to set forth the use of any particular kind of carbon, and it is therefore evident without further consideration that the others could in no way direct one wishing to practice the art of incandescent lighting towards the use of that particular kind of carbon referred to in the Sawyer and Man patent in suit. With regard to the three particular patents to which I have referred, I find them exceedingly indefinite, ambiguous, and calculated to confuse rather than to enlighten the mind of one reading them. I think that the justice of my conclusion will better be made evident by a specific though brief consideration of them.

I will consider first the British patent to Konn, No. 3809, of 1872. In this patent, which is a communication from Lodyguine of St. Petersburgh, there are described several forms of incandescent
1842 lamp in which carbon is used as the incandescing conductor.
The only particular form of carbon which is referred to in the patent is graphite, the patentee saying that the incandescing conductors are to be made "preferably of graphite." This lamp is referred to by defendant's expert, Prof. Barker, in his answers to

question 47, and cross-question 53. From the fact that Konn states that the incandescing conductors for his lamp are to be made "preferably of graphite," it seems to me unquestionable that his intention was, and that the effect of his patent necessarily would be, to guide one reading it and desiring to put into practice the invention therein set forth to the use of such graphite or gas carbon as was well known in the arts in connection with electric lighting. It is practically a statement that to get the full benefit of his invention one must employ that kind of carbon which possesses those peculiarities which were known to be possessed by graphite, especially, among different kinds of carbon. There is not in the patent the remotest intimation that anything but disadvantage could result from using carbon other than graphitic carbon; and an electrician wishing to construct an incandescent lamp of the character subsequently invented by Messrs. Sawyer and Man, and set forth in the patent in suit, would have to turn his back upon the patent to Konn and walk directly away from it and from everything which it contains in order to reach his goal.

I observe that Prof. Barker draws a different inference from my own in regard to the statement of Konn's that his incandescing conductors were to be made "preferably of graphite." Prof. Barker states that to him this "clearly indicates" that "Konn was fully aware that carbon in other forms was suitable for the purpose, and that these other forms had already been known and used as incandescing conductors for electric lamps." It does not seem to me that Konn's statement justifies the conclusion which Prof. Barker draws from it. On the contrary it appears to me that whatever Konn may or may not have been aware of, he intended to state, 1843 and does distinctly state, that for an incandescent lamp, such as he describes, graphite is pre-eminently the thing to be used, and that other kinds of carbon are distinctly not the things to be chosen by one wishing to practice his invention.

Adjourned till 2.10 p. m.

2.30 P. M.

The "Golos article" referred to in an article in the Journal of the Society of Arts, for Aug. 22, 1873, Defendant's Exhibit No. 39, relates to certain experiments with a lamp of Lodyguine. There is no scientific description of the lamp, but only a brief, popular statement which shows that it was an incandescent lamp having a carbon conductor. Referring to this lamp, the article says "only one piece of charcoal or other bad conductor is required;" and the same term "charcoal" is applied to the conductor in the latter portion of the same sentence, and once again in a subsequent sentence in which it is stated that "the charcoal becomes gradually and equally heated." The word "charcoal," as used in this publication, however, does not denote any kind of fibrous carbon, as will immediately appear from the consideration of the manner in which the same word is used somewhat earlier in the same article. Referring to the electric arc, it is spoken of as being formed "between two points of charcoal," and it is further said that difficulties arose from "the rapid consumption of the charcoal points." There can be no question, therefore, that the word "charcoal," as used in this publication, in no way refers to fibrous carbon, but rather to the hard gas-retort carbon which, at the date of publication of that article, had for many years in Russia as elsewhere been employed in arc lighting.

That I am correct in my view, that the term "charcoal" is employed in this article with reference to gas carbon, will further appear from a consideration of certain English patents
1844 relating to the same or similar forms of lamp, and originating with the same person or his colleagues.

The Golos article refers to Messrs. Kosloff & Co., of St. Petersburgh, as the proprietors of Mr. Lodyguine's patent for this invention, and Lodyguine was apparently connected in some way with this firm.

British patent to Konn, of the firm of S. A. Kosloff & Co., No. 3809 of 1872, Defendant's Exhibit No. 28, which is a communication by A. N. Lodyguine of St. Petersburgh, describes a new form of incandescent lamp, devised by the latter. Throughout this patent, wherever the material employed by it is specifically mentioned, it is stated to be graphite, which I understand to mean the material which had ordinarily been used for arc-light pencils. There are several other patents for incandescent lamps coming from the same firm. Konn's English patent, No. 91 of 1873, describes an incandescent lamp employing "solid stems of carbon," and the behavior of the "carbon stems" in this lamp is contrasted with the behavior of the "carbon points" as used in the arc light: from which I should infer without question that the same kind of carbon, that is hard carbon, was referred to in each case. Also, British patent to Kosloff, No. 441 of 1875, describes another form of incandescent lamp, in which "sticks of carbon" are made incandescent by the passage of a current through them. The specific form of carbon to be employed is not stated in terms in this patent, but I think that there can be no question that the patentee referred to such carbons as were used in electric arc lighting, and that this is the sense in which the patent would be understood. The patentee speaks of "the carbons" of the lamps in precisely the same way in which it was customary to speak of the pencils used in arc lighting as "the carbons," which he would have been very unlikely to do if they had not been of the same character. Also, British patent, No. 970 of 1875, to Jensen, is a communication from Konn of St. Petersburgh. It describes further improvements in the incan-
1845 descent lamp. In this patent the rods are also spoken of as made of carbon.

In none of these English patents is there any reference to any kind of carbon other than graphite, and in the Golos article it is clear, as I have shown, that the word charcoal is used as meaning hard carbon.

The statement in the Golos article reads very much as if translated or paraphrased from the French, and I have an impression that the periodical referred to employs that language; but whether this is or is not the case, it is clear that there is not the slightest reference in the Golos article to the use of fibrous carbon in an incandescent lamp.

British patent to Roberts, No. 14198, of 1852, contains a description of an incandescent lamp employing a conductor of carbon. He generally refers to this conductor as made of graphite. In stating his invention, however, he says, that it "consists of a mode of obtaining electric light by passing a current of electricity through a thin piece of graphite coke or charcoal or other infusible body being a conductor of electricity." This statement seems to be a very general one, and intended to indicate only that some form of conducting carbon should be employed. It certainly does not at all intimate the employment of vegetable fibrous carbon as in the patent in suit.

For the reasons stated I find myself quite unable to agree with the views regarding this matter expressed by Professors Brackett and Barker in their answers referred to in question.

Int. 8. In what sense do you understand the word "charcoal" to be used in the Roberts patent to which you have just referred?

Ans. It seems to me that Roberts merely intended to indicate by his reference the general use of carbon rather than the specific use of any particular kind, and he apparently uses language to indicate several forms of conducting carbon. It seems to me from the particular forms that he mentions, that he perhaps had in mind natural
graphite or plumbago, indicated by the word graphite; arti-
1846 ficial carbons made from pulverized coke, and indicated by
the word coke; and gas carbon as indicated by the word
charcoal. Such a use of terms would be quite in the line of that usage which I have already pointed out in my answer to question 3.

Int. 9. Assuming that the word charcoal in the Roberts patent is to be taken in its popular sense of wood charcoal, does the Roberts patent indicate any preference for such charcoal, or contain any statements which would lead a person skilled in the art to select such charcoal as specially suitable for use as the incandescent conductor of an electric lamp?

Ans. It does not in any way. Charcoal is merely mentioned, and that but once only, in the general statement of invention, as an infusible body which is a conductor of electricity, and the patentee suggests the use of any body whatever of this kind as suitable for his purpose. There is absolutely nothing in the patent to indicate the necessity of the conductor possessing any property except that of being infusible; and the patentee does not indicate any advantage in one of these forms over another, except in so far as his constant reference to graphite would indicate his preference for this; so that, if one reading the patent inferred that the word charcoal referred to the article of commerce popularly known as charcoal, he would in no way be led from anything in the Roberts patent to employ such charcoal in preference to any other form of carbon, as, for example, graphite or coke. I should say that, even if he understood the word charcoal to be used in its popular sense, as indicated in the question, the statements of the patent would lead him to employ the more infusible and less destructible forms of carbon mentioned therein, and especially graphite, which is the particular form most frequently referred to.

Int. 10. Assuming that the term charcoal, as used in the 1847 Roberts English patent, and in the description of the Lodyguine lamp published in the London Journal of the Society of Arts, is to be taken as meaning the article of commerce popularly known as charcoal, would either of these, in your opinion, constitute a description of the use, in an electric lamp, of the incandescing conductor of carbonized fibrous material of complainant's patent in suit?

Ans. It would not. What is popularly known as charcoal is a material not fitted for use as the incandescing conductor of an incandescent lamp. It is imperfectly carbonized, uneven in its structure, and its electrical resistance would be irregular. All of these qualities tend to render it ill-fitted for use in an incandescent lamp. Moreover, in shaping the conductor it would be necessary to cut across the fibres, which would be very undesirable, and would seriously interfere with its utility. It might be possible to produce an incandescing conductor made from the charcoal of commerce, which could be used for a short time in an incandescent lamp, but, if possible, this could only be done as a sort of "tour de force" of the skilled workman undertaking it, and it could not be made commercially useful. What is popularly understood as charcoal is a very different thing from such carbonized fibrous material as is set forth in complainant's patent in suit, which implies a perfectness of carbonization and a choice of material not found in the charcoal of commerce, and not suggested by the use of that term.

Int. 11. Do you agree with the opinion expressed by defendant's expert, Prof. Brackett, in his answer to question 5, that the advantages of the arch or horseshoe form of an incandescent conductor for an electric lamp are present, whatever may be the material, whether it is metal or carbon?

Ans. I do not agree with Prof. Brackett in this opinion. A very important advantage of the horseshoe form with carbon consists in the fact that it permits the material to readily alter its shape with change of temperature. With platinum, or any other 1848 metal which is not brittle, this is an unimportant matter, since the metal readily bends, more or less, as is necessary to adapt itself to the conditions of stress which arise within it when its temperature changes. Hence, with metal as an incandescing conductor, so far as this particular point is concerned, it makes no difference whether the conductor is straight or arch-shaped; but with carbon as an incandescing conductor, the reverse is the case. This material is brittle, and cannot adapt itself to any material extent to such stresses as are produced by its change in temperature. It is therefore exceedingly liable to breakage from expansion or contraction if it is used in the form of a straight strip. Liability to rupture from this cause was well known in the arts at the date of the Sawyer & Man patent in this suit, and is frequently referred to in various patents and publications. It is, moreover, referred to at length in the Sawyer & Man patent in suit.

It seems to me, therefore, that there is clearly a great value in the arch-formed incandescing conductor, as contrasted with all other forms of conductor in incandescent lamps when carbon is used for that conductor, which does not exist in incandescent lamps employing metal as the incandescing conductor.

Int. 12. Do you agree with the opinion expressed by Prof. Brackett in his answer to question 33, and by Prof. Barker in his answer to question 43, that the advantage to which you have just referred is not present in the lamp described in the patent in suit, but that the conductor there shown and described is as liable to fracture in the arch form shown as it would be in the form of a straight rod?

Ans. I do not agree with Profs. Brackett and Barker in this opinion. On the contrary, it seems to me evident that the arch-shaped form is one which produces much less tendency to rupture when the carbon is heated or cooled than if it were straight. I do not see that the mere fact, suggested by Prof. Brackett, that the conductor is a somewhat thick one, deprives the arch-shape conductor of its confessed value. A thick filament would very likely 1849 be more brittle, other things remaining the same, but such brittleness would be more harmful in a straight conductor than in an arch-shaped conductor. Moreover, my understanding has been that it was a matter of confessed experimental knowledge that the arch-shaped carbon possessed this advantage over the straight carbon.

Int. 13. Do you agree with the opinion expressed by Prof. Barker in his answer to cross-question 53, that the advantages set forth in the patent in suit as belonging to the arch form of incandescent conductor, are secured to the same extent by the form of the said conductor shown in the Roberts English patent?

Ans. I do not. The Roberts patent describes a lamp, containing an incandescent conductor of carbon in which a straight conductor is employed, as I have already explained in my answer to question 7. This straight carbon possesses none of the ability of free expansion or contraction, with change of temperature, which is a special advantage of the arch-shaped form as set forth in the Sawyer & Man patent in suit.

Adjourned till 8 p. m.

Resumed at 8 p. m.

Int. 14. Do you agree with Prof. Brackett in the opinion he expresses in answer to question 35, that in the modern incandescent lamp the advantages arising from the capacity of the conductor to contract and expand without breaking or disturbing the position of the fixed terminals, would be present whatever the form of the conductor, whether that of a loop or of a straight piece?

Ans. I do not agree with Prof. Brackett in the opinion referred to. It seems to me that with a straight carbon fixed at the extremities there would necessarily and evidently be much greater likelihood of rupture than with the horseshoe form; the rigid extremities would not allow the carbon to accommodate itself 1850 to changes in temperature, and the stress produced in it by such change could hardly fail to exert a deleterious influence. I am confirmed in this opinion from the fact that in certain forms of incandescent lamp that I have seen, in which a straight carbon was employed, delicate and complex mechanical arrangements were necessary to suitably support the carbon in order to prevent its breaking. Still further, a straight carbon would be liable to injury in transportation, on account of its greater rigidity to which the horseshoe filament would be much less subject.

Int. 15. Was the liability of the carbon conductor to fracture from the effects of expansion and contraction recognized in the art as a defect of the incandescent lamps having straight carbon conductors which were known prior to 1880?

Ans. It was fully recognized and stated in printed publications, as will be seen, for example, by reference to the description of the electric lamp described by Kosloff in British patent No. 441 of 1875. In this patent the defect in question is described, and a particular device for avoiding the difficulty is also explained. A similar device is also found described in Jensen's British patent No. 970 of 1875. The difficulty under consideration is also alluded to in U. S. patent to Sawyer and Man, No. 210,809, and a device for remedying it is described in that patent.

Int. 16. As a matter of fact, what is the form of the incandescent conductor used in incandescent lamps which have gone into commercial use since 1880?

Ans. In all cases which I recall, of lamps commercially used, the arch-shaped form has been employed. Sometimes a simple arch, as figured in the Sawyer and Man patent, or as used, for instance, in the Edison lamp, sometimes an M-shaped carbon with rounded angles, as in the Maxim lamp, sometimes a sinuous carbon, 1851 as in one of the Weston lamps, and sometimes a helical carbon as in the Swan lamp, have been employed.

Int. 17. Do you agree with the opinion expressed by Prof. Brackett in his answer to question 5, that a V-shaped burner and burners with rectangular bends, instead of curvilinear ones, are described in the patent in suit as equivalent in shape for the arch or horseshoe form?

Ans. I do not. Messrs. Sawyer and Man state that they have used V-shaped conductors, and conductors with rectangular bends, but they distinctly state that they prefer the arch shape; from which I understood that they regard this last as having a distinct advantage over the others, so that these are not equivalents for it.

Int. 18. Do you agree with Prof. Brackett in the opinion he expresses in answer to question 6, that the arch or horseshoe shape described and claimed in the patent in suit, was old in carbons? Please consider in this connection Prof. Brackett's answer to questions 5 and 9, and Prof. Barker's answers to question 14 and to cross-questions 64 and 65.

Ans. I do not agree with Prof. Brackett in his opinion as referred to. In none of the patents and publications which have been put in evidence, nor in any others of whose existence I am aware, is there any reference to the use of an arch shape or horseshoe conductor formed of carbon. The only carbon conductor, other than a straight strip, which is shown in any of the publications put in evidence, is the V-shaped carbon shown in the British patent to Konn, No. 3809 of 1872.

In my opinion, a V-shaped carbon is not an equivalent of the horseshoe conductor of carbon, for there is not the same liberty of free expansion or contraction with the former which exists with the latter, as the two arms of the V would be thrust the one into the other, inducing liability to fracture; also, in such a conductor the lines of flow of the current through the apex of the V would not
be uniform, so that it would become unequally heated at dif-
1852 ferent points, and thus give less satisfactory results than if
the form were that of an arch.

But still more than this, in the Konn lamp under consideration, the incandescing conductor is not the V-shaped carbon as a whole, but simply the apex of the V. The patentee describes the carbons for his lamp as made thinner in the middle; and with reference to the lamp having the V-shaped conductor, says that the current passed down one side of the V and up the other side, "the light being formed at the angle at the bottom." I, therefore, quite fail to see that the use of the V-shape in this lamp is at all material, so far as concerns any of the advantages of the arch form that I have pointed out. It simply allows of a rather more convenient mounting, and avoids shadows. In fact, the two legs of the V are simply conductors of carbon which might perfectly well, so far as the only function that they perform is concerned, be made of metal. Manifestly, therefore, this lamp with the V-shaped carbon gives simply a brilliant spot of light at the angle of the V, and is not in the remotest manner an equivalent for a carbon of horseshoe shape.

Adjourned to April 4, at 9.30 a. m.

April 4, 1889—10 a. m.

Int. 19. Do you agree with the opinion expressed by Prof. Brackett in his answer to question 36, that the primary advantage of using the arch or loop form of conductor in modern incandescent lamps is to allow of great length of conductor?

Ans. I do not. I understand that this form is used chiefly because of the diminished liability to straining and rupture from
changes in temperature or other causes. The horseshoe form
1853 is certainly used in some cases in which a straight filament
of sufficient length could be used without the least inconvenience.

Int. 20. Have you lamps of the kind you have just referred to, and if so will you please produce them?

Ans. I have two such lamps, which I produce. One of these is a lamp made by the Thomson-Houston Electric Company, of Boston, and which is used by them for running in series on the ordinary arc-light circuits. It requires a current of a little less than ten amperes to bring it to a proper state of incandescence. The second lamp is a Bernestein series lamp, also intended to be used on arc-light circuits, and requiring a current of about ten amperes. In both of these lamps the filaments are quite short, but have the usual arch-shape form.

Complainant's counsel offers the lamps referred to in evidence, and the same are marked respectively, Complainant's Exhibit Thomson-Houston Lamp and Complainant's Exhibit Bernstein Lamp, H. C. M., Spe. Ex.

Int. 21. As a matter of fact of what material have the incandescent conductors of such incandescent lamps as have gone into commercial use in this country since 1880 been made?

Ans. In all of them, without exception, carbon is employed. They do not, however, in any case make use of mineral carbon; nor, so far as I am aware, has any attempt been made to make use of mineral carbon in a commercial lamp. In all of those incandescent lamps which have gone into practical use to any material extent, fibrous carbon has been used in the fabrication of the filament, and in all, with the exception of a single style, the fibrous structure is distinctly and evidently maintained.

For example, the Edison lamp employs a carbonized filament of bamboo; the Sawyer and Man lamp uses a filament of carbonized bamboo; the Maxim lamp a filament of carbonized paper; 1854 one of the United States Company's forms of lamps also employs a filament of carbonized paper; the Swann lamp employs a filament of cotton which has been parchmentized; the Westinghouse lamp employs a filament of silk that has been parchmentized. The only lamp which is or ever has been in commercial use, and which does not show an evident fibrous structure, is a form of lamp recently made by the United States Company, which is made of tamadine, a material not known prior to 1880. Tamadine is made by dissolving cellulose in some suitable solvent, as in making ordinary collodion, and the cellulose is then precipitated in a gelatinous state. From this the filaments are cut and afterwards carbonized. This mode of procedure of course obliterates the evident, superficial, fibrous structure of the material, but permits it to retain that ultimate cellulose structure which gives to fibrous or textile material its peculiar value for use in the filament of an incandescent lamp.

Int. 22. Does the process of parchmentization to which you have referred, as used in the process of making some of the filaments, destroy the fibrous structure of the material?

Ans. It does not, it merely serves to consolidate the material and make it denser and more uniform.

Int. 23. Are you familiar with the lamps referred to by Prof. Brackett in his answers to question 31 and cross-questions 67–72, inclusive, redirect question 116, and recross-questions 130–132, and have you taken these lamps into account in your answer to question 21?

Ans. I am familiar with the lamps referred to and did take them into account in my last answer. The Bernstein lamp, which I did not refer to in my answer to the 21st question, employs a filament of woven silk. The vitrite and luminoid lamp makes use of a filament the precise preparation of which I do not know, and which I understand is not made public; it is however fibrous in its character.

1855 Int. 24. Please read Mr. Edison's answer to question 437, and state how far you took into consideration in your answer to question 21 the various processes of making carbon there referred to by Mr. Edison?

Ans. In making that answer I had in mind most of the processes referred to by Mr. Edison. I am not familiar, however, with the use of melassic acid or of the artificially made chemical, to which he refers in that answer. All the other processes mentioned by Mr. Edison in the answer referred to were in my mind when I answered the 21st question.

Int. 25. Have lamps having conductors made of a solution of melassic acid or of the chemical compound or artificially made chemical referred to by Mr. Edison, gone into commercial use at all, so far as you know?

Ans. Not at all, so far as I have any knowledge.

Int. 26. Has the carbonized fibrous or textile material of complainant's patent in suit any special advantages over other forms of carbon for use as an incandescing conductor for an electric lamp, and, if so, in what do these advantages consist?

Ans. It has, as is clearly indicated in that patent.

Thus, by the use of material of this character it is possible to obtain a carbon conductor of exceedingly great purity, and of evenness of texture throughout, so that the conductor will be free from spots, having a greater of less density than that of the conductor as a whole, a defect which when present is a very serious one. Such carbon, moreover, besides its evenness of structure, possesses in virtue of its cellular structure, a high resistance in proportion to its length and section, or what is technically called a high specific resistance. This is an extremely desirable property in such a filament, inasmuch as, for a given strength of current and for a conductor of given length and section, the heating effect is proportional to the specific resistance, so that, to derive a great amount of light from a filament of given size it is desirable that its specific resistance
1856 should be high. This is a well-recognized fact in incandescent electric lighting. Also, fibrous carbon is particularly fitted to undergo such treatment after carbonization as is found desirable in order to harden it and give to it a uniform and definite resistance, which is referred to in the patent as its "susceptibility to tempering." This tempering may be done by treatment with hydrocarbons, or by carrying a strong current through the conductor *in vacuo*, raising it to high incandescence, or by both of these methods combined. Moreover, the carbon of complainant's patent in

suit is naturally firm, elastic and tough. Still more, the carbon of the patent has the great advantage of readily allowing the conductor to be shaped and given the proper dimensions before carbonization, which is a most desirable characteristic. This facility for shaping before carbonization also, of course, carries with it the ability to predetermine approximately and before carbonization the resistance which the conductor is ultimately to have. These are the principal advantages that occur to me as being possessed by the fibrous carbon of the complainant's patent.

Int. 27. Mr. Edison seems to be of the opinion that while the quality of high specific resistance, to which you have referred, is desirable for lamps of very high resistance and intended to be used in parallel or multiple arc, it is no advantage for incandescent lamps of comparatively low absolute resistance, intended to be used in series; do you agree with him in this opinion? Please read Mr. Edison's answers to questions 432, 467–470 inclusive, and give your reason for any opinion you may express.

Ans. I find myself forced to disagree with Mr. Edison, in this matter as it appears to me that there can be no possible doubt that a high specific resistance is in itself desirable in any form of incandescent lamp whatever, whether the lamp be intended for working in parallel or multiple arc, or in series. As I have already pointed out, for a given current the heating effect in the lamp, other things remaining the same, is proportional to the specific resistance of the
1857 incandescing conductor. Now the total amount which is
utilized of the electrical energy furnished by the dynamo machine is that which is spent in heating the incandescent conductor, and hence, the higher the resistance of this in proportion to the resistance of the rest of the circuit, the greater will be the fractional part of the total energy which is usefully employed in heating the conductors in the lamps, and other things remaining the same, if the specific resistance is high, the same absolute resistance of the lamp may be employed although a shorter and stouter carbon is used, which is in itself a distinct advantage, as such a carbon is more easily obtained.

Int 28. In your answer to question 26 you refer to certain treatment which may be used for tempering an incandescent conductor made of carbonized fibrous or textile material; was this treatment, in both of the forms you have referred to, known in the art as applicable to carbon conductors of other kinds prior to 1880?

Ans. It was well known. I find a description of the hydrocarbon process in U. S. patent to Sawyer and Man, No. 211,262, dated Jan. 7, 1879, and a description of the tempering by heating in U. S. patent to Sawyer and Man, No. 210,809, dated Dec. 10, 1878.

Complainant's counsel offers in evidence the Sawyer and Man patent 211,262 referred to, and the same is marked "Complainant's Exhibit Sawyer and Man Hydrocarbon Treatment Patent, H. C. M., Spe. Ex."

Int. 29. Has the fibrous carbon of the patent in suit any greater susceptibility to or fitness for the processes of tempering to which you have referred, than the forms of carbon used in incandescent lamps prior to 1880?

Ans. It has, owing to the fact of its porous cellular struct-
1858 ure, which in the hydrocarbon treatment allows that material
to penetrate the conductor throughout so that the deposit of carbon thus made is not a purely superficial one, but such as to influence the entire structure of the carbon; while in the treatment by heating, the fibrous structure allows of the ready expulsion of gases from the whole interior of the filament.

Int. 30. To what extent and for what purposes have these processes been used in the manufacture of incandescent lamps since 1880?

Ans. As far as I am aware, the process of heating to a high temperature has been and is used with all incandescent lamps, while the hydrocarbon treatment has been applied to all with the exception of a very few. The hydrocarbon treatment is employed to give uniformity of resistance throughout the filament itself, and to bring the filaments of individual lamps to a given standard resistance, thus healing the defects incident to the manufacture of the filament, and allowing the employment of very many filaments which, without the use of this process, would have to be rejected, avoiding the peculiarties of the individual filaments, and causing them to approach more nearly to the condition of the ideal filament, such as would be furnished by a perfect fibrous or textile material. The extent to which the hydrocarbon treatment is carried is different with different kinds of lamps, differing with the material used by the various makers.

Int. 31. Mr. Edison, in his answer to question 54, appears to be of the opinion that when the hydrocarbon treatment is applied, the character of the carbon conductor used for such treatment is wholly immaterial, and that it makes no difference what kind of carbon is used for this purpose, or even if a metal is used. Do you agree with him in this opinion, and would such a result follow from the use of hydrocarbon treatment as applied in the commercial manufacture of incandescent lights?

1859 Objected to as being a misstatement of Mr. Edison's testimony, his opinion being expressed with reference to the experiments of Sawyer and Man, as is shown in the interference case, and not with reference to the modern practice in using the hydrocarbon treatment.

Ans. I do not agree with Mr. Edison is the opinion referred to in the question. The hydrocarbon treatment, as I understand it, is intended to remedy defects in the natural fibre, as I have already explained, but not to superede the original fibre. This is apparent from the fact that so much ingenuity has been spent in obtaining a suitable filament to begin with, although the hydrocarbon treatment was to be subsequently applied. Moreover, great care has to be taken in the original selection, and carbonization of the filaments, which otherwise fail notwithstanding that they have been subjected to treatment. As I understand the ordinary use of the hydrocarbon process, the filaments are usually treated only to a moderate or even slight extent, and not so as to destroy or render useless their original structure. That is, the original structure does not become, as Mr. Edison seems to suggest, a mere sort of scaffolding which supports the deposited carbon, but still remains an essential or indeed the essential portion of the whole conductor.

Adjourned till 2 p. m.

Resumed 2 p. m.

Int. 32. Would any of the forms of carbon of the incandescent lamps described in the prior patents and publications put in evidence by defendant, have the characteristics you have de-
1860 scribed in your answer to question 26 as possessed by the carbonized fibrous or textile material of the complainant's patent in suit?

Ans. They would not. In my opinion, there is not one of them which, even with the various improvements that have been made up to the present time, would be capable of commercial use for electric lighting.

Int. 33. Prof. Brackett states in substance, in his answer to question 5, that the construction of the bottom plate of the lamp chamber of glass, and that the dividing of the two parts by a ground joint, as shown and described in the patent in suit, was old in the art of incandescent lighting. Do you find this construction, or its equivalent, described or shown in any of the prior patents or publications put in evidence by the defendant, except the two prior patents of Sawyer and Man? Please read in this connection Prof. Brackett's answers to cross-questions 50–52, and cross-question 64; also Prof. Barker's answers to questions 10, 17 and cross-questions 58–61.

Ans. With the exception of the prior patents to Sawyer and Man, I do not find the construction in question, or an equivalent construction, in any of the prior patents or publications put in evidence by the defendant.

Prof. Brackett and Prof. Barker refer to the English patents to Staite and Kosloff, and to the United States patent to Kosloff, as embodying the particular construction set forth in the Sawyer and Man patent in suit. I fail to find any such construction in these patents.

The lamp described and figured by Staite employs a strip of metal for an incandescent conductor, which is covered by a sort of shade, presumably to screen it from the air. This shade rests upon a support, and a block of glass or some similar bad conductor of heat closes the mouth of this globe. The object of this block of glass is stated to be to aid in keeping up the temperature of the incandescent conductor. The globe covering the metal strip is filled with air at the ordinary density, there being no need of removing
1861 it, or replacing it, by an inert gas. The block of glass is not used as a stopper to prevent any perceptible ingress or egress of air, but merely serves to close the mouth of the receiver. The

Kosloff patents show a receiver containing the incandescing pencils which are inclosed in an atmosphere of nitrogen. The bottom of this receiver, however, is made tight, not by means of a glass plate or stopper, but by a hydraulic-sealed joint.

Defendant's experts also refer to Robert's British patent of 1852, but there is no description whatever of the material of which the cap closing this lamp was to be made, and from the appearance of the figure, as well as from the custom of that time, I should infer that the cap was made of metal. Defendant's experts refer to certain devices in which ground metal plates were made use of, considing these as the complete equivalent of a glass plate. I do not agree with them in this view since the coefficient of expansion of metal is so very different from that of glass that the use of a metal stopper or metal plate would unquestionably cause difficulty on this account, and the comparative rapidity with which the metal would heat or coal, as compared with glass, would be a further cause of difficulty. It seems to me that the use of the glass plate or stopper is entirely novel with Messrs. Sawyer and Man.

Int. 34. Defendant's experts have expressed the opinion that the lamp structure of the complainant's patent in suit has all the defects of the lamp structures of incandescent lamps described in the prior patents and publications in evidence; and that the lamp structure of the patent in suit would be wholly unsuitable for maintaining with sufficient stability any definite condition of the atmosphere within it, whether a vacuum or non-combustion supporting gas, to make the lamp a practically useful structure for the purpose of electrical illumination; and, moreover, that the low resistance of the incandescent conductor would make the lamp practically
1862 useless. Do you agree with them in this opinion? Please consider, in this connection, Prof. Brackett's answers to questions 12, 15, 28, and cross-questions 74–78; Prof. Barker's answers to questions 11 and 12; Mr. Edison's answer to question 61, cross-questions 306–337, questions 402–405, 476, 478, 479, cross-questions 507–515.

Ans. I do not agree with defendant's experts in the opinion which they have expressed. The lamp structure which is set forth in complainant's patent in suit employs as its conductor carbonized fibrous or textile material, which, as I have already pointed out, possesses the greatest advantages over such materials as I have mentioned before. It is true that the dimensions of the particular conductor shown in the figures of that patent are such that it would have a low absolute resistance, and hence that it would require only a low electro-motive force to furnish the somewhat strong current requisite to bring it to a proper state of incandescence. It seems to me, however, that defendant's experts are entirely in the wrong in assuming that because of these facts the structure would make "a lamp that would not be practicable." My quotation is taken from Prof. Brackett's answer to question 12. It is quite true that any lamp possessing such a low resistance would not be suited for use over considerable districts in a parallel system of illumination; but, on the other hand, it is in this respect exactly the kind of lamp that is wanted for use in a series system, and in fact lamps of low resistance and adapted to be run in series are now customarily made and employed.

So far as the other matter referred to by defendant's experts is
concerned, that is, the liability to leakage, there is no doubt that
the method devised by Sawyer and Man, like every method that
has been devised, is subject to certain imperfections; and I do not
doubt that for general use on a large scale, some other methods are
preferable, since a multitude of persons have been at work upon
this subject since 1878, and numerous improvements have
1863 been devised. But I am confident that the structure of the
lamp of complainant's patent in suit is such that, notwithstanding the fact that it is not an absolutely perfect structure, it is fitted for practical commercial use. I do not mean by this that the lamp of the Sawyer and Man patent would be able to compete commercially with gas, which appears to be Mr. Edison's test of the practical usefulness of an incandescent lamp, or that it would meet the requirements for a commercial incandescent lamp laid down by Prof. Brackett in his answers to questions 74–78. Indeed, the standard (1,000 hours) which Prof. Brackett sets up as necessary that a lamp may be "practically useful," is far above that which, as I am informed, any of the companies manufacturing incandescent lamps are at present willing to guarantee. Nor do I think that it would be able to compete commercially with more recent and improved forms of incandescent lamp, upon which a great wealth of experimentation has been lavished. But I am very confident that if we had no better styles of incandescent lamp, this would have a distinct commercial value for many purposes. And I am sure that it could be made sufficiently lasting to be of decided use. For example, I think there can be no question that a lamp of this construction could be made to last as many as fifty or one hundred hours, and such a lamp would certainly be of value for practical purposes.

I do not agree with defendant's experts that the lamp structure of complainant's patent in suit has all of the defects of the lamp structures set forth in the prior patents and publications in evidence. The use of a stopper of glass or a plate of glass, ground to the receiver as described in the patent, would very greatly diminish liability to leakage and materially prolong the life of the lamp.

Int. 35. Defendant's experts express the opinion that the in-
ventors, Sawyer and Man, made no substantial advance in the art,
or at least none that is shown and described in the patent in
1864 suit. Do you agree with them in this opinion? I call your
attention, particularly, to Prof. Bra-kett's answer to question
5, and Prof. Barker's answer to question 9.

Ans. I do not agree with Professors Brackett and Barker in regard to this. On the contrary, I find set forth for the first time in the Sawyer and Man patent in suit the use of carbonized fibrous or textile material in general, as the incandescing conductor of an electric lamp, and also of the use of such conductor in a horseshoe shape. As I have stated in answers to previous questions, I regard these as important improvements over anything that has been done before, and I am confirmed in this opinion since these are used in all modern incandescent lamps. The use of the particular form of carbon referred to, in addition to the advantages of structure and character, allows, as I have already explained, the shaping of the material prior to carbonization, which is an advantage that cannot be overestimated, and of which substantially all manufacturers of incandescent lamps have availed themselves. In fact, in this patent, Messrs. Sawyer and Man have supplied a carbon possessing those peculiar qualities which have made modern incandescent lighting a possible thing, and such carbon is actually employed in all, or nearly all, incandescent lamps which are in commercial use.

Adjourned to New York, at the office of Duncan, Curtis & Page, March 5, at 10.30 a. m.

New York, *April 5th*, 1889.

Met pursuant to adjournment.
Present: Counsel as before.

Direct examination of Prof. Cross continued as follows:

1865 Int. 36. Do you agree with the opinion expressed by defendant's experts that there is no novel or useful invention described in the first claim of complainant's patent in suit? Please read Prof. Brackett's answers to question 6 and cross-questions 37–43, and Prof. Barker's answers to question 14 and cross-questions 53–55.

Ans. I do not agree with defendant's experts in the statements referred to in the question. The first claim of the patent in suit sets forth the use of a peculiar material, namely, carbonized, fibrous or textile material, which is to be given a horseshoe shape.

The material of the incandescing conductor set forth in this claim is entirely new and not found, in my opinion, in any previous incandescent lamp; and there are, moreover, as I have already explained, advantages in the use of the arch shape with this material which do not exist with the metal conductors with which alone it had previously been employed. The form of carbon set forth in the claim, that is, carbon made by carbonizing fibrous or textile material, possesses, as I have already explained, many marked advantages over such carbon as had previously been suggested for use in incandescent lamps. Fibrous or textile material possesses the special advantage of being adapted for shaping before carbonization, a feature which is of the greatest value in the manufacture of an incandescent lamp. Moreover, as I have explained in previous answers in this deposition, there is a material advantage given to the lamp by the use in it of a conductor of horseshoe shape, in that this can adapt itself to variations of temperature which would cause a rupture of a straight filament of carbon, although with metal this is not a matter of any importance. It appears to me that the first claim of the patent in suit sets forth a distinctly new invention which did not previously exist, either in the exact form set forth in the patent in suit or in an equivalent form.

Int. 37. Do you agree with the opinion expressed by defendant's experts that there is no novel or useful invention described 1866 in the second claim of the patent in suit? Please read Professor Brackett's answers to question 8, and cross-questions 43 to 49, and Professor Barker's answers to question 16 and cross-questions 56 and 57.

Ans. I do not agree with defendant's experts in their conclusion with regard to this claim. It seems to me that they overlook the fact that there is an entirely new element which enters into the combination therein set forth; namely, that the incandescing carbon conductor is made of "carbonized fibrous material," so that the combination set forth in the claim is itself new. It does not appear to me that the lamps referred to by defendant's experts as anticipating the structure set forth in this claim really do so, for reasons that I have explained at some length in a previous answer. I know of no lamp prior to that set forth in complainant's patent in suit which contains the combination set forth in this second claim.

Int. 38. Do you agree with the opinion expressed by defendant's experts that there is no novel or useful invention described in the fourth claim of the patent in suit? Please read Professor Brackett's answers to question 9 and cross-questions 50 to 52, and Professor Barker's answers to question 17 and cross-questions 58 to 61.

Ans. I do not agree with their opinion in this matter. The fourth claim referred to is for a combination of elements one of which, the illuminating conductor made of carbonized fibrous or textile material, is entirely new, which, therefore, gives an entirely novel combination. Still more, as I have already explained at length in previous answers, the lamp structure set forth in this claim is one better adapted for preserving a stable condition of the vacuum or atmosphere of inert gas within the hermetically sealed chamber. And this last fact is of importance in its relation to the peculiar kind of carbon used for the conductor. Such fibrous carbon needed a better protection than the hard gas carbon which had previously been used as a conductor in incandescent lamps, inasmuch as it is more readily destroyed by the action of oxygen.

Adjourned to 2 p. m.

1867 2 P. M.

Met pursuant to adjournment.

Int. 39. I call your attention to the statements made by defendant's experts and Mr. Edison in regard to the extremely small proportion of fibrous vegetable materials which are suitable for making carbon filaments, and particularly to Prof. Brackett's answers to questions 16 to 18, Prof. Barker's answers to questions 22 and 23, Prof. Wilson's answers to questions 10 to 33, and Mr. Edison's answers to questions 418 to 435. What is your opinion in regard to this?

Ans. I have carefully considered the various answers referred to, and it seems to me that they all make certain assumptions which are entirely uncalled for, and without which the statements in the answers would be incorrect.

They assume in the first place that the conductor of an incandescent lamp is to be necessarily a hair-like filament, and that unless a material is particularly suited to give such a filament it is therefore quite unfitted for use as a conductor in an incandescent lamp. Now there is no assumption of this kind made by the patent, nor is it at all proper to make such an assumption, since it is by no means essential to the practical utility of such a lamp that the conductor shall be hair-like in form. On the contrary, the conductor might be of considerable magnitude without thereby impairing its value. Indeed, in certain cases a larger conductor might be highly desirable. It is unquestionably true that many vegetable materials would be fitted to produce conductors for an incandescent lamp if the assumption made by defendant's experts were removed. I am not, however, quite able to agree with them as to the difficulty in finding a material even for a fine filament which would be of material value, though it is of course true that for very fine filaments very careful selection would be necessary with respect to obtaining a material with its fibres parall- and of a dense and uniform structure.

1868 Defendant's experts, in the answers alluded to in the question, also tacitly assume that the material employed is to be used just as it comes from the muffle in which it is carbonized and without any subsequent treatment. But at the date of complainant's patent in suit there were processes of treatment well known, by means of which material which might otherwise be unsatisfactory could readily be made suitable for practical use.

Defendant's experts also assume in the answers under consideration that the material employed in the lamp of complainant's patent must be capable of competing with the best materials employed in the commercial manufacture of lamps; quite overlooking the fact that at the date of the patent it was true, as it would be true at present if great improvements had not been made in the art, a lamp would be valuable for a great number of purposes even though its life were not very long and its cost were considerable.

The complainant's patent in suit makes no such assumptions as those that are made by defendant's experts. It does not limit itself to any particular size of conductor, or to the necessary use of material fresh from carbonization and without treatment, nor does it assume a standard of excellence such as has now been reached in the development of the art of incandescent lighting. Taking it as it stands and without importing these assumptions into it, it seems to me that defendant's experts greatly exaggerate the difficulty of obtaining suitable materials for use in the lamp which it sets forth.

I am confirmed in the opinion which I have expressed in this answer with regard to the possibility of finding the various materials which may form the conductor in an incandescent lamp by the statement which I find in some of the patents which have been issued to Mr. Edison himself. Thus in United States patent No. 223,898, dated January 27th, 1880, I find the following passage:—

Int. 37. Do you agree with the opinion expressed by defendant's experts that there is no novel or useful invention described 1866 in the second claim of the patent in suit? Please read Professor Brackett's answers to question 8, and cross-questions 43 to 49, and Professor Barker's answers to question 16 and cross-questions 56 and 57.

Ans. I do not agree with defendant's experts in their conclusion with regard to this claim. It seems to me that they overlook the fact that there is an entirely new element which enters into the combination therein set forth; namely, that the incandescing carbon conductor is made of "carbonized fibrous material," so that the combination set forth in the claim is itself new. It does not appear to me that the lamps referred to by defendant's experts as anticipating the structure set forth in this claim really do so, for reasons that I have explained at some length in a previous answer. I know of no lamp prior to that set forth in complainant's patent in suit which contains the combination set forth in this second claim.

Int. 38. Do you agree with the opinion expressed by defendant's experts that there is no novel or useful invention described in the fourth claim of the patent in suit? Please read Professor Brackett's answers to question 9 and cross-questions 50 to 52, and Professor Barker's answers to question 17 and cross-questions 58 to 61.

Ans. I do not agree with their opinion in this matter. The fourth claim referred to is for a combination of elements one of which, the illuminating conductor made of carbonized fibrous or textile material, is entirely new, which, therefore, gives an entirely novel combination. Still more, as I have already explained at length in previous answers, the lamp structure set forth in this claim is one better adapted for preserving a stable condition of the vacuum or atmosphere of inert gas within the hermetically sealed chamber. And this last fact is of importance in its relation to the peculiar kind of carbon used for the conductor. Such fibrous carbon needed a better protection than the hard gas carbon which had previously been used as a conductor in incandescent lamps, inasmuch as it is more readily destroyed by the action of oxygen.

Adjourned to 2 p. m.

1867 2 P. M.

Met pursuant to adjournment.

Int. 39. I call your attention to the statements made by defendant's experts and Mr. Edison in regard to the extremely small proportion of fibrous vegetable materials which are suitable for making carbon filaments, and particularly to Prof. Brackett's answers to questions 16 to 18, Prof. Barker's answers to questions 22 and 23, Prof. Wilson's answers to questions 10 to 33, and Mr. Edison's answers to questions 118 to 135. What is your opinion in regard to this?

Ans. I have carefully considered the various answers referred to, and it seems to me that they all make certain assumptions which are entirely uncalled for, and without which the statements in the answers would be incorrect.

They assume in the first place that the conductor of an incandescent lamp is to be necessarily a hair-like filament, and that unless a material is particularly suited to give such a filament it is therefore quite unfitted for use as a conductor in an incandescent lamp. Now there is no assumption of this kind made by the patent, nor is it at all proper to make such an assumption, since it is by no means essential to the practical utility of such a lamp that the conductor shall be hair-like in form. On the contrary, the conductor might be of considerable magnitude without thereby impairing its value. Indeed, in certain cases a larger conductor might be highly desirable. It is unquestionably true that many vegetable materials would be fitted to produce conductors for an incandescent lamp if the assumption made by defendant's experts were removed. I am not, however, quite able to agree with them as to the difficulty in finding a material even for a fine filament which would be of material value, though it is of course true that for very fine filaments very careful selection would be necessary with respect to obtaining a material with its fibres parall- and of a dense and uniform structure.

Defendant's experts, in the answers alluded to in the question, also tacitly assume that the material employed is to be used just as it comes from the muffle in which it is carbonized and without any subsequent treatment. But at the date of complainant's patent in suit there were processes of treatment well known, by means of which material which might otherwise be unsatisfactory could readily be made suitable for practical use. 1868

Defendant's experts also assume in the answers under consideration that the material employed in the lamp of complainant's patent must be capable of competing with the best materials employed in the commercial manufacture of lamps; quite overlooking the fact that at the date of the patent it was true, as it would be true at present if great improvements had not been made in the art, a lamp would be valuable for a great number of purposes even though its life were not very long and its cost were considerable.

The complainant's patent in suit makes no such assumptions as those that are made by defendant's experts. It does not limit itself to any particular size of conductor, or to the necessary use of material fresh from carbonization and without treatment, nor does it assume a standard of excellence such as has now been reached in the development of the art of incandescent lighting. Taking it as it stands and without importing these assumptions into it, it seems to me that defendant's experts greatly exaggerate the difficulty of obtaining suitable materials for use in the lamp which it sets forth.

I am confirmed in the opinion which I have expressed in this answer with regard to the possibility of finding the various materials which may form the conductor in an incandescent lamp by the statement which I find in some of the patents which have been issued to Mr. Edison himself. Thus in United States patent No. 223,898, dated January 27th, 1880, I find the following passage:—

"I have carbonized and used cotton and linen thread, wood splints, papers coiled in various ways," etc.

Also, in his patent No. 238,868, dated March 15th, 1881, Mr. Edison says, after referring to the peculiar characteristics
1869 necessary for the carbon of the conductor in an incandescent
lamp, that "simple wood carbon of unchanged structural condition possesses these qualities." In the same patent he describes the production of such a carbon for a conductor from "a block of wood." In the same patent he claims a method of forming carbons which he says consists "in shaping a block of wood as described," and subsequently shaping and carbonizing it.

Also in United States patent, No. 248,417, dated Oct. 18, 1881, Mr. Edison uses carbons made from "a block of wood taken and cut in a machine or lathe." He then proceeds to describe the particular way in which such a block of wood is to be split and carbonized, and shows in his figures such a block of wood; also, in the claim of this patent he sets forth a method of forming the carbons "consisting in cutting or turning a block of wood," etc.

And again in United States patent No. 251,540, dated December 27th, 1881, Mr. Edison, referring to what he designates as a "filament of carbon bent into a curve now generally designated the 'horseshoe' carbon," says, "Great success has attended the use of such carbons made from a natural fibrous material capable of carbonization—for instance, wood formed into proper shape and then carbonized."

Int. 40. Were the peculiarities of structure of exogenous and endogenous plants and the other vegetable growths referred to by defendant's experts, and the effects of such structure upon the character of the carbon resulting from carbonizing them, known prior to the filing of the applications for the patent in suit?

Ans. They were. All of the matters referred to as to the structure of plants have been perfectly well known, not merely to botanists, but those who like myself are not skilled in that science. Also the methods of carbonization of such structures and the effect produced upon them by the process of carbonization were perfectly
1870 well understood. It was well known that certain woods were
fitted, and certain others unfitted, to produce a carbon of even and dense structure, and the state of knowledge was such that one skilled in the art would have known that certain woods must be rejected and that certain others would be better fitted for his purpose. The desirability of avoiding a cutting across the fibre and of selecting a wood possessing fibres which were parallel, would certainly have been recognized by one skilled in the art and wishing to practice the invention set forth in complainant's patent in suit.

Int. 41. Were the general peculiarities of structure of the bamboo in regard to which Professor Wilson testifies, generally known prior to the filing of the application for the patent in suit?

A. They were well known at the date mentioned. It seems to me that at the date of the patent in suit a person who was searching for a suitable woody fibre to use in an incandescent lamp would very naturally have picked out bamboo fibres for his purpose.

Int. 42. I notice that defendant's experts have very little if anything to say in regard to textile materials; what is your opinion in regard to the suitability of materials of this general class for making conductors for incandescent lamps?

Ans. I should say that they were pre-eminently suitable for this purpose. They already existed in such a shape that, when carbonized, they may be used in an incandescent lamp, and I think my opinion is justified from the fact that such materials are widely used in the manufacture of incandescent lamps.

Int. 43. What do you understand to be meant by textile materials, and what are the most common materials, of this class in the market?

Ans. Defendant's expert, Professor Brackett, gives a very clear definition of textile material in his answer to question 2 of his second deposition in this suit. The definition of textile material 1871 there given is that it is a material suited to be spun or woven. Thread is of course a material of this kind. The most common materials of this class in the market are cotton and linen thread, silk and hemp.

Adjourned to April 6th, 11 o'clock.

NEW YORK, *April* 6, 1889.

Met pursuant to adjournment. Present, counsel as before, and the examination of Prof. CROSS was continued as follows:

Complainant's counsel offers in evidence Patent Office copies of U. S. patents granted to T. A. Edison, No. 238,868, dated March 15, 1881, and No. 248,417, dated October 18, 1881, and the same are marked respectively, Complainant's Exhibit Edison Patent No. 238,868, and Complainant's Exhibit Edison Patent No. 248,417, both of April 6, 1889.

Int. 44. Do you agree with the opinion expressed by defendant's experts that there is not a sufficient description in the specification of the patent in suit as to the character of the fibrous material to be used for the burner, its selection, its preparation for carbonization, and its carbonization, to enable others generally skilled in the art as it existed at the date of the application, viz.: January 9, 1880, to produce a practically operative incandescent conductor without experiment? Please read Prof. Brackett's answers to questions 16 and 19, inclusive, cross-questions 55 to 63 inclusive; also Prof. Barker's answers to questions 22 to 27 inclusive, and cross-questions 66 to 85 inclusive; also Mr. Edison's answers to questions 418 to 429 inclusive, 433 to 435, inclusive, 439 to 441 inclusive, 449 to 464½ 1872 inclusive, and give your reasons for any opinions that you may express. I also call your attention to Mr. Edison's answers to questions 25 and 26.

Ans. I do not agree with defendant's experts in their opinion that the Sawyer and Man patent in suit is defective in the matter referred to in the question. The patentees direct the use of carbonized fibrous or textile material and state that they have used carbonized paper and also wood carbon. With regard to the use of the first of the materials mentioned, I think there is no possible question that one wishing to make use of the invention described in the Sawyer and Man patent would have known how to proceed in order to procure a paper suitable for his purposes. He would naturally have assumed that a pure paper was desirable, and so would have rejected papers which were loaded with mineral matter or with size and similar materials. He would also have sought a paper of even texture. I am confident that at the date *at* the application for the patent in suit and for many years before as well as since pure paper could readily be procured in the market. For example, bristol-board is a kind of paper that was well known to be pure in quality and even in texture and which, I think, one would naturally have selected for the purpose. Blotting paper is another well-known variety which could be obtained in a state of purity. Still more, there were various processes by the use of which the adulterants employed in the manufacture of paper could have been removed, had such paper been employed. As a matter of fact, paper has been largely and successfully employed in the manufacture of incandescent lamps. Thus Mr. Edison, in that portion of his deposition referred to in the question, describes his own employment of that material. Also, some of the types of lamp manufactured by the United States Electric Lighting Company have been made of paper and have been very widely used and with satisfactory results.

With regard to wood carbon, it seems to me that the directions in the patent are quite sufficient to have enabled one to utilize
1873 this in a lamp of commercial value. I think that one reading the Sawyer and Man patent would have understood the term "wood" in the sense in which it is defined by Prof. Barker in his answer to question 22 as referring to

"The material which constitutes the stems of most, if not all, vegetable substances."

With this understanding he would doubtless have selected from among the various well-known forms of woody tissue those in which the fibres were parallel, long and even. He certainly would not have limited himself to exogenous growths, but would have included in his range the various endogenous plants. Also, he would probably have picked out a thread of cotton or other material of even texture and pure quality.

Having selected the material it would be neessary to determine upon its shape. There is no question that in the use of textile material the shape would be determined prior to carbonization. Indeed, the very nature of such material in general necessitates this and unquestionably implies it. If paper were the material selected I cannot imagine that any one would fail to see the desirability and practical necessity of shaping it before it was carbonized. It is already shaped in one dimension and would naturally be cut or stamped into shape while the paper was still uncarbonized and easily cut. This mode of procedure is infallibly suggested by the statements of the patent.

As to the carbonization, the patent gives no especial description, but contents itself with referring to the various well-known processes of carbonization. And it does this very properly, since the subject of carbonization had been carefully studied and the methods whereby thorough, uniform and complete carbonization could be secured were perfectly well known to those skilled in the art.

It is, of course, true that in one desirous of practicing the invention under consideration an exercise of common sense, good judgment and technical information would be necessary in order
1874 to exclude unsuitable and select suitable materials for the
purpose, and undoubtedly experience would show one that certain of the various materials selected were much better adapted to the purpose than others; but, in my opinion, all this would involve simply the ordinary skill of the artizan and not the ingenuity of the inventor.

The same remark applies to the subsequent process, as of carbonization.

I think there can — no possible question that one familiar with the state of the art at the date of the application for the Sawyer and Man patent in suit, by the exercise of existing knowledge, employing only the skill of the trained artizan and without invention, would have been able to construct an incandescent lamp which would serve a useful purpose and have a commercial value.

Int. 45. Would it, in your opinion, have required experiment on the part of a person skilled in the art as it stood prior to 1880, to reach the conclusion expressed by Prof. Barker in his answer to question 27 that a carbon conductor made from a strip cut across the grain or fibre of wood would be useless for incandescent lighting?

Ans. In my opinion, it would not.

Int. 46. Would it have required experiment to ascertain the defects stated by Prof. Barker in his answer to question 25, of carbon formed by cutting blanks of arch form from wood in such a manner that the fibres were cut across in a part of the length of the conductor?

Ans. It would not. This fact was perfectly well known.

Int. 47. Do you think any person skilled in the art as it stood prior to 1880 would have attempted to make carbons in that way if he were merely told to use carbonized fibrous or textile material for the conductor of a lamp?

Ans. I should not think it possible that he would have done this. Such a procedure is not at all that which is suggested by the direction.

Int. 48. What would such a person have known to be
1875 requisite with respect to uniformity of resistence in the
conductor of an incandescent lamp, and what would this, in your opinion, have necessarily implied to such a person in the selection and preparation of the material before carbonization?

Ans. He would have known that the resistence of the conductor should be as nearly as possible uniform throughout. This would have led him to select fibrous material or fibers which were continuous, and which would not be cut or broken in shaping.

Int. 49. If such a person desired to make a conductor in an arch form from carbonized wood, what would, in your opinion, have been the method of making it which would most readily have occurred to him with no further instructions than those stated in question 47?

Ans. It seems to me that it would naturally have occurred to him to make use of the long fibers of some of the different varieties of grass or reeds or perhaps the woody leaves of some plants, or probably some fibrous bark. I think he would have selected such a fibre, bent it into shape and keeping it in that condition would have subjected it to thorough carbonization.

Int. 50. Do you think that a person skilled in the art as it stood prior
to 1880, and desiring to succeed in producing a very slender
1876 filament from carbonized fibrous or textile material would
select wood having interlaced fibres and thereby encounter
the difficulties referred to by Prof. Wilson in his answers to questions 19 to 23, inclusive?

Ans. Certainly not. That would be the precise way not to do it.

Int. 51. Do you think he would select wood so resinous as to produce the defects referred to by Prof. Wilson in his answer to question 24?

Ans. I cannot imagine that he would do this.

Int. 52. Do you think he would select vegetable tissues merely because they could be readily cut, although they would be practically worthless for electrical purposes or merely because the wood in itself was tough before carbonization, as is apparently assumed by Prof. Wilson in his answer to question 25?

Ans. Certainly he would not do this.

Int. 53. In your answer to question 39 you say that the defendant's experts assume that the conductor of an incandescent electric lamp is to be necessarily a hair-like filament, and that you find no such assumption in the patent in suit. Would there be less difficulty in selecting proper fibrous or textile material for making thicker conductors, as, for instance, conductors approaching the thickness of that shown in the drawing of the patent in suit, than in selecting proper material for hair-like filaments?

Ans. There would, unquestionably. Many substances
1877 which would not furnish fine hair-like filaments of the qual-
ity necessary for use in an incandescent lamp would be
amply sufficient if the conductor was to be heavier.

Int. 54. What is the reason for this?

Ans. There are many vegetable substances which cannot readily be split into very fine filaments or which if so split are too brittle to give satisfaction, which will nevertheless furnish filaments of large section.

Int. 55. In your answer referred to you also say that there were processes of treatment well known by means of which material which might otherwise be unsatisfactory could readily be made suitable for practical use. To what processes did you refer?

Ans. I had in mind that consolidation of the carbon which occurs when occluded gasses are driven from it on raising it to a high state of incandescence by carrying a heavy current through it and especially the beautiful process of hydrocarbon treatment, which was also devised by Messrs. Sawyer and Man. In this latter process the filament is carried to incandescence by passing a heavy current through it while surrounded by an atmosphere of hydrocarbon vapor. The vapor is decomposed and carbon deposited most 1878 abundantly wherever the heating is greatest. And as such heating is necessarily most pronounced at those points in the lamp which are defective, carbon is most abundantly deposited at these points, thus healing the faulty places in the lamp. This process is so valuable that it is employed with most types of lamps of to-day.

Int. 56. Are these the processes to which you refer in your answers to questions 26 to 28?

Ans. They are.

Int. 57. Would the use of these processes materially increase the proportion of fibrous and textile materials which would be available for making practically useful incandescent conductors for electric lamps?

Ans. They would very greatly increase the number of such materials.

Int. 58. In selecting endogenous stems do you think that a person skilled in the art, as it stood prior to 1880, would select material which would produce the undesirable results set forth in Prof. Wilson's answer to question 28?

Ans. On the contrary, I should suppose that he would endeavor as far as possible to avoid the use of endogenous material in which these characteristics are prominent.

Int. 59. When translated into common language what is the substantial meaning of Prof. Wilson's disquisition on the structure of the bamboo stem contained in his answers to questions 29 to 32 inclusive?

Ans. As I understand Prof. Wilson's statements referred to, the structure of bamboo is identical in its nature with that of other endogenous plants, but that a certain kind of tissue, the bast cells, are so compacted and joined together as to give a very homogeneous filament which particularly fits it for use in an incandescent lamp.

Int. 60. Is there any other peculiarity of bamboo which makes it peculiarly suitable for making very slender filaments?

Ans. Of course its fibrous structure as a whole particularly fits it for this purpose and the special portion of the stem referred 1879 to by Prof. Wilson presents these characteristics in a very marked degree.

Int. 61. Were these peculiarities of bamboo known prior to 1880?

Ans. They were, all of them, as I understand the matter. Certainly its fibrous character and the facility with which it could be split into fine uniform fibres had been known for an indefinite period.

Int. 62. Defendant's experts express the opinion that the amendments made in the application for complainant's patent in suit materially changed the scope or nature of the invention which was described and claimed. Please compare the specification and claims of the patent as issued with the specification and claims as originally filed and state whether or not you find any invention described and claimed in the patent as issued which was not described in the application as originally filed.

Ans. Considering the patent as issued, I find that claim 1 sets forth: "Carbonized fibrous or textile material" as the material of the incandescent conductor and the "arch or horseshoe shape" as its form. The 4th claim of the specification as filed sets forth the use of carbonized fibrous or textile material as the material of the conductor and the horseshoe shape is fully described in the original specification in which the patentees speak of the "arch-shaped" carbon used.

The second claim of the patent as finally issued relates to the use of "an incandescing conductor of carbonized fibrous material," without reference to its shape, and enclosed in a transparent hermetically sealed chamber. The carbonized fibrous material of this claim is evidently referred to in the fourth claim of the specification as originally filed, and as I understand that in the fourth claim the shape of the incandescing conductor is not limited, I judge that the word "arc" used therein means simply strip. The specification as originally filed specifies the use of the incandescent carbon in
1880 transparent chambers. The specification also says that the patentees have used carbonized paper and wood carbon or charcoal.

The third claim of the patent as issued is for an incandescing conductor of carbonized paper. Besides the reference in the original specification to the use of the carbonized paper, to which I have already referred, the third claim of that specification relates to the use of carbonized paper.

The fourth claim of the patent as issued relates to the combination of the chamber "made wholly of glass" and containing no carbon-consuming gas, and other elements in combination with an arch-shaped incandescing conductor consisting of "carbon made from a fibrous or textile material." In the specification as originally filed the patentees after referring to their "burners" of carbonized paper, wood, carbon, etc., and of an arch-shaped form, among others, go on to say that they have used such burners "in close transparent chambers" *in vacuo*, in nitrogen, etc., and state that the important thing in this regard is to exclude oxygen. Also they state that their invention is an improvement upon the apparatus shown in their earlier United States patent (No. 205,144) which shows a carbon pencil enclosed within a hermetically sealed chamber made wholly of glass. I do not find any invention whatever described and claimed in the patent as issued which was not described in the original application.

Int. 63. Defendant's experts refer to the omission from the final specification of the words "ordinary gas carbon," which appear in the specification as originally filed. Does the omission of these words, in your opinion, expand or narrow the scope of the patent?

Ans. I should say that they narrowed it.

Int. 64. Defendant's experts also refer to the omission from the final specification of the word "charcoal," which appears in the specification as originally filed. Please read Prof. Brackett's answer to question 21, and Prof. Barker's answers to questions 30 to 32, inclusive, and state whether you agree with the opinions there
1881 expressed, and what your opinion is in regard to the effect of
the change referred to?

Ans. I do not agree with defendant's experts that the dropping of the word "charcoal," either designedly or in fact, alters or broadens the patent. As I have already shown in previous answers in this deposition, the word "charcoal" is very ambiguous. It might have been taken to mean gas carbon, or else the substance popularly known and sold as charcoal, neither of which meanings, as I understand it, was intended by the patentees. That is, the word as it stood was a misleading one, and calculated to obscure the specification, and was therefore dropped.

Int. 65. Taking any meaning of the word "charcoal," either as used in the arts or popularly, did the omission of this word, in your opinion, in any way broaden the scope of the patent?

Ans. I do not see how it is possible that the omission of the word "charcoal" in any sense in which it could be understood, can in any way broaden the patent.

Int. 66. Defendant's experts also refer to the omission from the final specification of the words "covered with powdered plumbago" used in the original specification in connection with the words "carbonized paper." Do you agree with them in the opinion they express in regard to the effect of this change? Please read Prof. Brackett's answers to questions 22 and 23 and Prof. Barker's answer to question 37, and give your reasons for any opinion that you may express.

Ans. I do not agree with them. The original specification sets forth the use of carbonized paper, which is no less paper because it has been covered with plumbago. Such treatment with plumbago certainly was not essential and was not intimated as being essential in the original specification, nor would any one have had reason to assume from that specification that it was essential. Whether the paper was or was not covered with plumbago, it was equally susceptible to shaping before carbonization and likewise possessed
1882 the valuable properties characteristic of fibrous carbon for
the conductor of an incandescent lamp. It seems to me that the expression, which is vague and indefinite, and hence obscure, was for this reason omitted from the final specification.

Int. 67. Do you find anything in the expression "carbonized paper covered with powdered plumbago," or in any other language used in the original specification that would in any way suggest to a person skilled in the art that the method of carbonization by passing an electrical current through a piece of paper impregnated with powdered plumbago referred to in question 23 to Prof. Brackett, and in Prof. Barker's answer to question 37 was to be used?

Ans. There is absolutely nothing in that specification which could possibly convey the remotest suggestion to this effect.

Int. 68. Is it true as stated in the final specification that methods of carbonizing material while confined in retorts in powdered carbon were in practice before the filing of the application for the patent in suit?

Ans. It is true.

Int. 69. Was this method well known and had it been used in the art of electric lighting prior to the filing of the application for the patent in suit?

Ans. It was well known and had been so used.

Int. 70. Defendant's experts also refer to the fact that the expressions "composed wholly of glass," "that the entire wall of the chamber is formed of glass;" and "another important advantage resulting from our construction of the lamp results from the fact that the wall forming the chamber of the lamp through which the electrodes pass to the interior of the lamp is made wholly of glass by which all danger of oxidation, leakage or short circuiting is avoided," appear in the final specification, but that in the original application no such specific description is given of the lamp chamber. Please read Prof. Brackett's answers to questions 25 to 28 inclusive and Prof. Barker's answer to question 38 and state 1883 whether or not you agree with the opinions there expressed in regard to the effect upon the scope of the patent of these changes in the specification.

Ans. The specification as originally filed refers back to their earlier patent, No. 205,144, which unequivocally describes the construction under consideration. In that patent there is a minute description of the construction referred to in your question and also a specific statement that a ground-glass stopper may be used through which the leading wires of the lamp may enter. Under these circumstances I disagree from Messrs. Brackett and Barker with regard to the subject referred to in your question.

Int. 71. Is the language referred to in my previous question appropriate for describing the actual construction shown in the drawing of the patent in suit and described in the prior patent of Sawyer and Man referred to in the original application for the patent in suit?

Ans. It is perfectly appropriate to describe that construction.

Int. 72. Defendant's experts also refer to the statement contained in the final specification that "the sealing of the electrodes where they pass through the glass wall is done with any suitable cement or in any of the well-known methods of sealing glass upon metal electrodes previous to the filing of this application does not occur in the application as originally filed. Please read Prof. Brackett's answer to question 29 and *and* Prof. Barker's answer to question 39, and state whether or not you agree with the opinions there expressed as to the effect of this change.

Ans. I do not agree with Professors Brackett and Barker in the opinions which they express regarding this matter. Even without any specific statement it would of course be understood that one was at liberty to use any of the well-known methods of hermetically sealing the leading-in wires into the glass. The mode of doing this commonly employed at present has been known for a great 1884 many years in the manufacture of Geissler tubes and similar apparatus and was well known long prior to the date of Sawyer and Man's first patent.

Int. 73. Defendant's experts also refer to the fact that the statement contained in the final specification in regard to the advantage of the arch form in providing for the expansion and contraction of the carbon does not appear in the specification as originally filed. Please read Prof. Brackett's answers to questions 33 to 37 inclusive and Prof. Barker's answer to question 43, and state whether or not you agree with them as to the effect of this change in the specification.

Ans. I do not agree with Professors Brackett and Barker in this matter. On the contrary, it seems to me that the arch-shaped carbon as shown in the drawings of the patent in suit would possess that greater stability and adaptability to changes in temperature which are set forth in the specification, so that it would be much less liable to fracture. Inasmuch as this arch-shaped conductor was fully described and set forth in the original specification, I fail to see that the scope of that specification is enlarged merely by a fuller statement of its advantages.

Int. 74. Do you find anything in the application as originally filed which would suggest to a person skilled in the art as it stood prior to 1880, that in making carbon conductors from fibrous or textile material, such material was to be shaped to any extent before carbonization?

Ans. In the specification the patentees state that they have tried carbonized paper, which, from its very structure, is necessarily shaped in one dimension before carbonization and which would naturally have been shaped in all dimensions before carbonization as well. There is also a further reference to carbonized paper in the third claim. Still further, the fourth claim refers to the use of carbonized textile material as well as fibrous material and this would necessarily have its shape determined prior to carbonization. The fact that the textile material is to be carbonized would 1885 of itself indicate that such material was started with in an uncarbonized state and evidently its form would be there to begin with and could not be impressed upon it subsequent to carbonization. It seems to me that shaping prior to carbonization is necessarily implied in these references.

Int. 75. Do you agree with defendant's experts in the opinions they express on this point? Please read Prof. Brackett's answer to question 32 and Prof. Barker's answers to questions 41 and 42.

Ans. I do not. It seems to me that a person who started to employ paper as the material for the incandescing conductor of the lamp would inevitably begin by picking out a paper of what he judged to be a suitable thickness. And I do not doubt that he would also cut from that paper a strip of what he judged to be a proper size and then proceed to carbonize it. I cannot imagine that a person would be so stupid as blindly to take a piece of paper at random, carbonize it and then after it was all carbonized go to work for the first time to fix its dimensions, rubbing down its surface by filing or cutting it away. And if for any reason a person wished to use a strip of greater thickness than would be given by a single layer of such paper as he had chosen, I think there can be no reasonable doubt that he would have placed the layers of paper upon one another prior to carbonization rather than subsequently.

Int. 76. Do you think that a person skilled in the art as it stood prior to 1880, would have adopted any other or different method of making conductors from carbonized fibrous or textile material in following the specification of the patent as issued from that which he would have adopted from following the specification and claims as originally filed?

Ans. I do not.

Int. 77. When do the greater part of the changes in the original specification to which defendant's experts refer to have been made?

1886 Ans. They appear to have been made by the amendment dated May 17, 1880.

Objected to as a misstatement of what is shown by the record offered in evidence by complainant.

Int. 78. Prof. Barker appears to express the opinion in his answer to question 42 that in the original application as filed, the patentees did not express any preference for carbonized fibrous or textile material over the other forms of carbon mentioned in that specification. Do you agree with him in this opinion?

Ans. I do not. Carbonized paper and wood carbon are the first kinds of carbon which they mention in their statement of what they have used, gas carbon being mentioned subsequently to these. In the third claim the use of carbonized paper is set forth and in the forth claim an incandescing conductor made of carbonized fibrous or textile material is set forth. There is only a single specific reference in the whole patent to any kind of carbon other than fibrous carbon, and that is a simple statement that gas carbon has been tried. The only kind of carbon specifically referred to in the claims is fibrous carbon.

Int. 79. Do you agree with the opinion expressed by Prof. Barker in his answer to question 50?

Ans. I do not. The Gaudoin patent describes a process of making carbon pencils for use in electric lighting, which term at the date of the original patent was used only as referring to arc lighting, although later Gaudoin's carbons were used experimentally in some arc incandescent light. The whole process which Gaudoin describes is adapted and professes to be adapted to produce a hard and compact carbon precisely such as was suited for arc lighting carbons and not at all that which is adapted for incandescent lighting. That is, the pitch, resin and bitumen used in the original patent or the wooden object impregnated with these or other

1887 similar materials which are referred to in the certificate of addition are totally different things from the fibrous carbon set forth in complainant's patent in suit. The aim of the Gaudoin patent was to make pencils possessing the characteristics of pencils of gas carbon, an end which other inventors prior to Gaudoin had also sought to obtain. It seems to me that there is nothing in the Gaudoin patent which would in any way guide a person to use such carbon as he is taught to use by complainant's patent in suit.

Prof. Barker is incorrect in his statement that the Gaudoin pencils "not over a millimetre or two in diameter" were "adapted only to the production of light by incandescence" They were adapted to be used, and in fact, were used in arc incandescent lamps. It would of course have been possible to use them instead of gas-carbon pencils in such an incandescent lamp as that shown in Jensen's British patent No. 970 of 1875, but if they were to be so used they would possess no properties superior to or different from those of the hard gas-carbon pencils made for the same purpose.

Int. 81. Do you agree with the opinion expressed by Prof. Brackett in his answers to redirect questions 119 and 120, that there would be no difference in the relative value for electric lighting purposes between the lamp described in the patent in suit, and that of the prior patent of Roberts, Shepard, Konn, Koslorff and others to which he has referred, as anticipating the claims of the patent in suit?

Ans. I do not. It seems to me that the lamp of the patent in suit would possess a value much greater than that of any of the prior lamps.

Adjourned to meet at the Hotel Brunswick, Boston, Mass., Monday, April 8, at 9 a. m.

1888 Cross-examination of Prof. Cross by Mr. Dyer:

82 X Q. You stated in answer to question 2, that you had published a number of papers on the telephone and electric lighting. Please state where those relating to electric lighting can be found.

A. There is one paper on the inverse electro-motive force of the voltaic arc, published in the proceedings of the American Academy of Arts and Sciences, which was the particular paper relating to electric lighting which I had in mind in my reply to the question. I also published a paper a few years ago on an allied subject, namely, the melting platinum standard of light. I have also been a member of committees which have reported on electric lighting devices. I should have to hunt up the matter to see what portions of these reports have actually been written by myself. I do not recall any other papers relating to electric lighting besides these, though there are several which are at present waiting for publication as soon as I can get them into shape.

83 X Q. What is the principal source of light in all three kinds of electric lamp that you have referred to employing carbon for the burner?

A. In the electric arc, as I have already said, most of the light comes from the terminals of the pencils, which become white hot in virtue of the action which goes on there. In the arc incandescent light, the light emitted comes from the intense heating of the carbon at the joint made between the two conductors. In the incandescent lamp, the light comes from the intense heating of the whole carbon strip through which the current is passed. There is only one thing which is common to all three, and that is, that it is white-hot carbon which radiates the light. The laws governing the production of this light, and the various circumstances which influence its peculiarities, are vastly different in these different kinds of lamps.

84 X Q. Then the fact is, that in all three kinds of
1889 electric lamps, the light is produced by the incandescence of
the carbon?

A. It is, if you see fit to use carbon in all three forms. Of course substances other than carbon can be used for every one of these three lights.

85 X Q. Is there not also another source of light in the arc lamp?

A. There is the hot space between the two carbons emits a certain amount of light, being filled with various vapors and with matter coming from the hard carbon employed for the electrodes. The light from this space is objectionable rather than the opposite. I suppose also there is a little light which comes from the combustion of the carbon pencils employed; but if these are of hard carbon, this combustion is trifling.

86 X Q. Does this luminous space exist in the arc incandescent or semi-incandescent lamps?

A. I do not suppose that this space is present in what may be called the normal operation of that lamp. I think, however, that as the carbon wears away, minute arcs are probably formed. The theory of the operation of this lamp is in some respects a little obscure, since certain phenomena characteristic of such a joint come into play, that have not been very fully investigated.

87 X Q. The semi-incandescent lamp, then, differs from the arc lamp in the respect that in its normal operation the light is wholly produced by the incandescence of the carbon?

A. Yes, I suppose that is so, if the lamp ever operates normally, which I question. There is never any visible gap between the electrodes in the arc incandescent lamp, if that is what is meant by the question. These lamps have proved so useless in practice that they have not been studied very carefully, and although at one time they were looked upon as likely to be useful, they appear to have been set aside, so that their theory has not been studied as minutely as that of the arc or incandescent light.

88 X Q. Is it not a fact that in arc lamps the luminous
1890 space being depended upon to produce the effect, electrodes
of relative large diameter can be employed, while in the arc
incandescent lamp a relatively small carbon or pencil is necessary,
in order to produce the necessary resistance?

A. I do not think I understand the question; that is, I do not feel sure what "the effect" alluded to is. Certainly the luminous space does not produce the illuminating effect of the arc light, if that is what is meant. On the contrary, the luminous rays coming from this space are objectionable, if they are sufficiently abundant to be noticeable, and in some forms of lamp an endeavor is made to get rid of them. It is true that larger carbon pencils are usually employed with the arc light than with the arc incandescent light, but this is in order to confine the heating effect to the ends of the electrodes and to prevent the burning away of the electrodes for a considerable distance away from the air space. Also, it is highly desirable that the carbon pencils should be of large section in order that they may interpose as little resistance as possible to the passage of the current through them. One of the carbons of the arc incandescent lamp is usually brought down to a fine point, in order to localize the heating effect. But the other electrode is usually larger, and sometimes very large indeed.

89 X Q. It is the incandescence of the small-pointed carbon which produces the light, is it not?

A. I suppose that the light comes principally from this, though as I have already said, the phenomena attending the operation of this lamp are somewhat obscure.

90 X Q. How large in diameter are the smaller-pointed carbons of the arc incandescent lamp?

A. I have never seen such a lamp, as constructed by any manufacturer; but I suppose the diameter is somewhere between $\frac{1}{20}$ and $\frac{1}{10}$ of an inch. I once tried to make an experimental lamp of this character, and used a carbon of about the larger size mentioned, such as I happened to have. I brought its end down to a sharp point.

1891 91 X Q. How far back from the extreme point does the incandescence extend in these arc incandescent lamps?

A. As I understand it, only a short distance back. That is, the intention, I think, is rather to get the intensely bright light (which resembles in some of its characteristics that of the voltaic arc), from the point in which the two electrodes meet. In such experiments as I have made, the light did come from this point, and but little from that portion of the carbon which is beyond it. I have said that the operation of this lamp, and consequently the precise way in which its light is generated, is a little obscure. I have a notion that certain phenomena of repulsion which come into play when a current passes from one electrode to another, may operate here, and that some operation of this kind gives rise to an arc-like character at the joint of contact.

92 X Q. Is that repulsion sufficient to overcome the weights or springs that are used to maintain the electrodes in contact in these lamps?

A. Under certain circumstances, it might be. I cannot say that it is in all.

93 X Q. Do you know that it is in any?

A. I am confident that it was in the experimental lamp to which I refer, and I feel quite certain that it would be sufficient in some others, of which I have seen drawings. I do not wish it understood that I have any fully developed theory on the subject, but merely that the action which I had in mind, seemed to me to aid in the explanation of certain phenomena. I should want to investigate the matter with care before adopting any very positive opinion.

94 X Q. Please state what the construction of the experimental lamp you refer to, was.

A. I do not recollect minutely, but there was a light pencil of carbon which rested on a block of carbon, the current passing from one to the other. In another case, I remember carrying the current from a carbon electrode attached to a spring to another,
1892 on which it rested lightly; this last action happened accidentally in connection with some other experiments.

95 X Q. Is it not a fact that the extent of the incandescence of the pencil of the arc incandescent lamp will depend largely upon the size of that pencil; and if it is made small enough, the incandescent portion will extend back a considerable distance?

A. I suppose that it is true of the arc incandescent lamp, as it is also true of the arc lamp, in which with small carbons these become incandescent to a greater distance from the air space between them, the heat being conducted from the focus along the carbons. I suppose the same thing is true with the arc incandescent light, that is, the heating effect is particularly intense at the contact point of the two electrodes, and will spread from this focus to a greater distance along the electrodes if these are smaller. I should think, however, that in both cases it would be damaging to carry this effect to any considerable extent, and that it would be likely to render the arc incandescent lamp inoperative.

96 X Q. Would it still be an arc incandescent lamp, if the pencil were small enough to be heated to incandescence to a material extent back of the point?

A. I do not understand the force of the term "material."

97 X Q. What feature in the construction of an electric lamp makes it an arc incandescent lamp, and not an arc lamp?

A. The term arc incandescent lamp has been applied to lamps in which a pencil of carbon rests upon a second piece of carbon, so that there is a less intimate contact among the particles at this joint than among the particles of either carbon.

98 X Q. If the pencil of carbon of the same diameter throughout its length rests, end on, upon a block of carbon or upon a block of metal, say faced with platinum or iridium, and light be
1893 produced by passing an electric current through the point of contact or joint, would the light be of the arc incandescent character?

A. I should say that if the light were produced by the passing of the electric current through the joint, and by that only, or substantially by that only, the light would be of the arc incandescent character. I don't know what the effect of any metal might be, as I recall only the use of carbon in lamps of this character.

99 X Q. Would not the construction first assumed in my last question, namely, a pencil of carbon of the same diameter throughout its length, resting, end on, on a block of carbon, be one in which

there is a less intimate contact among the particles at this joint, than among the particles of either carbon?

A. It would.

100 X Q. Would a weight, or spring pressing the parts together, change the relative intimacy of the particles at the joint and in the body of the pencil to such an extent as to deprive the lamp of its arc incandescent character?

A. I do not see that such a weight or spring would produce any material change in the intimacy of contact of the particles in the body of the pencil. The effect which would be produced at the joint would depend altogether upon the magnitude of the force employed. I suppose that if a sufficiently strong pressure were used, an arc incandescent lamp might be rendered inoperative by excessive reduction of the resistance at the joint. But under these circumstances it would cease to operate as a lamp.

101 X Q. What would be the effect of increasing the current in such a lamp, so as to make the carbon incandescent?

A. What I suppose you really desire me to state is to what class of lamps your device properly belongs, if it were capable of being made operative under the conditions which you imagine. I should think that under these circumstances it would properly be classified as an incandescent lamp.

1894 102 X Q. Would not the pressure which you have assumed as sufficient to suppress the arc incandescent action at the joint, bend or buckle the carbon pencil if raised to a light-giving incandescence by the increase of the current?

A. The matter regarding which you are questioning me is purely hypothetical in its nature, so that I cannot speak as confidently as I would like to do. I think it would be possible to get up such an experiment substantially as you suggest, in which the incandescence was substantially from the carbon as a whole, and not from the joint in particular, without buckling the carbon to such an extent as to prevent the trial of the experiment. I do not believe that a commercial electric incandescent lamp could be made in this way.

103 X Q. For an operative incandescent lamp, it is essential, is it not, that a better connection should be made with the end of the carbon pencil than would be formed by pressing a pencil of the same diameter throughout its length, end on, on a carbon block by means of a weight?

A. I should not choose such a method of connection, but I should think that a lamp of this kind could undoubtedly be made to operate, notwithstanding the use of such a connection.

104 X Q. The carbon pencil would be hotter at the joint, would it not?

A. I don't know. I suppose that the greater resistance there would make it somewhat hotter, but the great heat of the other portions of the pencil would, I should think, prevent any large difference from existing. I never saw a lamp of this kind.

105 X Q. Then, as I take it, if you were shown the drawing of an electric lamp having a carbon pencil resting on a block of carbon, and pressed down by a weight, you could not say whether it was an

arc incandescent or an incandescent lamp, unless you knew how heavy the weight was intended to be?

A. That would depend entirely upon the drawing.

1895 106 X Q. What features of the drawing would guide you?

A. I suppose that if it were a device unlike any that I recognized, the size and arrangement of the pencil and the general aspect of the device would guide me in coming to whatever opinion I reached. It is very likely that a drawing might not of itself be sufficient to indicate the precise character of the apparatus.

107 X Q. In view of the well-known fact that it is necessary in incandescent lamps to securely clamp the ends of the carbon, would you not assume, in the absence of clear indications to the contrary, that such a lamp as that referred to in X question 105 was intended to operate upon the arc incandescent principle, and to feed the carbon forward as it wasted away?

A. I cannot say that I should, necessarily.

108 X Q. What is the effect of placing the arc incandescent construction in a chamber exhausted of air, or filled with a gas such as nitrogen?

A. I do not recall any such lamp, and cannot say what the result would be.

109 X Q. How are the arc incandescent lamps described as used?

A. In air, as far as I recollect.

110 X Q. What change in the phenomena would be produced by inclosing such a lamp in a chamber exhausted of air or filled with nitrogen?

A. I do not see that any material change would be produced. *In vacuo*, the phenomena might be complicated by such an effect as one gets in a Geissler tube. I do not know of any experiments relating to this matter, however.

111 X Q. The effect of producing a voltaic arc between carbon points *in vacuo* and in nitrogen has been investigated?

A. Yes.

112 X Q. Cannot you judge from the results of those investigations what would be the effect of placing an arc incandescent lamp in such atmospheres? 1896

A. Not with any certainty.

113 X Q. A wasting away of the carbon pencil at the joint is a feature of arc incandescent lamps, is it not?

A. It is.

114 X Q. Is not this feature characteristic of arc incandescent lamps, and not found in incandescent lamps?

A. I do not recall any incandescent lamp now in commercial use which possesses this peculiarity.

115 X Q. Would there be any such wasting away at the joint unless the particles of carbon were in less intimate contact at the joint than in other parts of the carbon?

A. I should think not, as far as I can call to mind the various actions which go on. Of course it would not at all follow from this that such a structure as you have described is an arc incandescent lamp.

116 X Q. Why would it not follow?

A. Because as I understand the hypothetical device under consideration, the current might be so strong as to render the pencil incandescent throughout its whole length, so that only a negligible amount of light in comparison with the whole would come from the joint. Especially might this be so if the pressure was such as to produce a very intimate contact between the two carbons. Still further, I think it probable that such an arrangement of parts could be made that there would be no incandescence at the joint although the pencil was made to incandesce.

117 X Q. Then the intimacy of contact between the carbon pencil and the carbon block would not determine the character of the lamp, in your opinion?

A. You are asking me to classify a hypothetical lamp which I have never seen, and the conditions of which are only indefinitely outlined; and your question, moreover, calls for an attempt to draw
a dividing line between lamps which might possess the char-
1897 acteristics of either, or both an arc incandescent and an in-
candescent lamp. This is difficult to do.

Adjourned till April 9th, at 11 a. m.

Resumed April 9, 11 a. m. (Witness continues his answer:)

The intimacy of contact would of course act to determine whether there was or was not a materially increased incandescence at the joint.

118 X Q. I call your attention to the lamps of Renier and Werdermann, illustrated and described on pages 56, 57, of Sawyer on Electric Lighting, put in evidence by the defendant; are these arc incandescent lamps?

A. I have always seen them described as such.

119 X Q. These lamps employ, do they not, a long carbon pencil pressed by a weight upon a block of carbon, a connection being made with the pencil near its point, so as to remove the resistance of the entire pencil from the circuit, and confine the electric current principally to the end of the pencil?

A. I understand from my previous knowledge of these lamps that they operate in that way. The description which accompanies the figures to which you have referred me is not at all clear, and does not give much of an explanation of the manner in which these lamps operate.

120 X Q. The figures show the pencils passing through clamps near their ends, with which one of the circuit connections is made, do they not?

A. The Werdermann lamp is clearly thus shown in the figure. I should judge the connections to be similar in the Renier. I imagine the figure of the Werdermann lamp is intended rather for a
diagram than for a picture of the lamp.

1898 121 X Q. The lamps of Starr, King, Konn, Bouliguine,
Fontaine and Farmer, described and illustrated in the same chapter of Sawyer's book, are incandescent lamps, as distinguished from arc incandescent, are they not?

A. I observe that Sawyer in his book referred to, does not seem to use the term arc incandescent or semi-incandescent lamp, or to use this classification. He simply speaks of "two types of incandescent lamps in use, those which burn in the air, and those in which the luminous conductor is inclosed in a globe exhausted of air, or containing an atmosphere of nitrogen or other gas for which carbon at high temperature has no chemical affinity." Sawyer's description of the lamps referred to in your question is in some cases very meagre, but they are all understood to be incandescent lamps.

122 X Q. Is the fact that the lamps of Renier and Werdermann burn in the air, an essential to their arc incandescent character, or would they still be arc incandescent lamps if inclosed in a receiver exhausted of air, or filled with nitrogen?

A. I don't know just how they might act *in vacuo.* I should suppose, however, that in this case, and undoubtedly with nitrogen, they might be operated as arc incandescent lamps.

123 X Q. Is the lamp illustrated in Fig. 10 of Shepard's English patent No. 13302, of 1850, and described in connection with that figure, an incandescent, or arc incandescent lamp?

A. I should understand it as being an arc incandescent lamp in fact, though the patentee does not distinctly describe it as thus operated. His statement is somewhat indefinite.

124 X Q. The statement of the patent that the light is produced by the incandescence of the charcoal cylinder E, does not lead you to classify it as an incandescent lamp?

1899 A. The statement itself would lead me to infer that the patentee meant to obtain light by incandescence from the carbon cylinder. It is not stated whether this incandescence was to be limited to the contact or otherwise. I do not think that the patentee had very definite ideas on the subject, and do not believe at all that he ever made and tried the lamp in question.

125 X Q. If enough current were passed through a lamp of this construction to make the carbon pencil E incandescent throughout its length how would you then classify the lamp?

A. If accuracy in classification were of any moment I should insist upon trying the experiment before making any such classification. If substantially all of the light came from the incandescent carbon, and the phenomena at the joint were comparatively insignificant, I should consider it an incandescent lamp.

126 X Q. Is it not the essential difference in construction between an incandescent lamp and an arc incandescent lamp that the former has a carbon pencil clamped firmly at each end, and the latter has the carbon clamped firmly only at one end and provided with means for feeding the pencil forward as it wastes away at the other end?

A. I have never seen this distinction made the basis of classification, and it would be a very unphilosophical one to make. I fail to see that such a difference of construction is essential. Our modern, commercial incandescent lamps are of course clamped firmly at each end, but this is not essential to an incandescent lamp.

127 X Q. How would you classify the lamp shown and described in the patent to Sawyer and Man, No. 205,144?

A. As an incandescent lamp.

Adjourned till 2.15.

Resumed at 2.15.

1900 128 X Q. In expressing the opinion of your last answer, did you take into consideration the fact that the current is principally confined to the point E^1 of the carbon pencil, that the carbon block D has a rounded top, and that the end of the carbon pencil resting on it is shown as slightly rounded, so as to bear on the carbon block for only a portion of the area of its end?

A. I did.

129 X Q. Did you also take into consideration the fact that the lamp is provided with a feeding device, namely, sliding weight F, for feeding the carbon forward as it wastes away at the end?

A. I took into consideration the presence of the rod F. The description of the operation of this rod, however, which I noticed in the patent, seems to me somewhat different from what one might infer from your question. The patent says: "The rod F exerts a pressure upon the carbon E, which continues the same without regard to the length of the carbon, and thus should fracture or a slight consumption of the carbon occur at the first lighting, or any subsequent lighting of the lamp, the necessity of taking down the same, renewing the carbon, and recharging the globe is obviated, inasmuch as the weight of the rod F gently forces the carbon through the clamp G, until a new contact between E and D is established." If by "feeding" you mean the operation thus described, I took it into consideration in my answer.

130 X Q. The weight F is described as gently forcing the carbon pencil through the clamp G:—would such a pressure of the pencil upon the carbon block, in view of the fact that the meeting faces of the block and pencil are rounded, and only a portion of the area of the end of the pencil is in contact with the block, produce a sufficiently good contact to prevent the arc incandescent action at the joint?

A. I cannot say without experiment whether such action would be entirely absent or not. I do not think, however, that it would play any material part in the phenomena accompanying the operation of the lamp.

1901 131 X Q. Why do you classify the Konn English patent of 1873 among the arc incandescent lamps in your answer to question 7?

A. I did not intend so to classify it, and it must have got into my list through some slip of the pen. In my 5th answer, I refer to it as an incandescent lamp, which it really is.

132 X Q. In classifying the English patent to Greener & Staite, No. 11076 of 1846, among the arc incandescent patents, did you intend to include all the forms of lamps described in that patent? I call your attention to the form described beginning at line 33, page

3, of the patent, in which a hollow cylinder of carbon is placed between two platinum cones connected with the circuit wires, the carbon cylinder being inserted, "so far into the cones at the two ends as to be in perfect contact therewith all around."

A. The patent in question describes a great variety of devices which I had assumed to be for arc incandescent lighting. I must have overlooked the particular device to which you refer, which I judge from the description is intended to operate by incandescence.

133 X Q. When was the arc lamp first introduced extensively for commercial use, if you know?

A. The arc lamp began to be employed for special purposes about 1845. After 1854, or thereabouts, it was used to an increasing extent, for light-house illumination. After 1873, or thereabouts, and to a certain extent before this, it was employed more or less in the illumination of dock-yards, buildings in process of construction, etc. Its use, however, was quite limited. About 1876 or 1877, it began to be used for street lighting, for which it has been extensively used from 1878 onwards. Since the latter date it has been very widely used.

134 X Q. Where were the early industrial uses of the arc light made?

A. It was used in some of the French light-houses, and also
1902 in some of the English light-houses as well. It was used, I
believe, in some of the French docks, and it was used for
lighting some of the streets of Paris.

135 X Q. Was it used industrially, so far as you know, say, prior to 1853, except its use for theatrical effects in Paris, as stated by Fontaine in his work on electric lighting?

(Objected to as immaterial.)

A. I do not recall any specific instances earlier than this. I think very likely it may have been used, but only to a trifling extent. I think it was sometimes used in illuminations, and for like purposes.

136 X Q. Where do you find the suggestion of Foucault to use gas-retort carbon for arc-light electrodes first recorded?

A. I have not looked up this matter, and therefore cannot state where it was first recorded. If it is a matter of any consequence I shall be glad to ascertain.

137 X Q. What is the foundation for your statement that Foucault made this suggestion about 1845?

A. That is my remembrance of the history of the art, I think there is no question about the fact, but in what place it was first published I do not recall.

138 X Q. Have you in mind any publication of the suggestion prior to, say, 1853?

A. I have none such in mind, and I never had occasion to hunt up the matter. It is a subject frequently referred to in books on electric lighting, and my remembrance has been that 1845 was about the time of the invention. I think I can very easily find a specific and authoritative statement if the matter is of sufficient importance to take the time for it.

139 X Q. What is the ordinary meaning of the English word charcoal?

(Objected to as immaterial.)

1903 A. The popular sense in which the word would now be understood by the public generally is the material commonly sold under that name.

130 X Q. What is the material?

A. A more or less impure form of carbon obtained by heating branches of wood in the absence of air.

141 X Q. Wood carbon or charcoal had been, prior to 1878, produced at various temperatures, both high and low and under quite perfect conditions as to the exclusion of air, had it not?

A. It had been.

142 X Q. And the electrical properties of such carbon had been, prior to that time, investigated, had they not?

A. They had to a certain extent.

143 X Q. And such wood carbon had been, prior to the date named, employed in exhibiting the heating effect of the electric current to the extent of producing light, both by means of the voltaic arc and by the incandescence of a slip or piece of wood carbon?

A. Such charcoal pencils were the first ones employed in the production of the voltaic arc. Sir Humphrey Davy observed in some of his experiments that charcoal became incandescent when a strong current was passed through it.

144 X Q. How widely known were the publications of the experiments of Davy and his contemporaries?

A. The experiments of Davy were, of course, widely known, as were also the experiments of many of his contemporaries.

145 X Q. Referring to the English patent of Konn, No. 3809 of 1872, what is the material intended to be used, in your opinion, for the incandescent material, as indicated by the word graphite?

A. I imagine that he means gas carbon; of course it might also be taken as meaning natural graphite.

146 X Q. Was the natural graphite or plumbago used in arc lighting, so far as you know, and is it suitable for such use?

1904 A. I do not recollect that it was so used. I do not think that it is well suited for this purpose.

147 X Q. Why do you think the word "graphite" in the Konn patent is intended to mean gas carbon?

A. The term "artificial graphite," often applied to gas carbon, had by the date of that patent frequently become changed in usage to "graphite" without any adjective. Hence, reading that patent, I should naturally infer that the artificial graphite was intended.

148 X Q. What did you mean in answer to question 7 by the statement in reference to the use of the word graphite in the Konn patent that "the effect of his patent necessarily would be to guide one reading it, and desiring to put into practice the invention

therein set forth, to the use of such graphite or gas carbon as was well known in the arts in connection with electric lighting"?

A. I meant that, in my opinion, a person reading the patent would select gas carbon or artificial graphite for use in the Konn lamp.

149 X Q. Why would he select it?

A. Because Konn states that his conductors are to be made "preferably of graphite."

150 X Q. Am I to understand that the fact that gas carbon was well known in the arts as suitable for the arc light has anything to do with your opinion in this matter?

A. You are. My feeling is, that if a term had a certain meaning in such electric lighting as was practised, and that same term were used without qualification in a publication relating to some new kind of electric lamp, the term would be understood in its usual acceptation.

151 X Q. That is to say, knowledge of the art of electric lighting generally would be applicable to the construction of such a patent?

A. So far as it related to similar matters, it would be. A man's knowledge of arc lighting would presumably be of use to him in considering other kinds of electric lighting.

1905 152 X Q. Referring now to the English patent of Roberts, No. 14198 of 1852, this patent describes, does it not, arc lamps as well as an incandescent lamp?

A. It does.

153 X Q. What kind of carbon do you find described as used for the arc-light electrodes?

A. The only kind particularly mentioned, as far as I observe, is graphite.

154 X Q. What do you understand that means in the patent of Roberts?

A. He seems here to use graphite as synonymous with carbon, although his expressions are somewhat obscure. If the patent were a more recent one I should naturally assume graphite to mean gas carbon. At the early date of the Roberts patent I do not feel certain whether it means natural graphite or artificial graphite, the latter would undoubtedly be better suited to his purpose.

155 X Q. Why does the early date of the patent make you doubtful as to the meaning of the word graphite?

A. Merely because of my impression that the term graphite as applied to the gas carbon was not of immediate introduction. At the same time I have not considered this matter with special care, and may not be correct in my inference.

156 X Q. Do you find the word "charcoal" used anywhere in that patent in connection with the arc-lamp electrodes or pencils?

A. I do not. They are spoken of as either of graphite or carbon.

157 X Q. Is there any indication that this patent was translated from the French or other foreign language?

A. I know of none.

158 X Q. Is there any indication in the patent that the descrip-

tive words are used in any other than their ordinary English meaning?

A. I suppose that they are intended to be used in such a
1906 sense as to be understood by those skilled in the art at the
date of the patent.

159 X Q. Question repeated.

(Objected to as indefinite and ambiguous, also for immateriality.)

A. As I have already said, the patent is somewhat obscure in places. For example, it speaks of using "graphite or carbon." Now, if this means, as I have suggested in my answer to cross-question 154, that the two terms are synonymous, one of them is certainly not used in its ordinary English sense. On the other hand, if the expression means either graphite or carbon, the term carbon is not used in its ordinary English sense, since graphite is excluded from its meaning. Perhaps, again, it may mean either natural graphite or artificial graphite, that is, gas carbon. Again, if by "ordinary English sense," you mean the popular every-day sense of words, then the word graphite throughout the whole patent is not used in its ordinary sense, unless we assume the word to mean plumbago or natural graphite. Again, the reference to coke in connection with the incandescent lamp referred to in the patent does not seem to be in the ordinary English sense of that term.

160 X Q. Aside from what may be the indefiniteness or ambiguity of the patent, in your opinion, is there any indication in the patent itself that the words are used in any other than their ordinary English sense?

A. I do not know that I fully understand the question. As I understand it, however, you ask me whether aside from the known state of the art at the date of the patent, and without taking into account in any way what materials were or were not habitually used at that time, and assuming the document to be read and construed simply as a piece of English prose, appealing alike to any one understanding the language, whether otherwise informed or not, and not written with any reference to its meaning to those
skilled in the art of the time; whether, making these
1907 assumptions, I observe anything in the patent to show that
the words have any sense which they would not naturally
suggest to such a person. I do not observe that there is anything, unless it be the expression "graphite or carbon," which would show to any one, knowing what these substances were, that they were not used in their ordinary popular signification.

161 X Q. Referring now to the English patent of Binks, No. 119 of 1853, is there any indication that this was translated from the French or other foreign language?

A. Not so far as I am aware.

162 X Q. Omitting to consider the use of the word charcoal in connection with carbonized lignite, do you find anything in this patent of Binks to indicate that the expression "charcoal" is intended to have other than its ordinary English meaning?

A. I do not observe anything in the mere language of the patent itself, beyond the reference to carbonized lignite.

163 X Q. Do you disagree with the statement made by defendant's expert, Prof. Brackett (with reference to this Binks patent), that "lignite is partially-reduced wood, or other vegetable matter, in its progress from its condition in the organic state toward coal"?

A. I suppose that the statement is literally correct, though to me it seems somewhat misleading. I am not a mineralogist, but I think I am right in my understanding that lignite is classified as a mineral. I should think it was rather a kind of coal than a kind of wood. I have limited my consideration to the sentence quoted from Prof. Brackett's deposition, and have not considered the remainder of the answer in which this quotation occurs.

164 X Q. Lignite retains, does it not, to a very large degree, the grain and fibre of the wood from which it is partially reduced?

A. I cannot say to what extent it does this. As I have
1908 already said, I am not an expert in mineralogy, but the fact
that this substance is classed with minerals would lead me to
suppose that great changes had taken place in its structure.

165 X Q. Is not a carbon made by carbonizing lignite a carbon made from a fibrous material?

A. I suppose that would depend upon the sense in which the term fibrous material was used. If one were directed to make use of a carbon derived from fibrous material, I am confident that he would never think of using lignite. There is a certain sense, in which, I suppose, carbon made from lignite might be said to be carbon made from a fibrous material, just as there is a sense in which bituminous or even anthracite coal might be spoken of as a carbon made from fibrous material, since they all originated in woody tissue. But in all three cases it seems to me that the term "carbon made from fibrous material" can only be applied by a violent stretch of language.

166 X Q. Do you mean by your reference (in answer to question 5), to the English translation of the Gaudoin patent, that anybody skilled in the art at the present time would confuse the expressions "charcoal" and "retort carbon"?

A. I simply mean to make a statement of fact with regard to the apparent explanation which the translator of that article gave of the French term thus rendered. It seemed to me to bear on the frequent translation of the French word "charbon" by the English word "charcoal."

Adjourned till 7.30 p. m.

Examination resumed at 7.30 p. m.

167 X Q. The suggestion on the margin of the translation rather shows, does it not, that the translator was ignorant of the true translation of the French expression?

A. He does not seem to have understood the technical terms involved.

168 X Q. I show you a certified copy of French patent No.

1909–1919 97583, dated 18th December, 1872, and granted to Lodyguine & Co. Does this patent describe an incandescent lamp?

A. It does.

169 X Q. Is not the following description of the incandescing conductors found in that patent: "Les conducteurs m, m', m'' doivênt etre en coke, en graphite ou toute autre substance qui pourrait servir au memê, but et qui remplirait les mêmes conditions"? Will you also kindly translate the matter into English?

A. It is. The paragraph reads as follows: "The conductors m, m', m'' may be of coke, graphite or any other substance which would serve for the same end and which would fill the same conditions."

The patent referred to is offered in evidence by defendant's counsel, and the same is marked "Defendant's Exhibit Lodyguine French Patent," H. C. M., spe. ex.

Complainant's counsel objects to the foregoing exhibit for the reason that defendant's time for taking proof has expired.

At request of defendant's counsel complainants admit that the said exhibit is a correct copy of a French patent granted as set forth in X Q. 168.

170 X Q. Would you include this patent among the published descriptions of Lodyguine lamps which you have grouped together in answer to Q. 7?

A. I have not seen the patent until this moment. I see no reason for not including it among such descriptions.

171 X Q. In ascertaining what substances would be included by the expressions used in the paragraph quoted in X Q. 169, would you apply the same course of reason which you have applied to the Konn and Koslorff patents in answer to X Q. 7?

A. I should, if I understand the question correctly.

1920 172 X Q. What substances would be so included, in your opinion, by the paragraph quoted from the patent in X Q. 168?

A. I am sure I do not know. The statement in the patent is one of those indefinite expressions which seem to indicate merely that the patentees reserve the right to use any equivalents for the substances specifically mentioned. It is as if they said, "You may use coke, graphite or anything else which will prove operative."

173 X Q. Does not this paragraph throw some light upon the expression, "preferably graphite," employed in the English patent of Konn, No. 3809, of 1872?

A. I do not see that it does. I have not noticed, as far as I remember, any particular obscurity in that patent which seemed to render its meaning doubtful.

174 X Q. Does not the language of the French Lodyguine patent indicate that, besides coke and graphite, such other substances could be used as were known in connection with electric lighting?

A. The language indicates that one may use any substance which fulfills the requisites of such a lamp.

175 X Q. Would not the knowledge with regard to materials used in arc lighting be applicable in construing the language, the same as you found such knowledge applicable in construing the Konn and Koslorff English patents?

A. We should, of course, apply our knowledge of arc lighting operations to the method in question. If we use our judgment in applying it, it will doubtless be of value.

176 X Q. You have referred several times to the book entitled "Electric Lighting," by H. Fontaine, translated by Paget Higgs, published in London, 1878; is this a copy of the book you referred to? (Book handed to witness.)

A. Yes.

177 X Q. What is it a translation of?

A. I understand it to be a translation of a work entitled "Eclairage á L'Électricité," par H. Fontaine, published in 1877.

1921 178 X Q. Is the French publication the book I now hand you? (Book handed witness.)

A. Yes.

Adjourned to 10 a. m., 10th April.

April 10—10 a. m.

179 X Q. Referring to cross-question 133, I desire to call your attention to the statement made at page 126 in Higgs' translation of Fontaine to which you have referred. Is Fontaine's statement that the electric light was first applied to light-houses in 1863 probably correct?

A. I had the impression that experiments of this kind had been carried on at an earlier date than this, but my impression may be incorrect. As far as I know, the electric light was first regularly used for that purpose at or about that time.

180 X Q. Is the statement contained at page 105 of Higgs' translation that "the first permanent introduction of the electric light was realized in 1873, at Paris, in the workshop of the Gramme Company," the basis of your statement in answer to cross-question 133 as to the use of arc lights after 1873 or thereabouts?

A. The dates mentioned in my answer were simply intended to indicate my impression as to the matter inquired of, as I did not suppose the question demanded rigid accuracy. I think it probable that my impression was in part at least derived from Higgs or from the original French of Fontaine, as I had read both of these books.

181 X Q. You have stated, in answer 7, in connection with the Konn English patent, No. 3809, of 1872, that "there is not in the patent the remotest intimation that anything but disadvantage could result from using carbon other than graphitic carbon."

1922 Do you mean by this that there is anything in the patent showing that disadvantage would result from the use of other than graphitic carbon?

A. The inventor says that the conductors "are preferably graphite." I should infer from this that there would undoubtedly be certain disadvantages in the use of other forms of carbon. Otherwise I do not see why graphite should be preferable. And from the fact that this inventor thinks it worth his while to especially instruct one wishing to employ his invention, that by using graphite he will best secure the advantages of that invention, I should naturally infer that certain disadvantages would result from the use of other forms of carbon; that the patentee realized this and that he desired so to instruct the public.

182 X Q. Then the basis for your statement which is quoted in my question 181 is the expression in the patent "preferably graphite"?

A. Certainly.

183 X Q. In the English patent to Burleigh and Danchell, No. 3164 of 1857, charcoal and gas carbon are stated as different substances, are they not?

A. In his numeration of the substances which he proposes to use, the patentee separately mentions, among other things, "animal or vegetable charcoal" and "gas carbon."

184 X Q. In the original application for the patent in suit, charcoal and gas carbon are stated as different substances, are they not?

A. They are.

185 X Q. Is there anything in the language itself which you have quoted from Ure's Dictionary of Arts, Manufactures, and Mines, to show that the expression "charcoal" is used in other than its ordinary sense?

A. Dr. Ure says that "in nearly all the arrangements the beautiful arc of light produced between the poles, from the points of the hardest charcoal, has been the illuminating source." Now, for twenty years prior to the date of this publication, gas carbon had been used for that purpose, and the term "charcoal" had
1923 been used in England to designate this gas carbon. Dr. Ure
wrote originally in England as an authority on these matters, and his statement would be grossly untrue if by "charcoal" he meant the article popularly designated thus. For these reasons it seems to me unquestionable that his language is to be understood and would be understood by one skilled in the art as I have interpreted it.

186 X Q. You have misunderstood my question. I do not want to know how you would modify the ordinary meaning of the words by reference to what you consider was the practice of the art at the date of the publication. What I want to know is, whether there is anything in the language itself which excludes the idea that the ordinary meaning is to be given to the words employed.

A. I do not think that I get at the full sense of the question. It is not quite clear to me what I am to understand by "the ordinary meaning" of the terms. I suppose that the ordinary meaning of the terms employed in a scientific work is the meaning which they have in the art to which that work relates; and certainly I did not propose to in any way modify that ordinary meaning, which one skilled in the art would attach to these words. To one absolutely ignorant of the art, the paragraph quoted from Ure's dictionary would be entirely unintelligible. He would not know what was meant by a battery or by the arc, or by the poles; and if he attached to these words only their common, popular meaning, he would, to say the least, find the statements exceedingly confusing. On the other hand, if he attached to the various terms employed their usual signification in the art, he would understand all of them in their true and proper sense.

187 X Q. Your position, then, is that at the date of Ure's publication, by the ordinary meaning of the word "charcoal" in the art of electric lighting, the substance which is known as gas carbon was intended?

A. That was an ordinary meaning of the term in the art.

1924 188 X Q. Do you think that at that time, or at any other time, in the art of electric lighting, the use of the word charcoal would exclude the idea of wood carbon?

A. Not necessarily. I assume from the general tenor of the preceding questions that by "wood carbon" you mean what is popularly know- as "charcoal."

189 X Q. I mean to include charcoals produced at the best temperatures and under the best conditions for producing perfect carbonization, such as were known to and employed by Davy and others of his date, such as are described by Violette, by Watts' Dictionary of Chemistry, and by various English patents, including that of Harrison, No. 588, of 1857, and that of Slater and Watson, No. 212 of 1852, and by other publications; and I repeat the last question with this understanding.

A. Not necessarily. Of course what it did or did not exclude in any given case would depend largely on the context.

Adjourned till 3.20.

Resumed at 3.20.

190 X Q. Are you aware of the fact that the term "charcoal" is defined in Ure's dictionary as "the fixed residuum of vegetables exposed to ignition out of contact of air"?

A. I do not, of course, recollect the particular wording to which you refer. I should expect to find in it some difinition of this kind.

191 X Q. Are you also aware that Webster defines charcoal as "coal made by charring wood under turf, or in other circumstances to exclude air; wood coal," and also that Worcester defines 1925 charcoal as "coal made by charring or burning wood under turf, or with little access of air; coal from wood"?

A. I never had occasion to look up the word either in Webster or in Worcester; but the definitions which you have cited are what I should expect to find there.

192 X Q. Is there anything in the language used in the Way English patent to indicate that charcoal is used in other than its ordinary sense? I call your attention to English patent No. 2841 of 1857.

A. The only patent of Way which I have before me is 2841 of 1857. There is nothing in the mere language of this patent itself to indicate the sense in which charcoal is used.

193 X Q. Why, then, do you hold the opinion that it means gas carbon?

A. Because gas carbon was the substance universally in use at the date of the patent, for arc lighting; and in a patent issued the year before to the same Way, No. 2547 of 1856, the patentee makes a statement which can only be reconciled with universally known facts by assuming that he uses the term charcoal to indicate gas carbon. The matter which I refer to is quoted in my answer to interrogation 5.

194 X Q. How do you know that gas carbon was universally used for arc lighting in 1857?

A. From the statements which I have seen with regard to the introduction of that material by Foucault and its subsequent use. I do not think there is any question as to the facts.

195–'6 X Q. Can you refer me to the publications where these statements can be found?

A. I haven't any particular publication in mind since this is a matter which I had supposed unquestioned, and which I had accepted as true for years. I suppose that I originally learned it when I first studied physics. I do not doubt, however, that proper search would abundantly substantiate my belief.

1926 197 X Q. Was not arc lighting in its experimental stages in 1857?

A. No; not for the purposes for which it was employed. Of course, in relation to our commercial use of arc lighting, what was done then would be considered experimental.

198 X Q. How large was the experimental use of arc lighting in England in 1857?

A. What I had in mind was the use of the arc light in the theatre, and for illuminations; also its use as a brilliant source of light for optical purposes. It does not seem to me that these uses are properly called experimental, though of course its use at that early date was very limited. If one might judge by the number of patents prior to 1857 which I find put in evidence by defendants in this case, the matter of arc lighting might be supposed to have passed beyond a purely experimental stage.

199 X Q. Do you consider that the terminology of the art was such in 1856 and 1857 that the word charcoal as used in the two patents of Way excludes the idea of wood carbon?

A. I was led to conclude that Way used "charcoal" in the sense of "hard carbon" from his statement that "electrodes of charcoal had usually been employed" for the arc light. Since the electrodes which had usually been employed were of hard carbon, and since the word "charcoal" had been used to designate such hard carbon in electric lighting, I inferred that this was what was meant by Way; otherwise the statement made by Way would be incorrect in a matter regarding which he was presumably well informed; and, since the term is apparently used in this sence in the Way patent of 1856, I inferred that Way used it in the same sense in his patent of the next year.

200 X Q. Was the terminology of the art such in 1856 and 1857, that the word "charcoal" excluded wood carbon?

1927 A. I understand now that you have dropped the Way patents out of consideration in the question, and ask me whether in the art of electric lighting the word "charcoal" was never so used as to include wood carbon. My answer is that the word "charcoal" was frequently so used as to include wood carbon.

201 X Q. In arriving at the conclusion that the Way patents mean "gas carbon" when they say "charcoal," you are obliged, are you not, to discard from the knowledge of the art the use by Davy and his contemporaries of wood carbon for arc lights, and also to discard from the state of the art the knowledge furnished the art (at a later date than the date you have fixed for the contribution of gas carbon by Foacault) by the paper of Violette, and by the English patents of Harrison and Slater and Watson, referred to in cross-question 189.

A. By no means. The substances used by Davy were superseded by the gas carbon of Foucault. As to Violette, I never heard of his carbons being in use for electric arc lighting; and while I cannot of course say that they had never been tried by any one except himself, yet I am very confident that no such use had been made of them as would in any way influence the terminology of the art.

The same remark applies to the process described by Slater & Watson. It was certainly never used to any extent, if at all.

With regard to the invention of Harrison, this could not, of course, have influenced the terminology of the art at the date of Way's patent of 1856, because it was not issued until 1857. With regard to the relation between Harrison's patent No. 588, of 1857, and Way's patent, 2841, of 1857, it is clear that, since Harrison's patent was not issued until August, 1857, while Way's was issued in March, 1858, no change could have been effected in the terminology of the art by Harrison's patent in that brief time, even if that had been a document of recognized importance. Still more is this
the case when the carbonizing process, because of which I
1928 suppose you refer to the patent, is described in only three or
four lines, and is one which has never come into use in the making of arc-light carbons. But it should also be noticed, as bearing on the possibility of the patent to Harrison effecting a change in the terminology of another patent issued in the same year, that the Harrison patent is sealed the 28th of August, 1857, which is the earliest date at which it could have become known to the world, and so begun to affect the terminology of the art, while the patent to Way under consideration is dated Nov. 10, 1857, less than three months after the issuing of the patent to Harrison. It certainly is not probable that Way read the Harrison patent on the day of its sealing, and failed to put his own provisional specification in shape until the day at which it was received at the British patent office, so that there was only about two months at the outside for the Harrison patent to work a change in the terminology of the art. And inasmuch as there is absolutely nothing in the Harrison patent to make any such change, I see no reason

to suppose that Way was influenced in his use of words by the patent of Harrison.

The use of gas carbon by Foucault really marked an epoch in electric lighting, but none of the later devices which you have mentioned were of marked importance.

202 X Q. In considering what is meant by the expression "sticks of carbon," occurring in the English patent of Koslorff, No. 441, of 1875, as descriptive of the incandescent conductors used in his lamp, you arrived at the conclusion, as I understand you, that gas carbon was necessarily intended, because you thought that there could be no question that the patentee referred to such carbons as are used in electric arc lighting; do you mean to take the position that in making the Koslorff lamp under his patent one would not be entitled to take advantage of the various kinds of carbon that had been used in arc lighting, including pulverized and moulded mixtures of various kinds, as well as the wood carbon of Violette, of Sidot, Watt's Dictionary, Harrison, Slater & Watson.

1929 A. I suppose that one wishing to construct such a lamp would be at perfect liberty to use whatever he pleased, but there is nothing whatever in the patent to lead him to make use of the various substances mentioned in your question. If we consider the lamp described in British patent, 441, of 1875, in connection with the earlier lamps originating with the same firm, I think that one would be led to use graphite and graphite only. Furthermore, considering patent 441 of 1875, by itself, it seems to me that in view of the universal use of graphite as the form of carbon employed in electric arc lighting, and of the fact that these hard-carbon electrodes were commonly spoken of as "the carbons," it would be almost certain that one purposing to construct the lamp of Koslorff's 1875 patent, would select graphite.

203 X Q. Is there anything in the patent to exclude the idea that the patentee intended to take advantage of all forms of carbon known in the art of electric lighting?

Ans. I think it very likely that the patentee so drew his patent that it might be held to cover any form of carbon, but there is nothing in it to indicate that other forms of carbon could under any circumstances be preferable to hard carbon. I feel certain that if the patentee had intended to indicate that some other substance than hard carbon was preferable, he would have mentioned it. And still more, considering his use of hard carbon in his earlier and analogous lamps, it appears to me that if he had not intended that this lamp should be made of hard carbon, he would at least have mentioned some other form.

204 X Q. The fact is, however, that he mentions carbon generally, and not any particular form of carbon specifically?

A. He says "carbon" only.

Adjourned till 7.30.

1930 Continuation of Prof. CROSS.
Resumed at 7.45 p. m.

205 X Q. You have stated, in answer to question 79, and with reference to the Gaudoin carbon pencils of the smallest sizes, that they were "adapted to be used, and in fact were used with arc incandescent lamps;" do you mean that they were not used in incandescent lamps?

A. I cannot say as a matter of fact that they were not used at all in incandescent lamps; they may have been so used; but there is no evidence so far as I know that such was the fact. What I particularly wished to indicate by my reference to their use in arc incandescent lamps was the fallacy of the assumption made by Prof. Barker that "some of them being not over a millimeter or two in diameter, were, therefore adapted only to the production of light by incandescence." That is, Gaudoin describes specifically a process intended for the production of hard-carbon pencils for use in arc lighting. Some of these pencils were made small in diameter. Prof. Barker concludes from this, and from this only, that these could have been used only for incandescent lighting. As a matter of fact, they were better adapted for arc incandescent lighting, and moreover they were actually used for that purpose. I only wanted to point out that Prof. Barker's conclusion in this matter was not justified by his premise.

206 X Q. You did not intend, then, by your answer to question 79 to exclude the idea that such carbons were in fact used in incandescent lamps?

A. I did not. I cannot say but that they may have been used, but do not recall any evidence that such is the case.

207 X Q. You feel quite certain, however, that they were used in arc incandescent lamps?

A. That is my understanding.

208 X Q. What evidence of that fact did you have in mind at the time of making your answer to question 79?

1931 A. I recall having seen a statement in some book on electric lighting to that effect. My impression is that there is a reference to it somewhere in Higgs' book.

209 X Q. If it should appear as a matter of fact, that these small Gaudoin pencils were used in incandescent lamps, would you change your views as to the intention of Gaudoin in making them?

A. If they were merely used experimentally or occasionally for that purpose, this would not modify my opinion in that regard. If they were used habitually and in large quantities, I think it would be fair to conclude that they were made at least in part for that purpose.

210 X Q. Do you think they were used more than experimentally or occasionally for arc incandescent lamps?

A. I cannot say. Of course, in a sense the arc incandescent lamps themselves were experimental, so that the same would be true with regard to any special size of carbons made for them.

211 X Q. Do you not think that the fact as to the use of these carbons is the best test of the purpose for which they were intended?

A. Yes, that seems to me to be a fair conclusion, assuming, of course, that the use was sufficiently extensive to demand the construction of such material.

212 X Q. You state in answer to cross-question 205, that "as a matter of fact, they were better adapted for arc incandescent lighting;"—do you mean by this that in 1877, when these Gaudoin pencils were made, the character of carbon best adapted for incandescent lighting was understood?

A. I did not intend to be understood as saying this.

213 X Q. That statement was made, then, I take it, from your present information as to the desirable characteristics of such a carbon?

A. That is true to a certain extent. My statement, however, was
made with reference not so much to the material of which
1932 these small carbons were made as to their dimensions. I was
doubtless guided by my present knowledge in making that
answer. As a matter of fact, however, although we are discussing these Gaudoin pencils as though they were regular and well-known articles of commerce, the only definite statement with regard to them which I find anywhere in this case is the statement of Prof. Barker, in his answer to the 50th question, that he knows, apparently from having seen them, that these pencils were made of various sizes, some large and some small, even not over a millimeter or two in diameter. There is nothing in this to show that these small pencils were other than samples shown at some exhibition, merely as illustrative of the process. Still further, Prof. Barker does not say that the pencils which he saw were intended for the production of any kind of a light by electricity; and so far as I can see, these particular pencils may have been intended not for electric lighting, but for some of the other purposes for which, as stated by him in his patent, Gaudoin made pencils of carbon.

(The entire answer after the second sentence objected to as irresponsive and volunteered.)

214 X Q. What is there in the dimensions of these small carbons that would make them ill-suited for use in incandescent electric lighting?

A. I don't think that I have made the statement that they were ill-suited for incandescent electric lighting, but that they were better suited for arc incandescent lighting. These pencils, especially if they have the diameter of two millimeters, are large for incandescent lighting, unless their length is very short; and if the length used is to be very short, I should hardly think they would be made in long pencils, or in rods of sufficient length to have the name "pencil" applied to them.

215 X Q. Should you think that a diameter of 1.6 millime-
1933 ter and a length of from 15 to 18 millimeters would be large
for use in incandescent lamps of the character known in
1877?

A. I think there is no doubt that some of the incandescent lamps then devised were intended to employ a carbon rod as large as this, though I am not positive, in the absence of direct measurements.

216 X Q. Would a round pencil having a diameter of 1.6 millimeters, and a length of 15 millimeters, be radically different in size from the carbon for incandescent lamps, the proportions of which are given for a small form of lamp on page 99 of Sawyer's book on Electric Lighting?

A. It would not.

217 X Q. Would such a carbon pencil be radically different in size from the size of the carbon shown in figure 3 of the patent in suit?

A. I should say not.

218 X Q. I understand that your opinion, that the small Gaudoin pencils were used in arc incandescent lamps, is based, at least in part, on some statement in Higgs' translation of Fontaine's book, which has been several times referred to in the course of your examination. Please refer me to the statement.

A. It is based on a statement which I have read, and *and* which I think is somewhere in Higgs' books. I do not recollect where, however, but should be glad to try and find it. My own copy of Higgs is at present in New York, so that I have no access to any mark which might indicate its presence.

219 X Q. It is a fact, is it not, that the methods of making the Gaudoin carbon pencils, as well as carbon pencils of some other makers, and also various tests of the carbon pencils are described in chap. 3 of Higgs' translation, and in chap. 3 of the original book of Fontaine's, both of which I now hand you?

A. That is the case.

Adjourned till April 11, 1889, at 11 a. m.

1934 Resumed April 11th, 11 a. m.

220 X Q. It is also true, is it not, that in chap. 11 of each of the books referred to in cross-question 219 the use of Gaudoin pencils of small diameter in incandescent electric lamps of the Konn construction is described?

(Objected to unless the term "Gaudoin pencils" be made more definite; the necessary for this, in order to relieve the question from ambiguity, appearing from the fact, as shown by chap. 3 of Higgs' book, that Gaudoin seems to have had various modes of making carbon pencils.)

(Def't's counsel states that it sufficiently appears by the deposition as already taken, that the witness is amply able to give the testimony in the case, and that testimony by counsel is evidently improper.)

A. Reference is made to some laboratory experiments with Konn lamps using "in Gaudoin artificial carbon," 0.0016 meter in diameter, and 0.018 meter long in their incandescent part. In the French Fontaine the carbons in question are referred to as "Charbons artificiels Gaudoin."

221 X Q. Would your answers to cross-questions 216 and 217 have been different if the proportions of the carbon pencil referred to in those questions had been 1.6 millimeters in diameter and 18 millimeters in length, as stated in your last answer, instead of the different length stated in question 216?

A. They would not.

222 X Q. It is a fact, is it not, that, in the experiments with the Gaudoin carbons in the Konn lamps referred to by Fontaine, the incandescence of the carbon was carried to a much higher degree than is usually practised in modern incandescent lamps?

Objection continued.

1935 A. That is my understanding.

223 X Q. Would such a higher degree of incandescence have any effect upon the length of life of the carbon?

A. I should expect that it would tend to shorten the "life" of the carbon.

224 X Q. You have stated in answer to question 79, that the term "electric lighting" was used at the date of the original Gaudoin patent "only as referring to arc lighting;" did you intend to make any distinction between the use of that expression on July 12, 1876, the date of the original Gaudoin patent and April 7th 1877, the date of the first certificate of addition to the Gaudoin patent?

A. I did not have any such distinction in mind in answering that question. What I meant by my statement regarding electric lighting was that the term "electric lighting" was understood to mean arc lighting, and that such was the sense in which that expression would be taken. I did not intend to state that no other kind of electric lighting had been suggested at that time, but that, if lighting by incandescence was meant, it would be distinctly stated. Still further, the expression "pencils for use in electric lighting" would certainly have been understood as referring to arc lighting.

225 X Q. In view of the use of the small-sized Gaudoin pencils in incandescent lamps as stated by Fontaine, and in view of your own recollection of having seen a statement that such pencils were used in arc incandescent or semi-incandescent lamps, do you wish to make any modification of your answer to question 7, with respect to the classification of the Gaudoin patent and certificates of addition as being one of the exhibits which relate "only to arc lighting and to the preparation of carbons for this purpose"?

A. I do not.

1936 (Def't's counsel offers in evidence the title page and chapters 3 and 11 of the book entitled "Electric Lighting, by Hippolyte Fontaine, translated by Paget Higgs," and also the title page and chapters 3 and 11 of the book entitled, "Éclairage á L'Électricité, par Hippolyte Fontaine," which have been referred to by the witness, and the same are marked respectively, "Def't's Exhibit Higgs' Translation of Fontaine's Book," and "Def't's Exhibit Fontaine's Book," H. C. M , Spe. Ex.)

(The foregoing exhibits are objected to by compl't's counsel as incompetent, and immaterial, and particularly because def't's time for taking proofs and offering evidence has expired. In view of the course of the cross-examination, compl't's counsel believes that the only object of defendant in offering these exhibits is to get before the court matters contained in the chapters specially named and not referred to in the examination of the witness.

(Adjourned till 2.15 p. m.)

(Resumed 2.30 p. m.)

226 X Q. Is it not a peculiarity of arc-light points, or electrodes, made of charcoal, that they are rapidly consumed?

A. By "charcoal" I will assume you to mean the ordinary charcoal of commerce, or such charcoal as was used by Davy. It is true that this charcoal gave trouble from its too rapid consumption, among other causes.

227 X Q. Will you consult Ure's Dictionary and see if I have given in cross-question 190 the correct definition of "charcoal" as given by Ure?

A. That is the definition given in the supplement to Ure's Dictionary, published in New York, in 1866.

1937 228 X Q. Is this definition found in the same volume from which you quoted in answer to question 5?

A. It is.

229 X Q. Do not the carbons of Davy, Violette, Sidot, and Gaudoin come within the terms of Dr. Ure's definition of charcoal?

A. The carbons used by Davy unquestionably do. Violette's process produces charcoal by the action of superheated steam upon woody matters. I have never heard the term "ignition" applied to the application of steam to a substance. I see nothing in Violette's paper to indicate that the woody matters used by him were kept out of contact with air, that is, that the steam employed is kept perfectly free from air. In strictness, therefore, it seems to me that the carbon of Violette does not conform to the definition cited. In Sidot's process, the carbon is produced by placing wood in a porcelain tube through which the vapor of bisulphide of carbon is passed, and the tube is then carried to a red heat. If we understand this simple, intense heating to be "ignition," in the sense of the definition, then there is a sense in which carbon obtained by Sidot's process may be included within the definition. If by ignition is meant ordinary combustion by oxidation of the contained hydrogen and hydrocarbons, the process is not included. Ure's definition further says that the ignition is to be performed "out of contact with air." Now, if by "out of contact with air" he means that it may be in contact with any other substance whatever, provided air is excluded, the wood in Sidot's process might be spoken of as carbonized "out of contact with air," since it is surrounded by an atmosphere of the vapor of carbon bisulphide. I do not think, however, that this is the sense in which the definition was intended to be taken, because, "the fixed residuum of vegetables exposed to ignition out of contact with air," but in contact with certain other substances, for example with oxygen, would not be charcoal. In the case suggested, it would be wood ashes. Whether or not 1938 my reasoning is correct, this thing is certain; in his paper, Sidot does not once speak of this substance as charcoal, but always speaks of it as carbon—a "new carbon" he calls it. In another place he speaks of it in the original as "*charbon de bois transformé en coke*;" which I understand to mean wood carbon transformed into coke.

I assume that the Gaudoin carbons to which you refer are those described in the first certificate of addition taken out April 7, 1877. These carbons are formed from wood which is impregnated with various substances, either animal, mineral or vegetable (which substances contain carbon). They may also be subjected to the action of various chemicals. In a sense, I suppose, these might be included within the definition of charcoal cited, but it does not seem to me that the definition properly applies to them. It seems to me that what the definition is really intended to imply is, that charcoal is a substance which is nothing other than "the fixed residuum of vegetables exposed to ignition out of contact with air," and that a material which, beside receiving this treatment, has also undergone special chemical treatment, and an integral portion of which might be the residuum of mineral or perhaps of animal matter rather than of vegetable matter—still less than of vegetables—would not fairly be included within the definition cited.

Gaudoin in the document under consideration does not once speak of his carbon even as "a charcoal," still less as "charcoal."

It does not seem to me that the carbons of Violette, Sidot and Gaudoin properly come within the terms of the definition cited.

230 X Q. At a temperature of 1500° Centigrade do you not think that wood would be charred so as to reduce it to charcoal, even if surrounded by an atmosphere of steam raised to this high degree of heat?

A. I do not doubt that wood does become charred under the circumstances mentioned as Violette states. If you apply the 1939 term "charcoal" to any wood which is charred or carbonized, then it is true that this wood would be reduced to charcoal under such circumstances.

231 X Q. Would wood subjected to the high temperature evidently used by Sidot be charred so as to produce the fixed carbon residuum, even if surrounded by an atmosphere of carbon bisulphide?

A. It would, according to Sidot's statements, the correctness of which I do not doubt.

232 X Q. Have you any doubt, considering the results obtained by Violette and Sidot, as to the fact that the carbonization in each instance was carried on by charring the wood, while air was excluded?

A. There appears to be no question as to the process of Sidot. I do not feel positive in regard to the process of Violette.

233 X Q. Where in the patent in suit do you find any description of the particular form meant by the expression "arch-shaped"?

A. There are pictures of the arch-shaped form in the drawings, and the specification says, "the accompanying drawings show all our improvements embodied in an apparatus or lamp * * * being the form in which we have practically used it," and a specific reference follows. The patentees also say in the specification, "We have also used conductors of varying contours, that is, with rectangular bends instead of curvilinear ones, but we prefer the arch shape." Also in claim 1, the conductor is referred to as having "an arch or horseshoe shape," and in claim 4 it is spoken of as "having the form of an arch or loop."

234 X Q. Then aside from the illustration by the drawings, there is no description of what is meant by "arch shape"?

A. I think there is; the arch-shaped conductor is described by implication in the specification as a conductor with curvilinear bends. It is also described in claim 1 as having a "horseshoe shape." It is also described in claim 4 as having the form of a "loop."

1940 235 X Q. Where in the patent is there any description or illustration of the horseshoe shape and the loop shape?

A. I do not find any specific description or illustration of the horseshoe or loop as distinct from arch-shaped carbons in general. Nor do I see that the meaning of these terms would be made any plainer by further description or illustration.

236 X Q. Are you aware of the fact that arches are common with angular instead of curvilinear bends, and that one form of arch is similar to an inverted V?

A. I do not understand what is meant by an angular bend, and have not in mind the kind of arch meant by this expression. The inverted-V construction referred to, is not what is ordinarily understood by the term "arch-shaped," though I think that I remember having seen pictures of such a structure in architectural books, as one which was used considerably before the Norman conquest in England, and I believe that it was spoken of as a V-shaped arch, or something of that kind. Certainly the term "arch" is applied to such a construction by an extension of its original meaning.

237 X Q. Would the ordinary Gothic arch be within what is ordinarily understood by the term "arch-shaped"?

A. This construction is undoubtedly arch-shaped. It is a pointed arch.

238 X Q. Have you ever heard that a helix, or coil, is known as an arch?

A. It is not customary to designate it thus, and it is not a term which one would naturally apply to it, since the curve makes a complete turn of at least 360 degrees, instead of being limited to a less number of degrees. But we call the roof of a long tunnel "arch-shaped," and we call the tunnel itself "arch-shaped," even though its section extends over 180 degrees, and as is often the case, has the shape of a horseshoe. Or, looking at the matter from a geometrical point of view, if we have an arc of 180 degrees, the curve is unquestionably arch-shaped. If we extend this curve, until
1941 it is, say 270 degrees, it is still unquestionably arch-shaped,

and arches of such character are used in architecture. If we continue the curve through 360 degrees, I do not see that it ceases to be arch-shaped. But with either the helix or the spiral coil, the line is prolonged, so that instead of being 360 degrees, it is twice or thrice, or any number of times 360 degrees. And it seems to me that we must still consider it as arch-shaped; and, using the term in a technical sense, it might be spoken of as an arch, certainly without any greater extension of its meaning than when we apply the term "arch" to an inverted V.

239 X Q. Do you think the term "arch" is properly applicable to a form like the capital letter M with the angles rounded?

A. Such a figure, it seems to me, is properly included within the term "arch-shaped," and under certain circumstances might very properly be spoken of as an "arch." It is not, of course, for obvious reasons, a form used in architecture.

(Adjourned till 9 a. m., April 12, 1889.)

APRIL 12, 9.30 a. m.

240 X Q. Can you conceive of any form having the angles rounded that would not, in your opinion, be properly described as arc-shaped?

A. I do not think of any such form which might not without impropriety be thus described, though there are various such shapes which are not ordinarily designated as arches. Of course, this answer is not to be taken as having reference to the Sawyer and Man patent in suit, or to the shape of the carbon set forth in that patent?

1942 241 X Q. Do you think "arch-shaped" as used in the patent in suit is properly descriptive of every conceivable form having rounded angles.

A. I have not considered the range of applicability of this term as used in the Sawyer and Man patent.

242 X Q. Kindly do so, and answer my last question?

A. A question of this sort cannot of course be finally or properly answered without more study and thought than can be given in the brief time within which I suppose an answer is expected. I should suppose that a form which gave all the advantages of the horseshoe shape, and which possessed rounded angles would properly be described by that term as used in the patent.

243 X Q. Do you intend by your answer to question 17, to have it understood that in your opinion V-shaped conductors and conductors with rectangular bends are not conductors "of an arch or horseshoe shape," as stated in claim 1 of the patent in suit, or "having the form of an arch or loop," as stated in claim 4 of the patent in suit?

A. I meant by that answer to state that I did not understand Sawyer and Man in their patent to say that the V-shaped burner and burners with rectangular bends are full and complete equivalents for burners of the horseshoe form, since they regard this last form as having an advantage over the others.

244 X Q. Do you understand the words descriptive of the form of

the conductor in claims 1 and 4, as excluding V-shaped conductors and conductors with rectangular bends?

A. I have not considered the matter of the extreme limits of form which might properly be construed by authority competent to do it as coming within the scope of these claims. My individual judgement would be that if the forms to which you refer possessed all the advantages of the horseshoe form, they ought properly to be included within the scope of those claims.

245 X Q. Would a V-shaped carbon possess such advantages, or be the equivalent of the arc or horseshoe form? 1943

A. I should not think that it would possess all the advantages of the horseshoe shape.

246 X Q. If the V-shaped carbon had its angle rounded, would it be the equivalent of the arch-shaped conductor called for by claims 1 and 4?

A. It might be. One could tell better if he were referred to a particular lamp whose behavior he could study when in actual operation.

247 X Q. Referring to your answer to question 18, in what connection in the patent of Konn, No. 3809 of 1872, do you find the specific description of having the carbon "made thinner in the middle"?

A. In the patent referred to the patentee first describes the straight carbon which he uses in his lamp, and describes it as "composed of graphite or a composition of the usual description compressed or formed with a reduced diameter at or near its central part," referring to figure 7 in illustration. He afterwards goes on to describe a V-shaped carbon in which he says that the electric current passes "down one side and up the other side of the V, the light being formed at the angle at the bottom."

248 X Q. It is a fact, is it not, that specific description of reducing the diameter of the carbon at or near its central part, is given in connection with the straight carbon, and the straight carbon is shown in the drawing as having such construction?

A. The statement in words that the conductor is "formed with a reduced diameter at its central part" is naturally made with reference to the straight carbon, which is the first one described. The statement regarding the V-shaped carbon, that with it the light is "formed at the angle at the bottom" is in fact equally specific to one skilled in the art.

249 X Q. The straight carbons are clearly shown in the drawings of the Konn patent as having a reduced centre, are they not?

1944 A. The patentee gives very full and minute descriptions illustrated with numerous drawings—seven—of his lamp with straight carbons, and the patentee states that the straight stem is the form which he considers preferable. Those of his figures which are of such a nature as to indicate this peculiarity show it very plainly. The lamp with the V-shaped carbon which the inventor considers an inferior form is described very briefly and illustrated by only two figures neither of which is of such a nature that it needs to show or indeed ought to show this compression or reduction in size of the carbon, which naturally enough is not apparent in the figures.

250 X Q. Then it is a fact that the straight carbon is shown with reduced centre, and the V-shaped carbon is not so shown?—Kindly answer categorically, since I desire to make progress with the examination, and do not ask you for the reasons why such is the fact.

A. I am very sorry if I have needlessly consumed time in my answers, but I was unable to see how I could make them more brief, without danger of being misunderstood as to my views. I had supposed, however, that my previous answer was perfectly clear, and gave all of the information which your question asked for. I am glad, however, to answer categorically that in the Konn patent there are figures which illustrate the reduced section of the straight carbon, and that there is no figure which illustrates the reduced section of the V-shaped carbon.

251 X Q. What are the forms of incandescent lamps in which a straight carbon was employed, that you refer to in answer 14 as having seen?

A. Some of the earlier Bernstein lamps were those which I had in mind.

252 X Q. Were they lamps having tenuous, flexible carbons, like that of the Exhibit Defendant's Lamp put in evidence by the complainant?

1945 A. The lamp was for series lighting, and had a tubular carbon, in some respects like that shown in Complainant's Exhibit Bernstein Lamp, except that the carbon was straight, and, as nearly as I recollect, larger in diameter.

253 X Q. It was not a carbon of such tenuity as to have the high degree of flexibility that is possessed by the carbon in Complainant's Exhibit Defendant's Lamp?

A. It was a stout and comparatively short carbon and not tenuous like the carbon in defendant's lamp, and undoubtedly much less flexible.

254 X Q. Would not the filament of Complainant's Exhibit Defendant's Lamp readily bend and alter its shape as it expanded under increased temperature, even if made straight?

A. I have never seen such a lamp with the straight filament, and do not feel it at all certain as to what extent it could do this. Of course a tenuous filament would yield far more readily than a stiff one.

255 X Q. Have you any doubt that a filament of the extreme tenuity used in Complainant's Exhibit Defendant's Lamp would readily bend laterally without breaking under changes of temperature, even if in a straight form?

A. A filament as long as the one referred to would be, if straight, would undoubtedly bend with considerable readiness.

Adjourned to 2.10.

Adjourned to New York at office of Duncan, Curtis & Page, at 11 a. m., April 13, 1889.

1946 HOTEL BRUNSWICK, BOSTON, *April* 18, 1889.

Met pursuant to arrangement of counsel, and the cross-examination of Prof. CROSS herein by Mr. Dyer, was continued as follows, before William T. Farnham, special examiner:

Present: Edmund Wetmore, Esq., for complainant and R. N. Dyer, Esq., and H. D. Donnelly, Esq., for defendant.

256 X Q. The arch or loop form has as one advantage, has it not, that of permitting of an increased length of the conductor?

A. Of course with an arch form the length of conductor which can be contained within a globe of given size will be greater than if the conductor was straight.

257 X Q. This is also an advantage of a V-shaped conductor, is it not?

A. It is.

258 X Q. Could a straight carbon of the total length of that employed in Complainant's Exhibit Defendant's Lamp be placed within the globe of that lamp?

A. It could not.

259 X Q. In answer to interrogatory 23, you have stated that the Bernstein lamp employs a filament of woven silk. Do you consider silk a vegetable fibrous material?

A. It is a fibrous material but not vegetable in its nature.

260 X Q. Is it not a fact that the hydrocarbon treatment which you have referred to as described in the Sawyer-Man patent 211,262 may be carried to such an extent that the deposited carbon itself may be stripped from the core and used as the conductor?

A. I do not doubt that the carbon may be deposited to such a thickness that it will have a sufficient body to form of itself a conductor for an incandescent lamp. In saying this I do not of course express an opinion as to the practical value of a filament thus made.

261 X Q. What is the character of the carbon obtained by the hydrocarbon treatment?

1947 A. I have never seen any separated from the backing on which it is deposited. Apparently, however, it is firm and even in its texture, giving a lustre to the filament on which it is deposited.

262 X Q. Is it dense?

A. It is if it is deposited with sufficient thickness.

263 X Q. Does the deposited carbon of itself have a high or a low specific resistence?

A. I have never seen any measurement relating to this. I should suppose that if it were deposited in a thick layer such as we have been speaking of, its specific resistance would be lower than that of ordinary fibrous carbon.

264 X Q. Should you think it more or less hard and dense than gas-retort carbon?

A. I have never compared the two and cannot say.

265 X Q. Is the deposited carbon *per se* vegetable or fibrous or textile?

A. It is neither.

266 X Q. Would an incandescent conductor made from the deposited carbon have the properties which you consider requisite for the conductor of an incandescent lamp?

A. I have no experimental knowledge as to the action of such a conductor.

267 X Q. Does the fact that you have no experimental knowledge on this matter deter you from expressing an opinion upon it?

A. I always dislike to speculate unless I feel certain of my premises.

268 X Q. What experimental knowledge have you with regard to the use of gas-retort carbon for incandescent lighting?

A. Little, so far as my own individual experiments are concerned, but a good deal as shown by the experiments of others.

269 X Q. What experiments of others do you refer to?

1948 A. I had in mind the descriptions which are given in various patents and publications, such, for example, as the various exhibits in the present suit.

270 X Q. Have you any actual experimental knowledge yourself as to the use of gas carbon for incandescent electric lighting?

A. I do not recollect that I have ever tried to render gas carbon proper, incandescent by the passage of an electric current.

271 X Q. Have you any experimental knowledge as to the action of such wood carbon as is described in the Gaudoin French patent when employed for incandescent lighting?

A. I was not aware that these carbons had been used for incandescent lighting, and, if such is the case, I have no knowledge of the fact.

272 X Q. You, then, have no experimental knowledge as to the action of such a conductor when employed for the conductor of an incandescent lamp?

A. If you ask me whether I have ever tried or seen tried, the Gaudoin carbons for this purpose, my answer is that I have not. What I have said in my direct examination with regard to these carbons has been derived from the statements relating to them in the various publications in evidence, and from what seemed to me the immediate consequences of such statements.

273 X Q. But, as I understand you, not from actual experimental knowledge?

A. That is the case.

274 X Q. What is the difference between the character of the carbon, as a carbon, deposited by the hydrocarbon treatment, and the character of the carbon which Gaudoin adds to his wood carbon by impregnating the wooden objects before carbonization with the materials he mentions?

A. The expression in the original Gaudoin certificate of addition for April 7, 1877, is "carbone d'hydrogené." This is a technical chemical term of whose meaning I am not positive, but which
I suppose is a compound of carbon and hydrogen, of
1949 which the various substances mentioned are examples.
The nature of the deposited carbon will undoubtedly

differ to a greater or less extent with the substance from which it is deposited, with the rapidity at which deposition takes place, with the temperature at which deposition takes place and with the freedom of immediate complete decomposition and with the nature of the products of decomposition. With such a large variety of influencing circumstances, you will readily appreciate the difficulty of giving a brief and positive answer to your question. I should expect, however, that there would be very decided differences between the results of the hydrocarbon treatment and those of Gaudoin's process, not only in the structure of the conductor as a whole, but also in the peculiar qualities of the deposited carbon. Certainly the carbon that is obtained by the decomposition of sugar is quite different from that which is obtained by deposition from hydrocarbon vapor upon the filament of an incandescent lamp.

275 X Q. It is true, is it not, that in each case, that is, in the case of the hydrocarbon process described in Sawyer-Man patent No. 211,262 and in the case of the process of treatment of the wood carbon described in Gaudoin's French patent, the carbon deposited is one obtained by the decomposition by heat of a hydrocarbon?

A. Sawyer and Man, in their specification, speak of using a hydrocarbon liquid, which, properly speaking, is a liquid containing only hydrogen and carbon. I am not certain, however, that all of the substances which they mention are free from oxygen. In their claim they speak of the use of a carbon liquid, which I suppose would not exclude a liquid of which oxygen was a constituent part, provided that this was practically operative. I should suppose, however, that the presence of oxygen in the liquid used would be objectionable. Gaudoin, on the other hand, in his patent, though referring to hydrocarbons, also refers equally to various other substances which contain oxygen as well. In my answer to cross-interrogatory 294 I omitted to notice that certain 1950 of the substances mentioned by Gaudoin are not, properly speaking, hydrocarbons, since they contain oxygen. I will assume, however, that your question limits itself to the case of the Gaudoin carbon, when a hydrocarbon is used. In that case it is true that with the Gaudoin carbon, as with the carbon treated by Sawyer and Man's process, the deposited carbon is obtained by the decomposition of a hydrocarbon by heat. It does not, of course, follow from this fact that the properties of the deposited carbon in the two cases are identical.

Last sentence objected to as irresponsive and volunteered.

276 X Q. And in each case the deposited carbon is neither vegetable, fibrous nor textile?

A. It is certainly neither fibrous nor textile, nor could it even be what is understood by vegetable carbon. Of course, if a hydrocarbon of vegetable origin exists and were used, the deposited carbon would, in one sense, have a vegetable origin, and in this sense one might possibly apply to it the term vegetable carbon. I do not think, however, that there would be any justification for this use of language.

277 X Q. Would the Gaudoin deposited carbon be more hard, dense or compact than that deposited by the Sawyer-Man process?

A. I should think not. I should suppose it would be less homogeneous and comparatively uneven in structure.

278 X Q. Would it have a higher or lower specific resistance?

A. I know of no data which would enable one to be certain as to this matter. I should think it would depend very much upon the rapidity with which the carbon was deposited in the Sawyer-Man process, and upon the precise mode in which carbonization took place
with the Gaudoin carbon. I suppose that it would be easy
1951 to give to the deposited carbon by the Sawyer and Man process a specific resistance either lower or higher than that obtained with the Gaudoin process. In discussing this matter of specific resistance, however, it seems to me that there is a large element of ambiguity which enters your questions, and which necessarily, therefore, enters my replies thereto. The specific resistance of a substance is the resistance of a cube of that substance having unit surface and a thickness unity. Now, in the Gaudoin carbon I do not see how one can so isolate the deposited carbon from the carbon upon which it is deposited as to determine its specific resistance.

Adjourned till Friday, the 19th inst., at 9 a. m.

FRIDAY, *April* 19, 1889.

Met pursuant to adjournment.

Present: Counsel as before and the examination of Prof. CROSS was continued as follows:

279 X Q. Is there any radical difference in the specific resistance of the carbon deposited in each of the two cases assumed in the last few questions?

Before answering this question, witness says:

I should like to say with regard to my answer to cross-question 275, that since the last session I have consulted with several chemists as to the term "carbone d'hydrogené." I am informed that this is not an expression which would be used by one conversant with chemistry, but it undoubtedly means a hydrocarbon as I had supposed. I find also in relation to the substances mentioned by Sawyer and Man in their hydrocarbon patent under consideration, that turpentine is a true hydrocarbon, but that beeswax contains oxygen.

Witness continues in answer to question 279:

A. I cannot say whether there is or is not; that is, if
1952 by specific resistance you mean the specific resistance of a
very small particle of the carbon. If by specific resistance you mean the resistance of the substance as it actually lies within and upon the treated carbon, I should think that there would be a difference, and not merely a difference between the Sawyer and Man deposited carbon and the deposited carbon in the Gaudoin process, but also a difference with the Gaudoin carbon according to the substances used and the precise preparation. This is what would

naturally be expected from the great difference in the two processes whereby what we have called "deposited carbon" is obtained.

280 X Q. Then in each case, that is the Gaudoin French patent and the Sawyer and Man patent No. 211,262, hydrocarbons, properly speaking, are mentioned as well as hydrocarbon compounds containing oxygen?

A. Taken literally, this is true, but I think there is quite a distinct difference between them. Sawyer and Man propose distinctly to make use of a hydrocarbon, and simply mention the substance beeswax which contains oxygen. Gaudoin, on the other hand, distinctly proposes to use any substance containing carbon, whether it is really a hydrocarbon or not, and merely enumerates "any hydrocarbon" among a large number of substances. That is, there is nothing to indicate that Gaudoin considered a hydrocarbon as in any way preferable to any one of the other substances which he mentions.

281 X Q. Aside from what you consider the order of importance in which the two classes of materials are named in the two patents, it is a fact, is it not, that they both mentioned hydrocarbon, properly speaking, and hydrocarbon which contains oxygen?

A. That is the case.

282 X Q. In your answer to question 33 you state:

"It seems to me that the use of the glass plate or stopper is entirely novel with Messrs. Sawyer and Man."

1953 In the assumption upon which this statement is based do you omit the general knowledge as to the use of such a plate or stopper in pneumatic apparatus?

A. I was perfectly familiar with the use of such a device in pneumatic apparatus. I did not consider it as material in its bearing upon the use of such a plate or stopper in an incandescent lamp.

283 X Q In answer to question 34, you state:

"It is quite true that any lamp possessing such a low resistance" (as that of the patent in suit) "would not be suited for use over considerable districts in a parallel system of illumination; but on the other hand it is in this respect exactly the kind of lamp that is wanted for use in a series system, and in fact lamps of low resistance and adapted to run in series are now customarily made and employed."

How long have such lamps been customarily made and employed?

A. I do not recall when I first knew of series incandescent lamps being used commercially and to any extent, but it is certainly a good many years. I think that such lamps have been constructed from the very beginning of the art of incandescent lighting. There are, of course, obvious reasons why in the earliest days of incandescent lighting general attention was turned from the use of such incandescent lamps in series to the use of incandescent lamps of higher resistence and in parallel.

284 X Q. Is it not a fact that incandescent lamps of low resistance

run in series have only been customarily made and employed within the last three or four years?

A. I am confident that I am correct in my recollection that incandescent lamps have been run in series for a much longer time than you mention. The resistances of these lamps were greater or less accordingly to the circumstances under which they were to be operated.

1954 285 X Q. Were they so "customarily made and employed" before January 9, 1880?

A. Not so far as I know. The conditions of electric lighting at that time do not seem to have been such as to call for them. The date that you mention was a very early one in the history of the art of commercial electric lighting.

286 X Q. At that date it is a fact, is it not, the art of commercial incandescent electric lighting had developed only in the direction of high resistance lamps adapted to be run in parallel?

A. The use of incandescent lamps in parallel was naturally the first to develop, and at the date you mention, so far as I recollect, the parallel system of distribution was the one ordinarily employed. The lamps used had various resistances, running perhaps from twenty ohms upwards. I think, however, that even at the early date you mention lamps of low resistance were made and used, although this may possibly not have been the case until a year or two later. I should wish to refresh my memory by contemporaneous data before being positive.

287 X Q. Complainant's Exhibit Defendant's Lamp is a high-resistance lamp adapted for use in parallel, is it not?

A. It is, unquestionably.

288 X Q. If no better styles of incandescent lamp existed, how poor a lamp would, in your opinion, have a distinct commercial value?

A. I do not know of any scale of excellence whereby I could rank the different incandescent lamps of history or imagination, or even if I had such a scale where its zero point would lie, and for this reason I am unable to give a satisfactory answer to the question.

289 X Q. Do you think an incandescent lamp having a life of one hour would have a distinct commercial value if no better style of incandescent lamp existed?

A. There would not be a large demand for such lamps 1955 commercially, but it is possible that such a lamp might have its use in special cases. Of course, such a lamp could not compete for general purposes with other illuminants.

290 X Q. But for soms special purposes it might have a distinct commercial value, as I understand you?

A. It is quite possible that it might.

291 X Q. How were the facts known which you referred to in answer to question 40?

A. I suppose that they had become known as all such facts become known, from observation and study.

292 X Q. Where are they disclosed; by what specific publications?

A. The general matters of structure will, I think, be found in the various text books of botany of the date. The methods of carbonization are described in various of the exhibits in evidence in this case.

293 X Q. Where was the knowledge published "that certain woods were fitted and certain others unfitted to produce a carbon of even and dense structure"?

A. In various places. Thus, in connection with the early history of the electric arc it became known that there was a marked difference between charcoal made from different kinds of wood. So also in the manufacture of charcoal for gunpowder and like purposes there had been much research.

294 X Q. Did the knowledge extend to the evenness and density of the resulting carbon with reference to its electrical qualities, resistance and conductivity?

A. There was considerable knowledge regarding this matter, though, of course, those especial peculiarities which would indicate that one particular wood was better than another particular wood had not been thoroughly studied with regard to the use of such a carbon in an incandescent light.

295 X Q. Where was the knowledge published showing the desirability of avoiding a cutting across the fibre and of selecting a wood possessing fibres which were parallel?

1956 A. I did not have in mind any specific publications when I made this statement. It seemed to me that the exercise of ordinary good judgment would indicate this.

Adjourned till 2 o'clock.

Resumed after adjournment.

296 X Q. You are aware of the fact, are you not, that the patent of Mr. Edison, No. 248,417, referred to by you in answer 39, describes a method of cutting the carbon from wood in which the carbon loop is cut across the fibres of the wood for at least a portion of its length?

A. That is my understanding of the description.

297 X Q. In the lamp structure of the patent in suit the joint between the plate *y* and the flange *x* of the globe, the joint between the tubular bolts and the plate *y*, and the joint between the tubular bolts and the covering caps are all points at which there would be liability to leakage?

A. That is true, so that especial care must be taken to prevent such leakage.

298 X Q. In answer to question 36 you have stated in substance that there are advantages in using the arch shape with carbon which are not possessed by the use of that form with metal conductors. Is it your opinion that those advantages are present with carbon generally or only with some special character of carbon?

A. I should think that there would be an advantage in using the arch-shaped conductor with any kind of carbon, since this form allows the material to expand or contract without producing the excessive strain which would occur if it were straight. It is very possible, however, that with a brittle carbon, such as gas carbon, even the use of the horseshoe form might not be sufficient to preserve it from rupture.

1957 299 X Q. Then, as I understand you, the arch form in your opinion is even more necessary with a conductor of brittle carbon, such as gas-retort carbon, than with a conductor of fibrous carbon?

A. I had not intended to be understood thus, and do not feel at all ready to make a broad general statement of this kind.

300 X Q. The advantages of the arch-shape would at least be equally important with the gas or hard carbon conductor?

A. It would seem so at first sight, assuming that the gas carbon is more brittle in all cases than the fibrous carbon. I do not feel at all positive, however, that the advantage of the shape with any and every kind of fibrous carbon is necessarily greater than with gas carbon, because there are various circumstances that come into play regarding which I have no data in mind which settle the matter beyond question.

301 X Q. Do you know of any paper which has a thickness sufficient after the shrinkage produced by carbonization to make a carbon of the thickness shown in figure 4 of the patent in suit?

A. I cannot say positively, but I should think that heavy paper board, mill-board I think it is called, or something of that kind would give this result.

302 X Q. How thick is the mill-board you refer to, and what is it used for?

A. I think I have seen it a tenth of an inch thick or more. I don't know exactly, but my impression is, that it is frequently used for the covers of books in binding.

303 X Q. Is it not a fact that Complainant's Exhibit Defendant's Lamp has a hair-like filament such as you had in mind in answering questions 53 and 54?

A. It is.

304 X Q. You have stated, in answer 62, that the word "arc," in the fourth claim of the original specification of the patent in suit, "means simply strip." Is not that an unusual meaning of the word?

1958 A. It is.

305 X Q. What is its usual meaning?

A. A portion of a curve, or a curved strip.

306 X Q. Is it not derived from the same root as the word arch, viz: *arcus*, a bow?

A. It is.

307 X Q. Is plumbago a vegetable or fibrous or textile carbon?

A. It is not, it is a mineral.

308 X Q. Has it the qualities as a carbon which make carbon from fibrous vegetable material peculiarly adapted for incandescent lighting?

A. It has not.

309 X Q. Do you know of any commercially used incandescent

lamp made with joints in its chamber such as those shown and described in the patent in suit?

A. I do not.

310 X Q. Do you agree with the following statements made by Prof. Edwin J. Houston, who testified as an expert for complainant in the suit brought by the same complainant upon the same patent as involved in this controversy against the Edison Electric Light Co. and Thomas A. Edison, defendants, and now pending in the southern district of New York?

Answer to cross-Q. 69:

"I think that in the manufacture of incandescent lamps the general custom in the art at the present time is to obtain the joint by the fusion of the glass, and not by the use of a current."

And the last sentence of answer to cross-Q. 73:

"As far as I am aware the incandescent lamps in general use are in accordance with the method in which the joints are fused together and not cemented."

Objected to as immaterial.

A. I do.

1959 311 X Q. Do you agree with the following opinion expressed by Prof. Houston in the same case in answer to cross-question 123 in comparing the Edison lamp with that of the Sawyer-Man patent 205,144?

"Or to summarize, I acknowledge that the following differences do exist in the two lamps in question, and I have endeavored to point out to counsel in previous answers that I am aware of the existence of such facts, namely: that we have in the case of the Edison lamp as contrasted with that of the lamp shown in Fig. 1 of 205,144 a high vacuum as contrasted with a low vacuum of an inert gas; that we have in the one a high resistance as against a low resistance in the other; that we have a lamp chamber made of two separate pieces of glass subsequently fused together, as against a lamp chamber made of two pieces of glass subsequently fitted together; that we have in the case of 205,144, which was presumably a lamp of high candle power, more heat generated than in the case of the Edison lamp exhibit; and that in 205,144 means are provided to prevent this heat from injuring the atmosphere left in the lamp chamber."

Same objection.

A. The differences between the two lamps referred to by Prof. Houston undoubtedly exist.

312 X Q. Do you agree with the opinion expressed by Prof. Houston as shown by cross-Q. 292 and answer which are as follows:

"292 X Q. I understand you to have testified that you regard within the meaning of the specification the word 'arc' as intended to cover these various shapes including the V-shaper burner. What I would like to know is whether you consider the word 'arc' as an

accurate term with which to describe a V-shaped burner or
1960 the burner shown in Defendant's Exhibit Arc with Curvilinear Bends, December 28, 1886"?

"A. I am of the opinion that the V-shaped burner would equally come under the general meaning of the word arc as would the three drawings which I have made and which I mark respectively 'arc with rectangular bends,' 'arc with curvilinear bends' and 'arch conductor' of December 28, 1886, since a burner terminated in parallel wires and joined at their upper ends by a 'V'-shaped extension thereof would also, like the drawings referred to, pass through an angular divergence of 180 degrees, as will be seen by referring to the drawing which I now produce"—

Referring to the three exhibits sketches which are referred to in the question and answer which are as follows:

Defendant's Exhibit Arc with Cuvilinear Bends, Dec. 28, 1886.
Defendant's Exhibit Arch Conductor, Dec. 28, 1886.
Defendant's Exhibit V-shaped Burner, Dec. 28, 1886.

Same objection.

A. I do not think I should have answered the question precisely as Prof. Houston answered it.

313 X Q. Do you agree with the opinion expressed by Prof. Houston in the same case as shown by cross-question 329 and answer, which are as follows:

"329 X Q. You have stated in your examination that the inventors incidentally considered the arch form as new with them. Were not the inventors mistaken in that opinion?

A. If it be true that the inventors thought that the arch form had not heretofore been employed when made of carbon, then
1961 they were wrong, since the patent 3809 of 1872 to Konn anticipated such general form."

Same objection.

A. I do not think that the V-shaped conductor of Konn is the equivalent of the arch-shaped carbon of Sawyer and Man.

314 X Q. You have stated, in substance, in answer to question 44, that the process of making a practical conductor for an incandescent lamp was well known prior to the application for the patent in suit. How widely was such process known?

A. I do not think that your question fairly represents my answer to interrogatory 44. In that answer, I endeavored to show what would have been done in the light of existing knowledge by one wishing to follow out the directions of the Sawyer and Man patent, and construct an incandescent lamp. I certainly did not state therein that "the process of making a practical conductor for an incandescent lamp was well known prior to the application for the patent in suit," but I did endeavor to show, and I think with success, that the state of knowledge was such that with the directions given by Sawyer and Man an incandescent lamp could be constructed by one skilled in the art, and without the exercise of invention.

315 X Q. In justification of your position that no especial description as to the carbonization was required in the patent in suit in order to enable one skilled in the art to produce a practical carbon conductor for incandescent lamps, you state, in answer 44, that—

"The subject of carbonization had been carefully studied, and the methods whereby thorough, uniform and complete carbonization could be secured were perfectly well known to those skilled in the art."

To what art did you refer?

1962 A. The art of carbonizing woods and other fibre. Illustrations of the state of this art are found in the papers of Violette and Sidot which are exhibits in the present suit.

316 X Q. Was the subject also well understood by scientific men and electricians such as yourself?

A. It was well understood by scientific men. I had not considered the subject of carbonization myself at the date of the application for the patent, and therefore was not particularly well informed regarding it. I do not think, however, that I should have found difficulty in putting the invention under consideration into practice.

317 X Q. That is, you think that you were sufficiently well acquainted with the art as to carbonization to enable you to do it or at least to direct workmen how to do it?

A. Of course if I had proposed to make such a lamp which involved the carbonization of paper or other similar material, I should have made inquiry of those possessing a technical knowledge of carbonization as to the best process to follow, just as in following out the directions of any patent to-day, I should inquire as to the technical details of any portion of the process outside of my immediate specialty. If, for example, I wish to make an Edison lamp to-day, following out the directions in any one of Mr. Edison's patents, I should make inquiry as to the best method of connecting the filament to the leading wires, the best form of air pump to use in practice, etc.

Adjourned to office of Messrs. Duncan, Curtis & Page, New York city, to meet to-morrow (Saturday) morning at 11 o'clock.

NEW YORK, *April* 20, 1889.

Met pursuant to adjournment.

Present: Mr. Curtis and Mr. Wetmore for complainant and Mr. Dyer and Mr. Donnelly for defendant, and the examination of Prof. CROSS was continued as follows:

318 X Q. Outside of details of manipulation, did you yourself at the date of the application for the patent in suit understand the perfection to which the art of carbonization had been carried? 1963

A. It is difficult for me to say specifically and in detail what I personally did or did not know regarding carbonization at the date mentioned in the question, since I had then had no occasion to consider any question involving the practice of this art. I am certain, however, that I was well aware that the art of carbonization had been carried in certain directions to a state of great perfection.

319 X Q. Were you better acquainted with the matter in 1881?

A. I do not doubt that I was.

320 X Q. Are you better acquainted with it now than you were in 1881?

A. I am.

321 X Q. Were you not at one time retained as an expert by the Edison Electric Light Co.?

A. I was; I accepted a retainer from them for a single year.

322 X Q. What time did the retainer cover?

A. I don't remember the date, but it must have been about 1881.

323 X Q. During the time of your employment by that company did you make an examination of patents and publications relating to electric lighting and give an opinion to the company upon the matters to which the examination was directed?

A. I did make an examination of certain patents and publications to which they directed my attention. I do not think that I made any extended research outside of these, although I doubtless made reference to such books as I was especially familiar with relating to the subject in question.

324 X Q. Are the two letters I hand you, dated June 23, 1881, and June 24, 1881, and addressed to F. H. Betts, Esq., the report which you made as the result of the examination referred to in your last answer?

1964 A. There is no doubt that such is the case. I recollect them perfectly.

325 X Q. What relation did Mr. Betts hold to the Edison Electric Light Co. at that time, if you know?

A. I understood that Mr. Betts was of counsel for the Edison Company.

The letters referred to are offered in evidence by counsel for defendant, and the same are marked "Defendant's Exhibit Prof. Cross' Report of 1881, April 20, 1889 (No. 1 and No. 2).

Said exhibits objected to as immaterial.

Redirect examination by Mr. WETMORE:

326 R. D. Q. I call your attention again to the English patent of Shepard, No. 13302 of 1850, and particularly to section VI of the specification, page 9, and figure 10 therein referred to. Please examine said drawing and description, and state how far down the little charcoal cylinder the copper tube comes, and what you now find to be the effect in the operation of the lamp of said copper tube?

A. On reading this patent again and more carefully, I find that there is a misapprehension of the statement referred to in the 124th cross-question, which misapprehension also exists in my answer to that question. This misunderstanding, on my part at least, came from a grammatical ambiguity in a statement regarding the cone D and the cylinder E. The statement is that—

"The other polar wire comes out under the lower end of this tube at about one centimetre (three-eighths of an inch) distance from its extremity, and terminates in a little cone, D, of prepared charcoal or coke, and against the top of which the little charcoal cylinder E rests, which, when the current is established, becomes incandescent, and remains in this state a very long time, because the small
1965 portions which are consumed are continually replaced by a portion of the cylinder which the metal presser forces onto the top of the cone."

At first sight on reading this it would seem as though the word "which" after the expression "against the top of which the little charcoal cylinder E rests" refers to the charcoal cylinder E. This was the assumption apparently made in cross-question 124 and which I made in my answer thereto. This assumption, however, is erroneous as immediately appears from an examination of Fig. 10 of the drawings which shows the device in question. The copper tube C is shown as descending sufficiently far to entirely cover the carbon cylinder, from which therefore, except at the surface of contact of the cone with it, no light could be radiated, and even from this surface of contact no light could be radiated except through the lower half of the globe. From this therefore it appears that it is the cone D, and not the cylinder E, which becomes incandescent. And this is quite consistent with the statement made in the specification, if we assume the word "which" to refer to the cone, as I have suggested. The patent goes on further to say that the incandescent portion, which I understand to be the cone D, "remains in that state (*i. e.*, incandescence) a very long time, because the small portions which are consumed are continually replaced by a portion of the cylinder which the metal presser forces onto the top of the cone."

By this I understand the patentee to state that, as small portions of the cone are consumed the cylinder moves downward under the "metal presser" so as always to keep a contact between the cylinder and cone, thus replacing the portions of the cone which are burned away by the lower end of the cylinder. This gives an excellent description of the operation of an arc incandescent lamp.

327 X Q. In 132 X Q. your attention is called to an incandescent form of the Greener and Staite lamp described at page 3 of the patent beginning at line 33. What is the kind of carbon
1966 referred to in that patent and which constitutes the hollow cylinder between the two platinum cones in the part of the description to which your attention was so called?

A. The same kind of carbon which Greener and Staite refer to in the other portions of their patent, the form which they prefer being carbon prepared from coke.

328 R. D. Q. For what sort of a lamp is the carbon prepared from powdered charcoal and pressed into shape and treated as described on page 2, lines 32 and following of said patent, suitable?

A. It is especially suitable for use in arc lighting or in arc incandescent lighting.

329 R. D. Q. Is it a carbon made from fibrous or textile material, or does it fall under the class of hard carbon?

A. It is a hard carbon, or at least is intended to possess the peculiarities of such a carbon.

330 R. D.—. In 137 cross-Q. you were asked the foundation for your statement that Foucault suggested the use of gas-retort carbon for arc-light electrodes about 1845. Have you since your cross-examination found any publication which enables you to verify your statement, if so, will you please produce the same?

A. What I think is the original statement of Foucault regarding this matter is found in Comptes Rendus for 1844, vol. 18, page 751, in a paper by Fizeau and Foucault, in which they say:

"L'un de nous, M. Foucault, a atteint ce but par l'emploi du charbon provenant de la distillation de la houille; ce charbon permet d'obtenir à l'air libre une lumière fixe et surtout durable, à cause de la lenteur de sa combustion; toutes nos experiénces out été faites avec ce charbon"—

which I translate as follows:

One of us, Mons. Foucault, has reached this end by the employment of the carbon resulting from the distillation of coal; this carbon allows us to obtain in the open air a light which is fixed and especially durable, because of the slowness of its combustion; 1967 all our experiments have been made with this carbon."

Also on page 861 of the same volume, in a second paper by the same authors, I find this statement:

"Le charbon très-dense qui provient de la distillation de la houille, et que nous avons employé, a des caractères physiques qui le rapprochment de l'espéce minerale appelée anthracite; en examinant, après les expèriences d'incandescence, le charbon transporté au pôle négatif et l'extrèmité du pole positif lui-même, nous avons remarqué que ses charactères physiques sont alors changés. Ce charbon est mou, traçant; sa surface, étant, frottée, devient d'untgris plombé métallique. Ces caractères l'assimilent complétement à l'espèce minérale appelée graphite; cette modification se fait très rapidement, et s'obtient également avec d'autres especes de charbons conducteurs. Il suffit de promener l'arc lumineux sur la *sur la* surface d'une des pôles de charbon pour que cette surface soit à l'instant revêtue d'une couche de graphite.

Cette formation de graphite, sous l'influence d'une température tres élevée, nous semble devoir jouer un rôle important dans l'étude des masses minérales où se recontre si fréquemment cette variété de charbon."

This I translate as follows:

"The very dense carbon resulting from the distillation of coal which we have employed, has physical characteristics which relate it to that kind of mineral called anthracite; on examining (after the experiments with incandescence) the carbon which has been carried from the negative pole to the end of the positive pole, we observed that its physical characters have been changed.

This carbon is soft and makes a mark; on being rubbed its surface appears of a metallic lead gray. This modification takes 1968 place very rapidly and occurs equally with other kinds of conducting carbons. It is sufficient to produce the luminous arc on the surface of one of the carbon electrodes to instantaneously cover this surface with a layer of graphite.

This formation of graphite under the influence of a very high temperature ought to have an important bearing on the study of the mineral masses which one so frequently meets in this kind of carbon."

The parts of the work quoted in the answer are offered in evidence and marked Complainant's Exhibit Extract from Comptes Rendus of 1844, W. T. F., sp'l ex'r, April 20, 1889.

331 R. D. Q. In cross-question 201 your attention is called to the process of preparing carbons described in the Slater and Watson and Harrison English patents. Suppose those processes to be carried out, what kind of carbon would be the result in respect to its being hard carbon or otherwise?

A. It would be hard carbon similar in its characteristics to that used by Foucault.

332 R. D. Q. Is there any substance enumerated in the Gaudoin patent or the additions thereto which if treated by the process therein described would result in the same thing, in structure and properties, as the fibrous or textile conductor of the patent in suit, if such conductor in the course of its manufacture was treated by the Sawyer and Man hydrocarbon process?

A. There is not. The endeavor of that patent is to produce a hard carbon, equally hard throughout. The aim of the hydrocarbon treatment as applied to a fibrous conductor is to equalize its resistance and to heal imperfections, the carbon being deposited precisely where it is needed and not elsewhere, so that its deposition is greater at those points where it is needed most. No such operation is intended or is possible with the Gaudoin carbons, and in that process there will be secured either an appoximate even- 1969 ness of deposition of the carbon or more likely an unevenness which would be quite as likely to give an excessive deposition where it would do harm in an incandescent lamp as where it would do good.

333 Re. D. Q. Please state generally, so far as you remember, what patents or publications you examined as the basis of your opinion to the Edison Co., which has just been put in evidence, and particularly state whether you had or had not then examined the Lane-Fox patent, in evidence in this case.

A. I must answer this question wholly from memory as my various memoranda are in Boston. I consulted chiefly, if not entirely, certain patents and publications of which a list was sent me by the

Edison Company. I have no recollection of reading the Lane-Fox patents till within a very few weeks.

Adjourned for lunch.
Resumed after lunch.

334 Re. D. Q. What is the object and effect of the glass plate stopper used in air pumps and other similar pneumatic apparatus?

A. The object of using the glass plate in an air pump or similar apparatus instead of the brass plate is to avoid corrosion of the plate in case any substances are used which might cause this. The metal plate with an air pump is equally efficient with a glass plate so far as holding a vacuum is concerned. So far as heating is concerned, it is desirable to avoid the use of a glass plate with an air pump from the danger of cracking it.

Recross-examination:

335 R. C. Q. With reference to the Shepard English patent, if the lamp shown in figure 10 were hung overhead as electric lamps usually are, would not a part of the lower end of the charcoal cylinder E be disclosed to sight?

1970 A. I suppose a trifling portion of it might be seen from certain positions, but it would be utterly ineffective as an illuminant, even though rendered incandescent, since the light would be cut off for more than 180 degrees by the tube, and from a very considerable angle below, by the shadow of the cone. Such a structure so operated would be manifestly absurd.

All the answer after the first thirteen words objected to as irresponsive and volunteered.

336 R. C. Q. If the cone D of the Shepherd patent is consumed and the charcoal pencil E fed down, would not the charcoal pencil E be further disclosed to sight?

A. It would, undoubtedly.

337 R. C. Q. If the cone is to be consumed, and not the pencil, does it occur to you that the pencil is made unnecessarily long to take up the consumption of the cone?

A. Of course there would be no necessity of using so long a pencil simply to take up the consumption of the cone, but, with such a construction as is shown, it would be very natural to use a pencil of moderate length like that shown in the figure. I do not imagine that the figure is a working drawing of the device.

338 R. C. Q. So you think to take up a consumption in extent about three-eighths of an inch, a pencil of an inch in length would naturally be used; that is, more than double the length required would be used?

A. I think that if one were making a model experimental lamp he would be very likely to do this, taking a pencil of such length as he happened to have, or breaking it off of a moderate length without very much regard to the minimum possible length. I know that I myself am likely to proceed in this way in making experimental devices, and I think that this is very common under such circumstances. If a device of this sort were made commercially, very likely the carbon cylinder would have been made shorter.

339 R. C. Q. If the cone is to be consumed and not the
1971 pencil, what will happen when the apex of the cone is worn
off, and the cross-section of the cone at the contact increased so as to be larger than the pencil?

A. I should suppose that the operativeness of the device as an arc incandescent lamp would cease long before this condition was reached. In any event the end surface of the cone, and probably the lower end of the cylinder would have become very rough so that they would both wear away. Very likely under these circumstances the cylinder might wear more than the cone, and I suppose that on the whole it would.

340 R. C. Q. Is it not the usual construction of an arc incandescent lamp to have the pencil which is consumed by being rendered incandescent at the point of contact of uniform diameter and fed forward as it is consumed?

A. I think that such cylinders are frequently pointed at the ends. They are usually fed forward as consumed.

341 R. C. Q. Aside from the pointing of the extreme end, the consumed pencils are of uniform diameter, are they not?

A. They often are. The pointing, however, may be quite acute.

342 R. C. Q. But however acute the point, the pencil has a body of uniform diameter extending back of the point?

A. Beyond the junction with the cone which ends in the point, the pencils have usually been, like those used in arc lighting, of uniform diameter.

343. R. C. Q. With reference to your answer to cross 339, at what point and why would the device cease to be operative?

A. I cannot say at what particular point this would happen, but the two flattened surfaces which would presumably result, are not well suited to the maintenance of such a light, so that I should expect irregularities to occur, so that difficulty would be found in keeping up the operation of the lamp without modifications of the current, and perhaps with them.

344 R. C. Q. But this would occur before the cone wears enough to prevent a cross-section greater than the pencil, as I understand you?

1972 A. I should expect this. Of course my replies are hypothetical, as I have never tried, or seen tried, such a lamp.

345 R. C. Q. Then you think that a pencil an inch long would naturally be provided to take up a wear of about an eighth of an inch?

A. You have evidently mistaken the sense in which I used the word "naturally" and perhaps my meaning was not made altogether clear. What I intended to convey was simply that, in my opinion, if a person were making such a lamp experimentally, or making a sketch of such a lamp, he would be very likely to break off a carbon pencil of greater length than was absolutely necessary, since it would be, for one thing, easier to handle in the actual lamp, and its position and purpose more evident in the drawing. The probability is that under the circumstances assumed, he would not give very much attention to the length absolutely needed, except that he would be sure to have it long enough. Nothing is more common in such sketches as are found in patents and illustrative diagrams generally, than to draw the various parts of quite different dimensions from those which would be best suited to their effective operation is actual practice.

346 R. C. Q. Then you do not consider it significant in determining which of the two elements D and E is intended to become incandescent and be consumed in the operation of the lamp, that the operative length of one element, viz: D is only about an eighth of an inch while the operative length of the other element E is about an inch?

A. I do not consider it as at all conclusive.

347 R. C. Q. When the cone D burns down to a larger area, is the arc suppressed by the additional area of contact?

A. Not necessarily, but it is desirable to have the contact
1973 area small that the apparatus may work at its best.

(Signed) CHAS. R. CROSS.

Subscribed and sworn to before me this 20th day of April, A. D. 1889.

WM. T. FARNHAM,
Special Examiner and Notary Public for the County and State of New York.

Certificate of examination to the above deposition of Prof. Cross is hereby waived by consent of counsel.

1974 NEW YORK, *April* 10, 1889.

Met pursuant to arrangement of counsel. Present, L. E. Curtis, Esq., for complainant and W. K. Griffin, Esq., for defendant.

Testimony of Henry Morton.

HENRY MORTON, being called on behalf of complainant and duly sworn, testifies as follows:

1 Q. What is your name, age, residence and occupation?

A. Henry Morton, 52 years of age; I reside at Hoboken, N. J.; am president of the Stevens Institute of Technology at that place.

2 Q. What knowledge have you of the science of electricity and its application to the various useful arts and what familiarity have you with electrical instruments and apparatus and particularly those used in the art of electric lighting?

A. For more than twenty-five years I have had in my possession and almost constant use a great variety of electrical apparatus and during this same period have given lectures to my classes on the science of electricity, and on the use and application of such electrical apparatus. At the time that electric lighting began to assume commercial importance I was a member of the United States light-house board and as chairman of the committee on scientific tests of that body I conducted a series of tests of various forms of apparatus employed in electric lighting, the results of which were embodied in reports published by the light-house board in 1879 and 1880. About the same time, and continuously thereafter to the present date, I have conducted numerous tests on the various forms of dynamo-electric machines, electric lamps, storage batteries and other apparatus used in the various systems of commercial electric lighting.

3 Q. What familiarity have you with the lamps and other devices used for incandescent lighting?

A. I have examined and tested a great number and
1975 variety of incandescent electric lamps, including most of
those which are in commercial use at the present day. I have also repeatedly witnessed the construction of these lamps at various factories where they are manufactured in quantities.

4 Q. Have you read complainant's patent in suit—letters patent No. 317,676, granted May 12th, 1885, to the Electro-Dynamic Light Co., of New York, as assignee of William Edward Sawyer and Albon Man, and do you understand the same?

A. I have carefully read this patent and I believe that I understand it.

5 Q. Have you read the depositions of Prof. Cyrus F. Brackett, Prof. Geo. F. Barker, Prof. Wm. P. Wilson and Mr. Edison who have testified as experts in this case?

A. I have.

6 Q. Do you agree with the opinions expressed by defendant's experts, or some of them, that there is not a sufficient description in the specification of the patent in suit as to the character of the fibrous material to be used for the burner, its selection, its preparation for carbonization and its carbonization to enable others generally skilled in the art as it existed prior to 1880 to produce a practically operative incandescent conductor without experiment? I call your attention particularly to Prof. Brackett's answers to questions 16 to 19 inclusive, cross-questions 55 to 57 inclusive, to Prof. Barker's answers to questions 22 to 27 inclusive, Prof. Wilson's answers to questions 5 to 29 inclusive, and Mr. Edison's answers to questions 412 to 435 inclusive, 439 to 441, 457 to 464½ inclusive. Please give your reasons for any opinion you may express?

A. I do not at all agree with the opinions expressed by the gentlemen named, and I think I can best make clear my reasons for coming to a different conclusion from theirs, by pointing out, in the first place, what I find in the patent referred to, as to the character of the fibrous material to be used for the burner, its selection, preparation and its carbonization.

1976 In the first place, at line 25th of the first page of the patent, I find these words:

"An incandescent conductor of carbon, made from a vegetable fibrous material."

At line 76 of the first page I find as follows:

"In the practice of our invention we have made use of carbonized paper, and also wood carbon. We have also used such conductors or burners of various shapes * * * but we prefer the arch shape."

At line 87 of the first page I find as follows:

"No especial description of making the illuminating carbon conductors, described in this specification, and making the subject-matter of this improvement is thought necessary."

At line 21, page 2d, I find as follows:

"The advantages resulting from the manufacture of the carbon from vegetable fibrous or textile material instead of mineral or gas carbon, are many."

Again, at line 45 of the second page, I find the first claim expressed as follows:

"An incandescing conductor for an electric lamp, of carbonized fibrous or textile material, and of an arch or horseshoe shape, substantially as hereinbefore set forth."

I also find in the second claim, the expression "carbonized fibrous material." In the 3d claim, the expression "carbonized paper," and in the 4th claim, the expression "consisting of carbon made from a fibrous or textile material, having the form of an arch or loop."

With these quoted passages either taken by themselves or in connection with their context before him, it seems to me that one skilled in the art would have abundantly sufficient instruction as to the material to be selected, its preparation and carbonization. The prominent features pointed out by the quoted passages are, that the incandescent conductor is to be made of a fibrous vegetable 1977 or textile material in the form of an arch or loop and carbonized so as to be converted into such a conducting material as would be useful in an incandescent electric lamp. The instruction that the material was to be at the outset of fibrous vegetable or textile character, would at once instruct any one desiring to carry out the invention that he should employ preferably, or as the most natural thing, such textile material as exists in the form of cotton or linen thread or vegetable fibre of any other sort which had been reduced to a textile shape, that is, brought into a condition fitting it for weaving or other method of producing a textile fabric. The most natural thing or material for the workman to employ would thus be the ordinary cotton or linen thread of commerce of the better sort, that is, such as consisted of fine vegetable fibre and was of uniform cross-section. Any one having the most ordinary knowledge of the art would be, of course, aware that irregularities in the material or lack of uniformity in cross-section, would be highly injurious because they would lead to irregularities in the conducting power of the resulting carbon conductor, which would be most injurious, if not fatal, to its utility. Next to cotton and linen thread, the workman desiring to carry out the instructions of this patent would, it seems to me, naturally consider such materials as are used in the weaving of baskets and other articles, and which consist of strips cut from various forms of grass or reeds and especially from bamboo, because these would be fibrous vegetable sustances already reduced to the form of textile material, that is to a shape adapting them to the process of weaving in the manufacture of baskets or the like. If the workman were to go further than this, as he might do were it his object to produce incandescent conductors of a larger size, he might then seek among the various woods those which most resembled in their structure the fibrous and textile materials which had naturally presented themselves to him in the first instance. In the next place, having in view the statement that the conductor was to be used in an arch form, he would, as a matter of course, give the material this arched 1978 form previous to carbonizing it, since he would certainly know that it would be much easier to bend or curve any of these materials into the arched form while they were in their fibrous or textile condition than after they had been carbonized. In the case of the textile materials this arch form would of course be given by simple bending and even in the case of woods, having in view the direction that fibrous vegetable material was to be employed, the workman would realize that he ought to preserve and not destroy the fibrous character of the material while reducing it to the arch form, and would therefore give it this shape by bending, and certainly not by so cutting it as to run across the grain and thereby practically destroy or render useless the fibrous structure of the material employed. In addition to these directions the patent also tells the artizan that this arched conductor may be made of paper, and under this instruction it seems to me that if the said artizan were possessed of ordinary intelligence he would, as a matter of course, shape his paper material before carbonizing it, and would select a variety of paper consisting of pure vegetable fibre unadulterated with mineral matter. Many such varieties of paper were known in the arts and easily procured. It is hardly necessary to say that an intelligent artizan would also select a paper of uniform thickness and fine structure and not a coarse and irregular specimen, which he would know must produce an irregular, and therefore inefficient, conductor for an incandescent electric lamp. It would also be true that if the supposed artizan was familiar with the art of electric lighting, as it existed in 1880, he would know about the methods of tempering or treating carbon conductors set forth in certain earlier patents of Sawyer and Man, and would therefore be prepared to subject his carbon conductor to such treatment if he found it desirable or necessary.

As to carbonization of the material after it had been selected and prepared by shaping, it seems to me that no specific instruction would be needed, because any one skilled in the art would be quite familiar with such methods of carbonization as would be 1979 manifestly efficient for the object in view. In other words, he would not need to be instructed that to carbonize relatively small and delicate objects like these, they should be inclosed in air-tight crucibles, being either pressed between surfaces or imbedded in carbon powder or the like, in such a manner as to exclude air as far as possible.

Having thus stated what I myself find in this patent in the way of directions as to the selection of material, its preparation and carbonization, I will take up in order and consider the various statements made by defendant's experts as to this same subject.

In considering the opinions expressed by defendant's experts, I should, in the first place, make the general remark that all these gentlemen seem to have overlooked the true significance of the expression "textile material" and to have directed their attention almost exclusively to the term "wood carbon." They have also, as it seems to me, assumed that the artisan attempting to follow the directions of this patent would fail to consider at once all its instructions and suggestions and would refer to only one at a time and would then proceed to consider that one with little or no reference to the state of the art and to the indications which the existing state of the art would furnish him as guides in his selection of material and treatment thereof. They also seem to assume that in order to be practically useful, an incandescent lamp must be able to compete successfully in cost and convenience with illuminating gas and even to rival the improved incandescent electric lamps of the present day, and they also, as I think, assume that to be practicable and useful, even in 1880, an electric lamp must have a carbon conductor of higher resistance, and of more slender structure than many which are in successful commercial use, even at the present day. These partial, or piecemeal methods of considering the patent, and these
various assumptions are, I think, quite unphilosophical and
1980 unwarranted, and when they are corrected, all grounds for
the opinions as to the insufficiency of the instructions contained in this patent, disappear.

Thus, for example, taking up first Dr. Barker's testimony as expressed in his answer to question 22, his first objection is, that the expression "a vegetable, fibrous material in contradistinction to a similar conductor made from mineral or gas carbon," and the expression "vegetable, fibrous or textile material," would cover thousands of distinct forms of vegetable materials, among which the artizan would be at a loss how to select, because unprovided with any criterion by which to discriminate. This, however, could only be so if the artizan in question failed to realize the force of the suggestion contained in the term "textile material," and also failed to realize the force of the term "fibrous," as meaning distinctively and characteristically fibrous, to a marked and practically effective degree, and finally also failed to realize that the state of the art instructed him that the carbon conductor must be of uniform structure and conducting power throughout its length. He must also fail to realize that according to the direction of this patent the finished conductor was to have an arched form.

If, on the other hand, the intelligent artisan realized all these things, then he would not see before him the thousands of vegetable structures among which Dr. Barker thinks he would be lost, but, as I have already pointed out, would have clearly indicated to him, in the first instance, such textile materials as cotton and linen thread; in the next place, such less familiar textile materials as the split canes, bamboos and the like as were also used for textile purposes; and lastly and only as a more remote suggestion, the use of such woods as by their peculiar, regular and even, fibrous structure were allied to the textile materials which would naturally be his first choice.

Dr. Barker next refers to the mention of paper as a material for the production of the carbon conductors, and thinks that because there are many varieties of paper, some of which by reason of 1981 the mineral impurities which they contain or their coarse and irregular structure would be unfit for the use indicated, the supposed artisan would be at a loss which to select and could only determine this by repeated experiment. This, however, I think, does great injustice to the intelligence and knowledge of the supposed artisan, who I think would undoubtedly know that in order to produce an article from paper which was otherwise to be made from vegetable fibre, he must select a pure paper not contaminated or loaded with mineral matter, and that to produce a carbon conductor of uniform resistance or conductivity, he must use a paper of fine and uniform structure and thickness, such, for example, as the familiar bristol-board. If the artisan had selected such a paper he would undoubtedly have succeeded in producing a carbon conductor capable of operating with entire success in an incandescent electric lamp, especially if he had also applied his knowledge and judgment to the extent of treating or tempering said conductor in the well-known manner after it had been carbonized. Among other reasons for this last conclusion I may state that during my experiments on incandescent lamps for the light-house board I operated many lamps whose carbon conductors were made from paper and that these lamps operated in a very satisfactory manner both as regards durability and efficiency.

Dr. Barker next takes up the expression "wood carbon," as though it stood alone and were to be considered without any limitation derived from other parts of the patent. The words as they stand in the patent are in this connection.

"In the practice of our invention we have made use of carbonized paper and also wood carbon."

Now, as I have already pointed out, any artisan of the most moderate degree of intelligence, if directed to make arch-shaped carbons from paper, would unquestionably cut or bend the paper into the arch shape before carbonizing it, and if he found directions or a suggestion as in the above quotation which coupled the making of 1982 carbons from wood with the making of carbons from paper, there cannot be the least doubt that he would also proceed to shape the carbon arches from the wood before carbonizing it. Moreover, if he had studied the rest of the patent and had realized the force of what is there said about textile material and vegetable fibre, and moreover knew something as to the necessity of uniform structure in the conductors of electric lamps, he would not feel that the entire class of exogenous woods was presented to him for selection, but that his choice must be confined to those which by their uniform and fibrous structure adapted themselves for this use and were in fact as closely as possible allied in these characteristics to the textile and fibrous vegetable structures which were manifestly the preferred and specially indicated materials. Had he used such knowledge and judgment as I have above indicated, and had he also, for further security, applied the process of tempering or treatment, I have no doubt that he would have produced directly and without experiment an incandescent conductor for an electric lamp which, at the date of the patent, would have been entirely operative and indeed commercially valuable in certain locations, although it probably would not have competed in economy with illuminating gas or with the improved incandescent lamps of the present day.

Near the conclusion of this answer 22 Dr. Barker uses these words:

"The bare statement of the patent in suit, therefore, that the material to be used for the production of the carbon conductor (which is the essential feature of an incandescent lamp), is vegetable fibrous material, seems to me to be utterly vague, indefinite and unsatisfactory, and does not seem to me to be such a full and complete description as would enable a person skilled in the art as it existed at the time the said patent was applied for, to produce a practically operative incandescent conductor without experiment."

1983 Now, if the assumption here made by Dr. Barker was correct, if the patent only contained the bare statement which he makes, then his conclusion might be warranted; but in order to secure this premise, Dr. Barker is obliged to ignore all that the patent says about textile material and the arch shape of the conductor and all that is implied in these and other parts of the document. When these matters are taken into consideration, then the statement of the patent is no longer in the crude and bare condition, to which Dr. Barker would reduce it, but is fully clad with abundant instruction such as would enable one skilled in the art, without experiment, to produce not only one, but several varieties of operative incandescent conductors for electric lamps.

In Dr. Barker's answer to question 23, he points out very correctly that there are many kinds of paper and also of wood, which would not answer for the construction of an incandescent electric lamp, and to his remarks on this subject I will only add that this would be equally manifest to an intelligent artisan who might be called upon to put in practice the invention of the patent in suit, and that such artisan would discard such varieties of wood and paper just as Dr. Barker has done, without experiment.

In his answer to question 24 Dr. Barker says in substance, that he considers explicit directions would be necessary as to the shaping and carbonizing of the conductors, and that said directions are confessedly not given in the patent, but are there stated to be unnecessary. I think that Dr. Barker's error in this as in other cases, arises from his having overlooked or failed to appreciate what the patent says about textile materials. Had he taken this into consideration he must, I think, have seen that the shaping of the material or the selection of the same ready prepared in the desired shape, was a matter not only suggested, but made in many cases absolutely unavoidable, and that this having been done, it was

manifestly unnecessary to instruct any one familiar with the art as to methods of carbonizing, since these were thoroughly well known and clearly defined as to such materials and products as are
1984 involved in this case. It would indeed seem almost an absurdity to tell a workman who had been instructed to make a carbon in an arched form out of a thread of some sort that he was to bend the thread into an arched form and then clamp it between smooth surfaces of resisting material or surround it with carbon powder, enclosed in an air-tight crucible and heat it in a furnace, because it would require more ingenuity than most people possess to devise any other possible way of doing the thing directed in the first case.

In his answer to question 25, Dr. Barker says in substance that it would make all the difference in the world as to the efficiency of the conductor made from wood, whether it was cut with the grain or across the grain, and that the patent contains no specific instructions in this regard and is therefore defective. I agree with Dr. Barker entirely as regards his facts, but not as to his conclusion. Any artisan acquainted with this art would know precisely what Dr. Barker does on this subject, and therefore would need no directions. In fact, to tell him not to cut his conductor across the grain would be as much of a reflection upon his intelligence as to tell him not to make notches in it or to make it of unequal section in different parts.

Dr. Barker's answer to the 26th question is substantially an amplification of what he says in the previous answer, and only expresses what any intelligent workman would know as to the proper or improper means of shaping a piece of wood which was intended, after carbonization, to be used as the incandescent conductor of an electric lamp.

In his answer to the 27th question, Dr. Barker states that an arched carbon made out of wood cut across the grain would not be useful as a conductor for an incandescent lamp, and in this I agree with him, as I think would any intelligent artisan familiar with the art of electric lighting as it existed in 1880.

Turning next to the testimony of Prof. Brackett. In his
1985 answer to question 16 he says, in the first place, that the instructions of the patent are insufficient as regards the selection of material. This opinion he apparently forms on the statement in the patent that the patentees have used carbonized paper, and also wood carbon, taking this statement alone, and making no use of anything else in the patent to qualify or explain it. Like Dr. Barker, he assumes that the artisan who is attempting to follow the directions of this patent would take this sentence by itself and would be ignorant as to the rest of the patent and the state of the art; that he would consequently select indifferently any kind of paper, no matter how impure and loaded with mineral matter, and no matter how rough and irregular in structure it might be; that similarly he would, as it were, go into the forest or to the wood pile and take the first stick he picked up and proceed to use it. After what I have said as to the actual instructions contained in the pat-

ent, and as to this method of piecemeal discussion, it is not necessary that I should here say more than that such an artisan as Prof. Brackett's remarks here imply, is not the artisan of ordinary intelligence, skilled in the state of the art, to whom the patent is addressed, but must be one either lacking intelligence and knowledge or not making use of the same in his attempt to put in operation the invention of the patent.

In his answer to question 17, Prof. Brackett goes over the same ground as Dr. Barker in reference to the necessity *or* cutting the carbon from wood with the grain and not across it, and I would only remark that I quite agree with him, but feel confident that any intelligent artisan would see this thing just as Prof. Brackett and I do, without any experiment being necessary to satisfy either him or us as to the result.

In his answer to question 18, Prof. Brackett points out, in substance, that only a small fraction of the entire number of vegetable growths would be adapted to the manufacture of efficient carbon conductors for incandescent lamps. In this statement, I have no doubt that he is substantially correct, but I do not understand that he has arrived at this conclusion only at the end of an immense 1986 series of experiments in which all these materials have been tested, but that he reaches this conclusion as a matter of deduction from his general knowledge concerning the conspicuous character-stics of the vegetable world and the requirements of a carbon conductor for an electric lamp. This, I think, any intelligent artisan, with the full text of this patent before him, would do equally well, and would be saved from any unnecessary and unsuccessful experiments by those considerations fully stated in the early part of my present answer, which would lead him to select only those few vegetable fibres which would produce efficient conductors, and not any of the numerous class which would be manifestly unfit.

In his answer to question 19 Prof. Brackett states in substance that he does not think there existed in the state of the art in January, 1880, anything which would supply the deficiencies he finds in the patent. With this I so far agree that if these deficiencies existed, or in other words, if we took a single phrase in the patent and considered it alone, we could not supply the imperfect inst-uctions secured in this way by going to the state of the art, since it was precisely the invention set forth by this patent as a whole which added to the existing state of the art the instructions which Prof. Brackett finds lacking in his selected fragments.

In answers 55 and 56 Prof. Brackett says in effect that the terms "fibrous" and "textile" cover in his opinion a great variety of substances and therefore are indefinite. This would be true if these words stood alone, but standing as they do in this patent in connection with the production of arch-shaped conductors for incandescent lamps they are, as I think I have already sufficiently shown, exceedingly clear and precise, and would lead any one who really desired to carry the invention into practice, directly to those materials which experience has shown are of all others best fitted for the construction of incandescent lamps.

In his answer to question 57 Prof. Brackett thinks that the carbonizing process ought to have been explicitly described; that is to say, as to whether, in the case of wood, the conductor was
1987 to be bent into an arched form before carbonizing or cut into such a form, the cutting involving, in the end, a carbon in which the grain would be in part crosswise. As I have already pointed out, it seems to me that directions on this subject would be entirely superfluous and that any intelligent artizan would adopt the expedient of bending the wooden blank before carbonizing, as a matter of course.

In reference to the testimony of Mr. Edison and Prof. Wilson I think I can avoid unnecessary repetition by saying that I find in them nothing substantially different from what I have commented upon in the testimony of Dr. Barker and Prof. Brackett, except that they seem to make more emphatically the assumption that for a practicable incandescent lamp an extremely fine or thin fibre is absolutely essential, and that the patent in suit requires that such fibre should be made out of wood. As regards this I should say that modern practice in electric lighting completely demonstrates that a very fine fibre is by no means universally necessary or desirable. In fact the Edison Company, in what they call their Municipal system, use lamps with carbons very many times as thick as those to which Mr. Edison specially refers in his testimony, and which are the kind commonly employed by his company in household illumination. I might also refer to Complainant's Exhibit Thompson-Houston Lamp, and Complainant's Exhibit Bernstein Lamp, as showing incandescent electric lamps which are used commercially to a considerable extent, and which have carbon conductors even thicker than those of the Edison municipal lamp. Still further, the lamps used in the Heissler system have carbon conductors still thicker than any of these. In all these cases the lamps are used in successive series; that is, are so connected that the current passes from one lamp to the other in succession. It is manifest, therefore, that a very fine fibre is no essential condition for an operative or even a commercial incandescent lamp. It is also manifest that the patent in suit is very far from suggesting that the only or usual material for the production of the carbon con-
1988 ductors is to be wood. On the contrary, as I have already pointed out, the first or most natural selection of an artizan, under the instructions of the patent, would be a thread or string, and if this was employed it is manifest that Mr. Edison certainly could not raise any question as to its operativeness and Prof. Wilson has not raised any which would have any force, if we assume the carbonization to have been effected in accordance with the well-known state of the art and the exercise of reasonable intelligence.

In such cases as make it desirable to use thick carbons, wood, under the conditions which I have previously pointed out, could undoubtedly be employed with success, and the difficulties of section would be undoubtedly less than in cases where a fine or elicate carbon was required, just as in every department it is easier o make a large or coarse thing than a delicate or fine one, but in each case fairness requires that similar and not dissimilar things should be compared and that we should not bring into comparison the material of the most delicate modern lamps with the roughest and coarsest of those suggested in the patent.

In view of this I think it will be very evident that the insufficiency pointed out by Mr. Edison and Prof. Wilson as well as defendant's other experts, does not exist in the patent in suit, but only in the minds of those gentlemen, and result from their erroneous assumptions in various directions which I have pointed out and from their partial or piecemeal discussion of the patent, whereby they have failed to appreciate the true meaning of its various statements, which can only be properly understood, as is the case with almost every documeut, by being considered in their mutual relations and as explanatory one of the other.

Adjourned till Thursday the 11th inst., at 2½ p. m.

1989 NEW YORK, *April 11th*, 1889.

Met pursuant to adjournment.

Present: Counsel as before, and the examination of Prof. MORTON was continued as follows:

7 Q. Do you understand that the patent in suit is limited to any proportions of the carbon either with respect to its length or with respect to its cross-section?

A. I do not.

8 Q. What would determine the size of the carbon, in the mind of a person skilled in the art desiring to practice the invention?

A. The conditions under which the lamps were to be used. If, for example, these lamps were to be used in what is known as parallel series or multiple arc, that is to say, when two parallel main wires are carried out from the dynamo or other source of electricity and the lamps are inserted between them like the rungs of a ladder, then the carbon conductors would be made thin and long so as to secure in them a high resistance. If, on the other hand, the lamps were to be run in successive series, that is, one lamp after another being inserted in the line of the main conductors, then carbon conductors, short and of thick cross-section would be employed so that each lamp would only add a relatively small resistance compared to the entire circuit.

9 Q. In your answer to question 6, you say that defendant's experts assume that for a practicable incandescent lamp an extremely fine or thin fibre is absolutely essential, and that for thicker carbons the difficulties of selection would undoubtedly be less. Please explain more particularly what you mean by this. I call your attention to the testimony of Prof. Wilson contained in his answers to questions 10 to 28 inclusive, in which he deals particularly with the difficulties met with in making very fine filaments out of ordinary exogenous and endogenous woods.

A. Prof. Wilson's very extended discussions of this subject may, I think, be fairly summarized as follows:

1990 All ordinary woods and most endogenous or grass-like plants consist of fibrous structures more or less irregular in character and in direction of their fibres, so that it is in his view practically impossible to cut from any of them a fine filament or thread-like strip which shall be free from very great irregularities or inequalities of structure in its length, owing to the fact that the vegetable fibres in all such materials are bent, distorted or interrupted by the presence of what are called medullary rays' in the exogenous woods and other variations in structure found in them as well as in the endogenous plants. It is manifest to any one that the importance of these irregularities in this, as in any other case, would be lessened just in proportion as the thickness of the conductor was increased, thereby averaging or equalizing the distribution of such irregularities. For example, in a very fine fibre or strip, a medullary ray might entirely interrupt the continuity of the fibrous tissue, but if the strip were ten times as large, then this same medullary ray, if it came near the surface, might only interrupt about one-tenth part of the fibres. So, in another case, the oblique or twisted character of the fibres in a fine strip might cause an absolute interruption of some of them whereby there would be a total interruption of the continuous fibrous structure of the entire strip. If, however, the strip were larger, there might not only be fewer of these fibres interrupted from their running out beyond the limits of the strip, but, even if this were not so, while some fibres were interrupted, others would remain intact, and thus maintain a relative uniformity of continuous fibre throughout the strip. In fact, the whole matter reduces itself to a question of averaging, by which substantial uniformity may be obtained out of great individual variety provided the number of individuals included is sufficiently great.

10 Q. If a person skilled in the art as it stood prior to 1880, had desired to succeed in making very fine or slender filaments by following the directions of complainant's patent, what sort of 1991 fibrous or textile materials would have, in your opinion, suggested themselves to him as most suitable for the purpose?

A. Cotton and linen thread would, I think, have been the first materials he would turn to. After those, such long-fibred grasses, reeds and strips of bamboo as were familiar to every one in the weaving of baskets and similar articles, and then such materials as broom-corn, or those woods like the ash which are noted for their conspicuously straight fibre.

11 Q. Would he naturally have selected woods with interlaced and irregular fibres, or those having very open and porous structure, with the imperfections of which Prof. Wilson's deposition deals at so much length?

A. If his desire was to succeed, I think he would naturally have avoided just such materials as you mention, and it would have been very strange and unnatural for him to have selected them.

12 Q. If carbons very much thicker than the filaments to which rof. Wilson refers were to be made, would the defects to which he refers be fatal or very serious ones, so far as most of the woods are concerned?

A. Not necessarily, and especially not if the process of tempering and treating set forth in the earlier patent of Sawyer and Man was availed of.

13 Q. To what process do you refer, and how would this serve to remedy the defects mentioned by Prof. Wilson and defendant's other experts?

A. The process to which I allude is that which is set forth in two modifications in the patents to Sawyer and Man, one of which is No. 210,809, Dec. 10, 1878, and the other No. 211,262, Jan. 7, 1879. In the first of these, the process is described in the following words, having reference to the gases that may be occluded by the materials enclosed within the lamp:

"To drive these out, we pass an electric current through the conductors *x*, *x*. The carbon pencil N is intensely heated, and considerable heat having extended throughout all the enclosed 1992 material, thus driving out occluded gases, the operation of exhaustion and refilling with nitrogen is continued until finally all the elements of danger are eliminated from the lamp."

The other process, or modification of the process is referred to, in substance, in the following words of the last-named patent:

"We have found that a pencil of carbon immersed in a hydrocarbon liquid and heated to an extremely high temperature by the voltaic current is not itself attacked, but decomposes the surrounding matter, the carbon of which enters and fills up its pores to an extent impossible, except with matter in a very attenuated state, and deposits a perfectly homogeneous layer, generally of a light gray color upon the exterior surface. * * *

"In this process it would seem that the carbon is never in contact with the liquid in which it is immersed, but surrounded by a carbonic gas of a very high temperature."

The reason for this treatment is given at the end of the paragraph immediately preceding the above quotation, in these words:

"Carbons of the ordinary sort, when heated by the electric current, exhibit points and lines of unequal brilliancy. Carbons prepared by our process, when so heated, glow with a uniform brilliancy throughout."

The tempering process described in the first of these patents seems to be a sort of fritting or agglomeration accomplished by the combined influence of a very high temperature, which softens without fusing or vaporizing the particles of carbon, and the exhaustion by which their occluded gases are extracted and their molecules thus allowed to come into closer contact. Its effect is to contract and solidify the carbon conductor and thus to render it more 1993 uniform in character and more capable of resisting destructive influences. The treatment described in the second patent, as the words I have quoted clearly show, consist in a local decomposition of the hydrocarbon vapor, by which the conductor is surrounded during this treatment, with the consequent deposit of carbon upon the parts of the conductor adjacent to where the decomposition takes place.

Now if, as originally made, this carbon conductor had a point of partial fracture or imperfect conductivity as compared with the rest, such point would be more highly heated by the current passing through, than the remainder of the conductor, and, therefore, a greater decomposition and deposit of carbon would occur at this point, thereby filling up the gap or curing the defect in an efficient manner. An extended experience has shown that a conductor, having considerable irregularities when first prepared, may be brought to a state of great uniformity and to an excellent condition for use by this treatment.

14 Q. How largely have these two processes of expelling occluded gases and hydrocarbon treatment been used in the commercial manufacture of incandescent lamps since 1880, and what is their importance or practical value in such manufacture?

A. The process of extracting occluded gases has been, I believe, employed universally in the manufacture of all electric lamps, and the hydrocarbon treatment has been applied in the majority of lamps, although I believe it is not universally used. One or both of these treatments I believe to be essential for the success of an incandescent-lamp factory at the present time. In other words, I do not think that a manufacturer who discarded both these treatments, could at all compete with those who used them, and he could only be successful, if he omitted the hydrocarbon treatment, so long as he confined his selection of material to a very narrow range, and at the same time manufactured his lamps on a very large scale.

1994 15 Q. Defendant's experts are apparently of the opinion that the invention described and claimed in the patent in suit is not the same substantial invention which is described and claimed in the original application. I call your attention particularly to Prof. Barker's answers to questions 28 to 43 inclusive, Prof. Brackett's answers 20 to 37 inclusive, and Mr. Edison's answers to questions 402 and 442 to 467 inclusive. Please compare the specification and claims of the patent in suit with the specification and claims of the original application, as shown by Complainant's Exhibit Patent Office Proceedings No. 1, and state whether or not you agree with the opinions expressed by defendant's experts in regard to the materiality or effect of the various amendments to which they refer, and give your reasons for any opinion you may express.

A. I may say that I very emphatically disagree with defendant's experts on the subject referred to, because, after a careful study of the patent in suit and the original application, I feel convinced that the invention here considered is quite as fully disclosed in the original application as in the patent in suit, and that one skilled in the art, desiring to obtain a successful result, would have succeeded with the instructions of the original application before him just as certainly as if he had the patent in suit in his hands. In my answer to question 6, after quoting from the patent in suit the passages which I consider to embody the instructions of that patent as to the choice and treatment of material, I said as follows:

"The prominent features pointed out by the quoted passages are, that the incandescent conductor is to be made of a fibrous vegetable or textile material in the form of an arch or loop and carbonized so as to be converted into such a conducting material as would be useful in an incandescent electric lamp."

And I also said a little further on in the same answer:

1995 "In addition to these directions the patent also tells the artisan that this arched conductor may be made of paper."

If now we refer to the original application, we will find there clearly stated all the points which I have above referred to as characterizing the invention disclosed in the patent in suit, as well as certain others which I have not yet had occasion to refer to, but will mention presently. In the first place, one of the prominent features of the invention disclosed in the patent in suit, is that the incandescent conductor is to be made of a fibrous vegetable or textile material. Now the 4th claim of the original specification reads as follows:

"An incandescing arc made of carbonized fibrous or textile material."

The only difference between this and the statement of the patent in suit is that in the patent in suit the invention seems to be more specifically limited to vegetable fibrous material than is the original application, although it is my opinion that in both cases vegetable fibrous material is all that is intended to be described. If, however, there is any difference, it is a limitation or restriction as to the range of the invention as expressed in the patent in suit. In the next place, the patent in suit describes, as another feature of the invention, the arch form which is to be given to the carbon conductor. In the second claim of the original application I find these words:

"Incandescing arcs of carbon in combination with the circuit of an electric light."

In the 3d claim,

"an incandescing arc of carbonized paper"

is referred to; and, as I have already pointed out, the 4th claim reads:

"An incandescing arc made of carbonized fibrous or textile material."

Also in the specification of the application I find as follows:

1996 "Our improved burner or incandescent arc consists of an arch-shaped or semi-cylindrical piece of carbon A mounted in its clamps or supports in usual well-known ways."

There are also various other references to the arc shape, but those I have quoted are abundant to show that this feature was fully set forth in the original application.

Again, as I have before pointed out, the patent in suit indicates that the arch conductor of the incandescent lamp is to be carbonized. This I find fully set forth likewise in the original application, as, for example, in the 4th claim, which reads—

"An incandescing arc made of carbonized fibrous or textile material."

This clearly instructs one skilled in the art to take fibrous or textile material, and, having bent it into an arched form, to carbonize the same so as to produce the article or object described, namely, an arch of fibrous or textile material carbonized or converted into carbon.

Another feature of the invention set forth in the patent in suit, as I before pointed out, is the production of the arch-shaped carbonized conductor made from paper. This I find clearly set forth in the 3d claim of the original application in the following words:

"The combination substantially as hereinbefore set forth, of the circuit of an electric light, an incandescing arc of carbonized paper included in the circuit, and a close, transparent chamber in which the arc is enclosed."

Also in the specification I find the expression—

"We have tried carbonized paper covered with powdered plumbago."

These references, I think, clearly show that all the features heretofore referred to by me as distinguishing the invention of the patent in suit are fully developed in the original application.

Adjourned till Friday, the 12th inst., at 10½ a. m.

1997 FRIDAY, *April* 12, 1889.

Met pursuant to adjournment. Present, L. E. Curtis and Edmund Wetmore, Esqrs., for complainant, and H. D. Donnelly, Esq., for defendant, and the examination of Dr. MORTON proceeded as follows:

Witness continues his answer 14.

From the character of the questions so far put, I have not had occasion to consider as yet another feature of the invention as expressed either in the patent in suit or in the original application, viz., the inclosure of the incandescent conductor in a transparent hermetically-sealed chamber as the patent in suit expresses it in the second claim, or an illuminating chamber made wholly of glass hermetically sealed and out of which all carbon-consuming gas has been exhausted or driven, as the patent in suit expresses it in its fourth claim. This feature, or these features, in whichever way we may choose to consider them, I find fully set forth in the original application in the following words and references. To begin with, in the statement of invention in the application I find as follows:

"Our invention, speaking generally, relates to that class of electric light employing an incandescent conductor enclosed in a vessel or chamber from which oxygen is excluded, and constitutes an improvement upon the apparatus shown in letters patent, No. 206,144, granted to us June 18, 1878."

(I understand that the number of the patent above given is an error which has been corrected and that the patent actually referred to is No. 205,144, which was in fact granted to Sawyer and Man, June 18, 1878.)

Turning to this patent I find it to describe fully and in detail an incandescent electric lamp having a carbon conductor enclosed in an air-tight vessel made entirely of glass. This last feature is specially set forth in the following words:

"Referring to figures 1 and 3, A is the glass globe provided 1998 with a rim or flange A^1 (better shown in Fig. 6), by means of which it is clamped to the glass base or stopper B, (better shown in Fig. 7)."

Also the following:

"To the base of the globe is ground the glass stopper B (better shown in Fig. 7), with great nicety, in order that the fit may be perfect."

Also the following:

"The rubber flange may however be omitted, and the form of the stopper B may be changed to that of a stopper ground into the end of the globe A, as stoppers are ground into bottles."

"In setting up the lamp we slightly coat the lower ground edge of the rim A^1, with fir balsam or some cement, in order the better to insure that hermetrical sealing which is indispensable to the preservation of the incandescent conductor."

As regards the exclusion of all carbon-consuming gas, the patent 205,144, is so full of references to it that it is hard to select any special part for quotation, but I would refer to the statement of invention on the first page and to the three last claims as bringing this feature out very prominently.

I think, therefore, that the statement of the original application which I have above quoted, taken in connection with the patent to which it refers, very clearly and fully describes a transparent, hermetically-sealed chamber in which the conductor is enclosed, or an illuminating chamber made wholly of glass, hermetically sealed and out of which all carbon-consuming gas has been exhausted or driven.

Turning again to the original application, I find near the end of the specification the following paragraph:

"We have used such burners in close transparent chambers, in a vacuum, in nitrogen gas, and in hydrogen gas, but have attained the best result, in a vacuum or attenuated atmosphere of 1999 nitrogen, the great desideratum being to exclude oxygen from the combustion chamber as is well understood."

These words, as it seems to me, taken in connection with those I have before quoted from the original application including the reference to patent 205,144, very clearly point out, as one department of the invention, the use of a hermetically-sealed chamber, entirely of glass, from which all carbon-consuming gas has been exhausted or driven, and thus contains everything on this subject which is set forth in the patent in suit.

Considering this subject at large then, I think that it is manifest from all the above, that the original application, equally with the patent in suit, contains everything necessary for the successful construction of the apparatus referred to and for reducing to practice the invention set forth in said patent in suit.

Turning now to the opinions expressed on this subject by Dr. Barker in his answers referred to, I would say as follows:

In his answer to question 28, Dr. Barker states in substance that he finds the patent in suit to differ from the original application, because, as he understands it, the invention set forth in the application is limited to, or consists of, a peculiar form or shape for the carbon forming the incandescent conductor of the electric lamp, and makes no reference to the material out of which the incandescent conductor is to be formed, except such as is entirely incidental and likewise indefinite, whereas, on the other hand, the patent in suit states that the invention relates to the substance as well as to the form of the incandescing conductor. Now, in this opinion, I think that Dr. Barker is entirely in error, and for a very manifest reason, mainly because he has entirely overlooked the significance of the fourth claim of the application, which is

"an incandescing arc made of carbonized fibrous or textile material."

2000 That he has overlooked this claim, appears very clearly from the following words which occur at about the middle of his answer to question 28.

"This conclusion that the invention of the application consists in the use of incandescing arcs of carbon, and that the material is specifically unimportant, would seem to be confirmed by the fact that the first two claims refer only to carbon arcs in general."

It is, however, manifest that whatever support is given to the view that the material is unimportant, because not mentioned in the first two claims, is entirely removed when we find that the material is made the special and emphatic subject of the fourth claim. Indeed, if there was no other reference in the entire patent to the material except what is contained in this fourth claim, it would still be, it seems to me, very clear that the material to be used was shown by this statement as an important and essential feature of the invention, but, besides this, we have in the third claim an equally prominent and emphatic reference to carbonized paper, and we have also in the specification the words:

"We have tried carbonized paper covered with powdered plumbago, wood carbon or charcoal, and ordinary gas carbon."

Now to my mind this statement, taken in connection with the fact that paper and fibrous textile material are the only substances alluded to in the claims, makes it very clear that the inventors intended to indicate, and have clearly indicated, that these are the substances which they specially valued and desired to cover by their application, and I do not find anything in the patent which is more clear and emphatic than these statements in the application as to the selection of material, or more certain to lead one skilled in the art directly and necessarily to the choice of such material as would have produced the operative and useful result to be sought for.

2001 In the next place, Dr. Barker says in substance that he thinks the materials specified to be used, have been greatly expanded in the patent as issued, as compared with the application, because, in the first place, the application speaks of carbonized paper covered with powdered plumbago, while the patent in suit speaks of carbonized paper without referring to the plumbago, and that where wood carbon or charcoal occurs in the application, wood carbon only is mentioned in the patent in suit, and, lastly, because the words "ordinary gas carbon" are omitted from the patent in suit and the substance to be used for the incandescent conductor is stated to be carbon from vegetable fibrous material in contradistinction to a similar conductor from mineral or gas carbon.

As regards the first of these distinctions, *i. e.*, the omission of powdered plumbago, I should say that I consider this entirely immaterial. In other words, carbonized paper covered with powdered plumbago was substantially carbonized paper. In the manufacture of the ordinary carbon pencils used for electric lights it was usual to finish them by rubbing them over with powdered plumbago, which gave them a relatively glossy surface, improving their appearance but having no substantial effect upon their electrical properties. This I understand to be the treatment referred to in the application where it speaks of carbonized paper covered with powdered plumbago, and the product thus indicated would be substantially a conductor of carbonized paper and nothing more, just as a stove treated with stove polish (which, by the way, is substantially powdered plumbago) would be neither more nor less a stove after such treatment. It was, therefore, I think a perfectly proper change, involving no substantial or material modification, to omit this reference to plumbago and to speak of the carbonized paper in the patent without this addition, just as it was referred to in the third claim of the application, where it is described as an arc of carbonized paper.

As regards the second point, the omission of the word "charcoal," this appears likewise to be a very proper change and 2002 to have acted in fact as a means of narrowing and not expanding, the subject-matter. "Charcoal," in the art of electric lighting, was undoubtedly used very generally as an expression for any kind of carbon electrode used for producing the ordinary electric light. The way this came about was very natural. The electric light when first exhibited by Sir Humphrey Davy was made between electrodes of wood charcoal, and though it *it* was very soon found that the hard carbon obtained from gas retorts and known as gas carbon was, in many respects, much better for this purpose, and was consequently generally substituted for wood charcoal, the old name was still employed for the new substance, and, even when the artificial carbon rods made by various methods came to be employed in electric lamps or regulators, the name "charcoal" was still very frequently used to designate them. This appears from a number of references to patents stated in the deposition of Prof. Cross in this case in answer to question 5, and also from the following references which I will quote:

"A Manual of Electricity, etc., etc., by Henry M. Noad, Ph. D., F. R. Soc., London, 1859, p. 316.

"It is this more rapid consumption of the positive than the negative carbon which has hitherto been one of the chief difficulties in the application of the electric light to practical illumination. Many attempts have been made to overcome this difficulty, but the most ample, perfect and portable apparatus are those invented by M. Jules Duboscq and by M. Deleuil.

"The object to be attained is the maintenance of the charcoal terminals at a constant distance from each other. The lower or positive carbon is, in Duboscq's lamp, pressed upward by a spring, the action of which is regulated by an endless screw set in motion by a lever which is worked by an electro-magnet; this electro-magnet, inclosed in the pillar of the lamp, is only active when the circuit is complete; the moment therefore the *charcoal* terminals become separated, its iron keeper is detached, and the action of the spring, previously restrained by the screw, is put in force
2003 and the carbon terminals are again brought into contract.

"P. 317, Fig. 179, represents the arrangement of Foucault's experiment of throwing the image of the carbon terminals during ignition, by means of a lens, on a screen, and shows in a beautiful manner, the gradual wearing away of the positive, and the increase of the negative carbons. The small globules or specks observed on the *charcoal* arise from the fusion of the minute particles of silica contained in the *coal*. When the voltaic current is thrown on, the negative carbon first becomes luminous. * *

"P. 315 (413) Fig. 175, represents the appearance presented by the voltaic flame between pencils of 'well-burned boxwood *charcoal*, or, which answers better, between pencils formed of that plumbago-like substance found lining the interior of long-used gas retorts." (The italics in the above quotation are mine.)

Even in works on chemistry, it was usual to employ the term "charcoal" very broadly, to cover any artificial carbonaceous product, as distinguished from the natural carbon in the form of coal. Thus, in the extended work by Gmelin on chemistry, in nineteen volumes, I find in volume 2, page 86, as follows:

"2. Charcoal. This form of carbon is obtained by strongly igniting in a covered vessel such non-azotized organic compounds, as, on burning, leave no fixed residue, *e. g.*, pure sugar—or by passing the vapors of volatile organic compounds, such as alcohol, ether, volatile or fat oils, through white-hot porcelain tubes. Page 84, Cagniard Delatours artificial diamond is charcoal intimately mixed with a hard crystalline slag containing aluminia and sesqui oxide of iron, together with silica and sesqui oxide of manganese."

In Knapp's Chemical Technology, vol. 1, p. 59, I find as follows: "Carbonization of pit coal. General principles. The charcoal which is left as the residue after the action of heat upon pit coal is commonly called coke."

Such references might be indefinitely multiplied, and indeed in

French works the word charbon, which strictly means char-
2004 coal, is almost always used for every form of carbon, although the word carbone, which strictly means carbon, is also occasionally met with.

In view of this breadth and indefiniteness of the word "charcoal," it seems to me evident that its omission from the patent in suit was highly proper, and decidedly in the direction of narrowing the scope of the invention.

Lastly, Dr. Barker, at this place refers to the omission of "ordinary gas carbon," as one of the possible materials for the incandescent conductor in the patent in suit. This is undoubtedly a change, but it is a change in the direction of a narrowing or limiting the scope of the invention, and the result of it is, that, while conductors of an arched form made from this kind of carbon would be included under some of the claims of the first application, they would not be included under any claim of the patent in suit.

In his answer to question 29, Dr. Barker says, in effect, that he does not consider the references to carbonized paper in the 3d claim, and to carbonized fibrous or textile material in the fourth claim, such as to indicate a preference for a specific kind of carbon. As to this, I can only say, that I entirely disagree with him, and think, on the contrary, that it would be impossible for a patentee to more emphatically indicate his preference for certain materials, than by making them the prominent features in special claims, as is here done.

In his answer to question 30, Dr. Barker again refers to the omission of the word "charcoal," and suggests an imaginary reason for this change. It does not seem to me that any such exercise of the imagination is called for, or that there is any foundation for the assumptions made by Dr. Barker, viz., that the inventors, between the times of their application and the issue of the patent, found out that charcoal was not a good material and must be excluded. What I have already said as to the undoubted breadth and ambiguity of the word "charcoal," furnishes, I think, an abundantly sufficient reason for the change.

In his answer to questions 31 and 32, Dr. Barker states
2005 in effect, that he agrees with Mr. Pope in thinking the words "wood carbon" and "charcoal" to be used as alternative expressions in the application, and that he also thinks that either term was intended to indicate commercial charcoal, or the result of any process of carbonizing wood. I agree with him as to the first part, but not as to the last of this statement. In other words, I think that the patentees intended in the application to indicate equally by the term "wood carbon" or "charcoal," the carbonized vegetable fibre or textile material specially indicated in their fourth claim, and that they used these words just as one might to-day use them in reference to the ordinary incandescent lamps in general use.

It would be quite correct to-day, in one sense, to speak of the incandescent conductors of ordinary electric lamps as consisting of wood carbon or charcoal, but it would involve undoubtedly some ambiguity, and it was, I think, to rid themselves of this ambiguity that the term "charcoal" was omitted from the patent in suit, as I have already pointed out.

In Dr. Barker's answer to question 33, he expresses his inability to understand what was meant by the expression "carbonized paper covered with powdered plumbago," although at the outset he says:

> "It seems to me that it means paper which has been carbonized and which is covered with plumbago."

This first impression of Dr. Barker's seems to me to have been a very correct one and agrees entirely with my own, and I think if Dr. Barker had remembered in this connection the common practice of finishing off carbon electrodes by rubbing them over with pulverized plumbago, which is, among other places, referred to in the Carré French patent No. 111,064, January 15, 1876, he would have been satisfied with his first impression without the rather unsuccessful efforts to develop it by considering all the possible or 2006 impossible processes that might be adopted to produce a piece of paper which had been carbonized and covered with plumbago.

In his answers to questions 33½, 34, 35 and 36, Dr. Barker in substance considers more in detail what strikes me as an utterly irrational suggestion as to what might possibly be meant by carbonized paper "covered with plumbago," viz, that it meant paper which had been covered with plumbago first and then attempted to be carbonized afterwards, not by any known process of carbonization, but by the passage of an electric current. As this entire suggestion seems to me utterly impracticable and indeed bordering on the limits of absurdity, it is hardly necessary to follow through all that has been said about it, but I will only say that in my opinion no such idea ever entered the minds of the inventors or is expressed in their application, and therefore that no change from an inoperative to an operative method is involved in the statement in the patent in suit where the words "covered with powdered plumbago" are left out and only the words "carbonized paper" are used.

In his answer to question 37, Dr. Barker states in substance that he agrees with Prof. Brackett in the opinions expressed by the latter in answer to questions 25, 26 and 27, and that he thinks the invention described in the patent in suit has been expanded so as to include structures quite different from those contemplated by the inventors at the date of the first application.

Having already pointed out that the original application contains everything necessary for the production of an efficient incandescent electric lamp containing every feature set forth in the patent in suit, I do not think it necessary to further discuss the imaginary motives which Dr. Barker assigns in this answer, as the reasons for equally imaginary and non-existent changes, and therefore I will only say, in this place, that I disagree entirely with the opinion here expressed by Dr. Barker as to the existence of any such changes as he suggests between the application and final patent, 2007 and therefore, of course, as to any significance which he supposes he has found in these changes which he has imagined.

Dr. Barker, in his answer to question 38, goes over substantially the same ground as in his previous answer, that is, assumes that differences exist and points out their significance. I have entirely failed to find any such changes, and therefore, of course, fail to see any such significances.

In his answer to question 39, Dr. Barker simply states his agreement with Prof. Brackett, and I will therefore leave that subject until I take up Prof. Brackett's own statement.

In his answer to question 40, Dr. Barker says in substance that he does not think that the mere mention of carbonized paper in the application, by itself indicates that the inventors intended to employ a fibrous material, shaped before carbonizing, or that a successful result would necessarily follow a process of construction founded upon such a meagre suggestion. Under the peculiar conditions assumed in this question and answer, Dr. Barker might be correct, but these assumptions do not represent anything before us in the present case. As I have already fully explained, the reference to carbonized paper is the least part of the instructions given by the original application on this subject, and I do not think there can be a shadow of doubt in any unbiassed mind that an intelligent artizan, with a knowledge of the art up to 1880, and the original application before him, would be certainly successful in producing an operative incandescent electric lamp by simply following, in the most straightforward and natural way, the directions and indications contained in that document.

Turning next to the testimony of Prof. Brackett, I find that in his answer to question 20, he states in substance that he finds only a remote and distant connection between the invention described and claimed in the patent in suit and the invention described and claimed in the original application. His reasons for this general opinion seem to be that he finds in the original specification special prominence given to the form of the incandescent conductor, while in the patent in suit the material of this conductor is made 2008 equally if not more prominent. As I have already pointed out, however, and as Prof. Brackett cannot, I think, deny, the material is clearly indicated and expressly claimed in the original application, and a change as to the relative prominence of two features, even if it existed, would involve no substantial modification of the invention, both features being in both documents fully stated and distinctly claimed. In the next place, Prof. Brackett remarks upon the omission of the "powdered plumbago" in connection with the "carbonized paper." What I have said in reference to this point in connection with Dr. Barker's remarks on the same subject, will apply to this case and need not be repeated. It is, I think, perfectly clear that the omission of "powdered plumbago" has no substantial effect or significance. Prof. Brackett next mentions the omission of "gas carbon." This, as I have already pointed out, is a change tending to narrow the scope of the invention and therefore altogether proper and commendable.

In his answers to questions 21, 22, 23 and 24, Prof. Brackett goes over the same ground about "wood carbon" and "charcoal," carbonized paper covered with "plumbago," and the possible and impossible processes which might be supposed to result in the production of such an object, which I have already discussed in connection with Dr. Barker's testimony, and I will, therefore, only say in this place that my previous remarks apply to these answers of Prof. Brackett, as they do to the corresponding ones of Prof. Barker, and, therefore, need not be here repeated.

In this connection, however, I will add a quotation from Mr. Edison's testimony showing his opinion as to this remarkable method of interpreting the expression "carbonized paper covered with pulverized plumbago."

"Question 445. In your opinion could a practical carbon for incandescent lamps be made by impregnating paper, such as blotting paper, with powdered plumbago, and then carbonizing it by passing an electric current through it?

2009 A. Do you mean in a vacuum or how?

446 Q. Either in vacuum, or air or nitrogen or illuminating gas?

A. My opinion is that it would require a great stretch of the imagination on the part of any expert skilled in the art, to conceive of a practical filament being made in this way. If you carbonize in vacuum there is never any carbon left in the paper. There is about forty-seven per cent. of carbon in paper, the balance being water and the oxygen of the water is sufficient to burn up all the carbon."

In his answers to questions 25, 26, 27, 28, 29 and 30, Prof. Brackett discusses the question of the enclosing chamber as referred to in the patent in suit and in the original application, and expresses the opinion that there is a radical difference in this regard between the inventions described in these two documents in this respect. In this, however, I entirely disagree with him. He does not seem to have realized that the reference in the application to the prior patent 205,144, practically brings everything contained in that patent into the application, and that, if we study the structure shown and described in that patent, we shall find it to contain everything that is indicated in the patent in suit and to correspond accurately with the language of this final patent.

Prof. Brackett seems to find particular difficulty with the passage in the patent in suit which states — "the sealing of the electrodes where they pass through the glass wall is done with any suitable cement, or in any of the well-known methods of sealing glass upon metal electrodes previous to the filing of this application," which he does not find in the original application. Now, in reference to this, I think it is only necessary to say that the earlier patent, 205,144, having described fully various methods of sealing in the electrodes,
2010 all other methods known at that date were by implication
included, and the use of them would have been involved

without any further statement or specification. Consequently, the specific statement on this subject referred to, is no change or addition to the invention, but is simply explanatory, and therefore is an entirely proper addition to the original application.

In reference to the comments made by Mr. Edison as to the differences he finds between the original application and the patent in suit, I used only say that I find in them nothing differing in substance from what has been already referred to in the depositions of Dr. Barker and Prof. Brackett, and that they, like the comments of these gentlemen, entirely lose weight and relevancy when each document is considered as a whole, and such fair interpretation is given to its various statements as I have endeavored to set forth in the early part of this answer.

Adjourned till Saturday, the 13th inst., at 10½ a. m.

NEW YORK, *April* 13, 1889.

Met pursuant to adjournment. Present: Mr. Wetmore for complainant, and Mr. Donnelly for defendant.

16 Q. Do you find anything described and referred to in any of the claims of the patent as issued which you do not find described in the application as originally filed?

A. I do not.

17 Q. Do you agree with the opinion expressed by defendant's experts that there is no suggestion in the application as originally filed that would lead a person skilled in the art to shape the material in either dimensions before carbonization, or to select such material as was already shaped? I call your attention particularly to Prof. Brackett's answer to question 22 and Prof. Barker's answers to questions 41 and 42.

2011 A. I do not at all agree with defendant's experts, but on the contrary consider that the original application contains very clear and distinct instructions, leading, first of all, to the selection of material which would be of necessity already shaped prior to carbonizing, and, secondly, to the shaping of such material as might require it, also prior to carbonizing.

In Prof. Brackett's answer to question 22 he confines his attention, as directed in the question proposed to him, to the words "carbonized paper covered with powdered plumbago." This of course places him at a great disadvantage as compared with an intelligent artizan, who would have had the entire patent before him, and, having been put on the right track by the references to textile material and vegetable fibre, would require the exercise of considerable ingenuity to escape seeing that the paper carbon was to be shaped prior to carbonizing just as the threads and other textile materials made of vegetable fibre had been. But even aside from this, I am at a loss to understand how any one under any circumstances should fail to perceive that when they were directed to make a conductor in an arch shape out of carbonized paper, the proper and natural way of carrying out such instructions, would be to cut the paper into the arch shape, or cut it into a straight strip and then bend it into an arch shape, prior to carbonizing.

Prof. Barker in his answer to questions 41 and 42, cannot claim the same excuse as Prof. Brackett, because, though the questions limited him to the words "carbonized paper covered with plumbago," or rather "carbonized paper," he says at the opening of his answer to question 41,

"I do not find in the application referred to any expression whatever which seems to me to justify such a conclusion,"

which would certainly imply that he had taken into consideration, not only the special reference to carbonized paper, but also the entire application. Such a conclusion, founded upon such premises, is to my mind simply irrational, and I can hardly believe that Dr. Barker really meant what he says in this place. This impression is confirmed by what follows in his answer, in which there is no reference whatever to those parts of the application which so clearly indicate the shaping before carbonization of a fibrous or textile vegetable material, but where I find an extended reference to a series of imaginary difficulties which would never present themselves to an intelligent artizan or require any experiment to overcome them, except such trials as to the best dimensions and proportions as are usual in the construction of any new form of machinery or apparatus. 2012

Dr. Barker's suggestion in his answer to question 42, that the "carbonized paper covered with plumbago," might mean paper which was covered with powdered plumbago and then carbonized by an electric current (which even Mr. Edison considers absurd), and that it might mean carbonized paper covered with so much powdered plumbago that the carbonized paper would be of no account, and the pulverized plumbago be the efficient conductor (this being in a patent in which the fibrous character of the material is so clearly developed as in this), do not seem to me to be worth serious consideration, and their force or weight becomes emphatically a vanishing quantity if we consider what the application says elsewhere, as well as what it says in the few words specially referred to.

18 Q. What is your opinion as to whether or not it would naturally occur to any electrician that he could change the thickness of the paper after carbonization, as suggested by Prof. Brackett and Prof. Barker?

A. I think that any electrician who had any familiarity with the property of carbonized materials would know that, while it might be a possible thing by the use of great skill and the expenditure of much time, to change the dimensions or shape of a piece of carbonized paper after carbonization, such a thing would be a mechanical feat of the greatest difficulty, and would be all but infinitely more difficult than to shape the paper beforehand and carbonize it afterwards. Moreover, he would know that his chance of producing a conductor of uniform conductivity would be almost infinitely greater when he shaped the paper before carbonizing than when he shaped the carbon afterwards. 2013

19 Q. Have you read the testimony of Profs. Brackett and Barker herein, and examined all the patents and publications put in evidence by the defendant relating to the prior state of the art?

A. I have.

20 Q. Defendant's experts have expressed the opinion that in view of the prior state of the art as shown in said patents and publications, there was "no novelty in the use of vegetable fibrous carbon as the incandescent conductor of the lamp of the patent in suit." Please state if you concur in this opinion, and give your reasons for any opinion you may express. I call your attention particularly to Prof. Brackett's answers to direct question 5, and cross-questions 41, 42 and 43, and Prof. Barker's answers to direct questions 9 and 47, and cross-questions 56 to 65 inclusive?

A. In his answer to question 5, Prof. Brackett enumerates and describes a long list of patents and publications which he there seems to think in some way or other anticipate the invention set forth in the patent in suit, but in his answers to questions 41, 42 and 43, he narrows down this broad field, by admitting that the best references as regards the use of a fibrous carbon or carbon made from a fibrous substance, are to be found in a paper by Violette, the description of Sidot's process, and the Binks English patent; and as anticipating the combination of the second claim of the patent in suit, that is, the combination of an incandescent conductor of carbonized fibrous materials with a transparent, hermetically sealed chamber, he finds the best anticipations in the English patent to De Moleyns, that to Greener and Staite, that to Shepard, that to Roberts, and the Lodyguine publication.

Dr. Barker, in his answers 9 and 47, in effect agrees with Prof. Brackett as to his large number of anticipations, but in his answers 51 to 65 inclusive, he also limits this broad field to the following publications, viz., English patents to Roberts, Shepard, Greener and Staite, and Konn, and the Lodyguine publication. Combining
2014 these together, we have the English patents to Roberts, Shepard, Greener and Staite and the Lodyguine publication agreed to by Profs. Barker and Brackett as the best anticipations, and the patents of Binks, Konn and De Moleyns, and the papers of Violette and Sidot referred to by one or the other of these gentlemen.

These I will consider in the order in which I have just named them.

In the first place, Roberts' English patent No. 14198 of 1852. On page 11 of this patent there begins a description of an incandescent electric lamp consisting of "a thin piece of graphite, coke or charcoal or other infusible body being a conductor of electricity while it is enclosed in a vacuum or space not containing any oxygen or other matter which can cause the combustion or destruction of it when brought into an incandescent state by the action of the current of electricity." There then follows the description of the lamp, having reference to a drawing. In this description the incandescent conductor is referred to six times as "graphite," and never by any other name. It is also shown in the drawing as a straight rod held between two clamps. It would therefore appear that in this patent there is no reference whatever to a conductor of an arched form, none whatever, nor the remotest suggestion, as to the employment of a fibrous or textile material which might be shaped prior to carbonizing, and no reference, even the most remote, to anything having a fibrous structure, except the one use of the word charcoal, provided we understand that word in its popular sense as meaning wood charcoal and not in its electrical sense as meaning such forms of carbon as were generally employed in electric lamps. In my opinion it is perfectly manifest that the word "charcoal," as used in this patent, is used in its technical electric sense, and does not mean wood charcoal, but does mean any of the various artificial carbon structures such as were used, and are used, in the production of the ordinary electric light, viz., the arc light. The repeated use of the name 2015 "graphite," and the knowledge which existed at that date that graphite possessed superior forms of resistance to any other form of carbon except the diamond, would, I think, of necessity result in the conclusion on the part of any one reading this patent that graphite or graphite-like material, such as gas-coke or similar resisting carbon, was the material to be used in carrying out this invention, and that to use wood charcoal or any like vegetable product would be to depart radically, and probably with disastrous results, from the instructions here given.

It is also to be noticed that in the description of the Roberts lamp, there is no instruction nor suggestion as to the making the transparent lamp chamber entirely of glass, but, on the contrary, the structure is shown as a flask-shaped globe cemented into a metallic cap, through which the electric conductors are passed, one of them, at least, being surrounded by an insulating sleeve of ivory. From this, I think it will be very manifest that not one of the important and characteristic features, which I have especially pointed out as distinguishing the invention of the patent in suit, is found in this Roberts patent. That is, it neither shows an arch-shaped incandescent conductor, nor one made from vegetable fibrous or textile material, nor an enclosing air-tight chamber made wholly of glass, and, therefore, in no respects at all, anticipates the invention of the patent in suit.

Considering next the Shepard patent No. 13302, of 1850, I find this to describe at page 9, an apparatus which may be correctly described as one for producing light by what is known as the arc incandescent system, that is, a system in which light is produced by the passage of an electric current through the high resistance produced by the imperfect contact between two pieces of carbon, one of which is continually fed forward as it is consumed at the end where the imperfect contact exists. In the apparatus described in this patent, there is a small cylinder of charcoal supported and guided by a vertical metal tube, within which it slides. The lower 2016 end of this rod of charcoal rests on the upper end or apex of a cone of "prepared charcoal or coke." Both of these are supported within a glass globe having a carefully luted stopper, and proper electrical connections. The only available light produced in this apparatus, would be that developed at, and close to, the point of contact between the conical point of prepared charcoal or coke, and the end of the cylindrical rod of charcoal, because the rest of the charcoal would be enclosed within the copper tube. Even then, if we assumed that in this case this thin rod of charcoal was made of wood charcoal, which perhaps it may be in view of the distinction that the little cone D is of "prepared charcoal or coke," the thin rod of charcoal would not act as the incandescent conductor of an electric lamp, because, in the first place, even if it acted by incandescence, the light so produced would not be availed of in the lamp, and, secondly, because it would not act properly by incandescence, but could only operate by the arc incandescent action which I have before stated. In addition to this, it is manifest that there is no suggestion of an arched form, nor of the use of vegetable fibrous or textile material in any way in which the peculiar properties of such substances would come into play. I should therefore say that, in the first place, this was not an incandescent lamp in the proper sense of that word at all; that it had no incandescent conductor in the proper sense of that expression as constituting part of an electric lamp, and nothing which would either suggest or admit of making such a conductor in an arched form, and likewise no suggestion of the use of fibrous or textile material in the production of any part of the lamp. It is, therefore, plainly no anticipation of the patent in suit.

Considering next the patent of Greener and Staite, No. 11076 of 1846, I do not find that this describes any form of apparatus, but in the first place, simply states in general terms that the inventors propose to illuminate various places by means of solid prisms or cylinders of carbon enclosed in air-tight vessels of glass or some other transparent substance, and ignited, or rendered luminous, 2017 by currents of voltaic or magnetic electricity, such carbon being previously freed from the impurities with which it is ordinarily combined, etc. The patentees then proceed to describe at length their method of producing the carbon material, in which they start with lamp-black or charcoal or coke, all reduced to powder. These powders they then treat with acids, alkalies and water, and, having dried them, form from them solid prisms or cylinders by means of hydraulic or other presses. They then proceed to describe the uses of these prisms or cylinders in a manner which is only consistent with the supposition that they are employed for arc lights, and then describe a further use which is only reconcilable with the idea that they intended to employ their artificial carbon cylinders in the manner of the arc incandescent lights. Taking it altogether, this patent clearly describes no structure whatever which can be regarded as constituting an electric lamp, but it does describe the manufacture of prisms or cylinders out of various forms of carbon reduced to powder. It says absolutely nothing about forming conductors in an arch shape, and is equally silent as to the use of any fibrous or textile material in the production of carbon conductors, because I do not regard the reference to powdered charcoal as containing the faintest suggestion containing the utility of a fibrous or textile material in the production of an arch-shaped conductor for an electric lamp. As this patent, then, contains not one of the elements constituting the invention of complainant's patent, I cannot see the slightest ground for referring to it as an anticipation of that patent.

Turning next to the Lodyguine publication in the London Journal of the Society of Arts, August 27, 1873: This, as I understand it, is an abstract or translation from a Russian newspaper which describes in a popular way the exhibition of some electric lamps made at St. Petersburgh by Messrs. S. A. Kosloff & Co. In this description the lamps exhibited are referred to as producing their light by the glowing of a piece of charcoal enclosed in a glass tube from which the air has been exhausted and which had 2018 then been hermetically sealed. In this document it is manifest that the word "charcoal" is used, not in the popular signification of wood charcoal, but in the technical electric sense of hard carbon, such as is, and has been almost from the first, used in the production of the arc light. This appears from the second paragraph of this article which read as follows: "By the old method the electric spark was passed between two points of charcoal, each attached to a copper wire connected with an electro-magnetic machine."

I think I can assert with the utmost confidence that an electric light was never produced between points of wood charcoal by a current from a magneto-electric machine. Long before the magneto-electric machine came into use, the pencils of hard carbon were devised and manufactured, and no one would for a moment think of employing wood charcoal, which was entirely unfit for any continuous maintenance of light with these machines, which were specially adapted for long-continued and uniform operation. It is therefore manifest that the writer of this article, when he spoke of charcoal points for the arc light, meant what we should now call hard-carbon pencils or rods made by the process of Carrè or the like, and that, when he used the same word a little further on to describe the incandescent conductors of the electric lamps used at St. Petersburg, he meant the same thing and would convey that meaning to any one skilled in the art who read this paper. Certain it is that there is here no mention of any arch-shaped conductor and no suggestion that such arch-shaped conductor was made out of fibrous or textile material, or even out of paper, or that any of these materials were to be put into an arch form prior to carbonizing. The only feature in common between this description and the patent in suit, is that in both cases incandescent carbon conductors are enclosed in exhausted air-tight glass vessels, but this is certainly not enough to render this publication in any sense an adequate anticipation of the patent in suit with its three prominent 2019 features of an incandescent conductor made of fibrous or textile material, having an arch shape, and being enclosed in a vessel wholly of glass.

Taking up, in the next place, the Konn patent No. 3809 of 1872: This patent describes an incandescent electric lamp consisting of a glass globe or cylinder containing a conductor, preferably of graph-

ite, in the form either of a straight rod or of a V-shaped piece. The glass globe is stated to be hermetically sealed and filled with nitrogen or other gas that does not support combustion. Graphite is described as the preferred material for the conductor, and graphite conductors are alone referred to in this patent, and therefore it seems to me that this patent contains no suggestion whatever as to the employment of a fibrous or textile material for the production of an incandescent carbon, since such material would be the very furthest possible removed from anything that the name graphite suggests. I do not at all agree with Dr. Barker that because the inventor says "preferably graphite" any intelligent person would understand that something utterly unlike graphite was also suggested, but on the contrary, I should consider that the preference for graphite indicated rather a preference for materials which were like graphite, such as the gas carbons and artificial carbon pencils well known at that date. Again, I do not understand that a carbon conductor in a V form shown in this patent, has any of the advantages present in the arched form, and therefore I do not consider carbon conductors of a V form referred to in this patent, as in any way suggesting the arch-formed carbons made of fibrous or textile material characteristic of the invention of the patent in suit. One of the most important advantages resulting from the arch form is, that it secures a perfectly uniform distribution of any strain brought upon the conductor by changes of temperature or any other cause, and another is, that it involves a uniform cross-section throughout the conductor, and another is, that it increases the length of the conductor without a corresponding increase in the size of the
enclosing vessel. None of these advantages would exist in
2020 the V-shaped conductor shown in the Konn patent, because
this conductor would be of very irregular cross-section; any
strain brought upon it would be unequally distributed, and its increase in length would be quite insignificant.

I therefore do not find in this patent any anticipation of the patent in suit, as to the character or form of the conductor, and nothing adequate as to the enclosing vessel wholly of glass, since there is nothing in the Konn patent suggesting this feature.

Turning next to the De Moleyns patent No. 9053 of 1841, I find here described a structure which seems to me entirely irrelevant to the present subject. It consists of an exhausted glass globe containing spirals of platinum wire heated by an electric current and an arrangement by which carbon in a condition of fine dust may be made to pour over these coils and glow by heat obtained in falling over them. I believe that this would be entirely inoperative and that the falling of the carbon powder would simply serve more or less to cut off or extinguish the light given by the platinum spirals. But aside from this, it hardly seems necessary to say that such a contrivance has substantially no relation whatever to an invention consisting of an incandescent conductor of an arched form, made out of carbonized fibrous or textile material and enclosed in a chamber wholly of glass.

Finally among these patents I come to that of Binks, No. 119 of

1853. The Binks patent may, I think, be easily disposed of as completely irrelevant, because it describes no form whatever of incandescent electric lamp, but only arc lamps and the electrodes used therein. Still further, the only form of purely carbon electrode, even for an arc lamp, is one formed by subjecting lignite to destructive distillation in closed vessels, by which the patentee says he obtains a hard, close-grained charcoal. The patentee also speaks of forming another sort of electrode by coating metal with tar, pitch, etc., and heating in closed vessels, but these likewise are used, as the patent plainly states, for the production of arc lights, and he also does the like by coating metal with slips or cuttings of charcoal or charcoal veneer. 2021 The fact that this patent contains no reference to incandescent lamps of any sort, would, as it seems to me, dispose of it in relation to the present case, but, as Prof. Brackett seems to think that lignite is not a mineral, and that therefore the production of carbon electrodes, even for the pencils of arc lamp from lignite, has some sort of reference to the use of fibrous textile material for the carbon conductors in incandescent lamps, it may be worth while to mention that, in the opinion of mineralogists, at least, lignite is a mineral despite the fact that, like the diamond and all forms of coal, it is undoubtedly of vegetable origin and contains more or less trace of its original structure.

Referring to Dana's Mineralogy, published in New York, 1877, I find on page 395 the general title "Mineral coal" and on the next page under the same general heading, "C., Brown coal, * * * (lignite.) Brown coal is often called lignite, but this term is sometimes restricted to masses of coal which still retain the form of the original wood."

In a work published by the U. S. Government, entitled "Mineral Resources of the United States," by Albert Williams, Jr., chief of division of mining statistics and technology, I find on page 85 as follows: "Wyoming. * * * In quality the coal is a lignite of superior grade."

It is unnecessary to multiply such references, and I will therefore only say generally that I find lignite referred to everywhere in works on mineralogy, and nowhere in works on botany, which makes me think that it would not naturally suggest the use of vegetable fibrous material to the ordinary intelligent artisan.

I notice another apparent slip or oversight on the part of Prof. Brackett, where, in reference to the Binks patent, he speaks of the thin carbon plates or veneers as being there described as used for incandescent lighting. I do not think he could have read this part of the patent with its context attentively, or he would 2022 have seen that the "electrodes" produced in this manner were clearly intended for use in arc lamps, the only kind anywhere referred to in this patent, and that the idea of their preparation was the same as that involved in the copper plating of arc light electrodes for arc lamps, so generally employed at the present day, viz., the reduction of the resistance of the electrode by the addition of a copper conductor, which Binks proposed to put inside, while in modern practice it is put outside.

Aside from all this, however, it is, I think, manifest at a glance that the Binks patent is no anticipation of the patent in suit, in so far as this patent describes the conductor of an incandescent lamp made of carbonized fibrous or textile material, of an arch shape, and enclosed in an air-tight vessel wholly of glass.

Adjourned till Monday, the 15th inst., at 11 a. m.

NEW YORK, *April* 15, 1889.

Met pursuant to adjournment.

Present: Mr. Curtis for complainant, and Mr. Donnelly for defendant, and the examination of Prof. MORTON was continued as follows:

Witness continues:

At the conclusion of the last session I had gone over all the patents referred to by either Prof. Brackett or Dr. Barker as containing the best of their references as anticipations of the patent in suit. Prof. Brackett refers also to two publications, one being that by Sidot in the Comptes Rendus. This I find to describe a method of carbonization of various materials, including many vegetable fibrous substances by enclosing them in highly heated tubes through which sulphide of carbon is made to pass. The author characterizes the product thus obtained in the following words:

> "It may be characterized from a point of view of conductivity as wood charcoal transformed into coke."

2023 The only reference to electric light in this article is the following:

> "The pencils made of them give an electric light far more intense than the light obtained with carbons from gas retorts."

From all this it will, I think, appear that in this article we have no suggestion whatever as to the use of carbon from vegetable fibre or textile material, made into an arc form, as the conductor of an incandescent electric lamp, but have only information as to a method of converting such materials into coke whereby their utility in replacing the ordinary arc light electrodes, generally made from gas coke, was set forth.

Finally, Prof. Brackett refers to a paper by Violette, published in the American Journal of Science and Arts in 1853. This describes a method of producing a red charcoal, specially fit for the manufacture of gunpowder, by the use of superheated steam. Incidentally the author notices that charcoal made at a high temperature conducts better than the charcoal of gas retorts, and serves better for electric illumination. It is hardly necessary to state that the electric illumination here referred to is arc lighting, carried on by the use of electrodes of gas carbon, and that this article on the preparation of charcoal for gunpowder and its incidental allusion to the improved conductivity of carbon prepared at high temperatures and its consequent usefulness for the electrodes of arc lights, contains no suggestion as to the subject-matter of the patent in suit.

I have now considered all the publications referred to by defendant's experts as being the best in the way of anticipations. As regards the other references to which they have referred in their direct examination, I will not spend the time which would be necessary in order to consider them in detail or individually, but will simply say in general terms that they divide themselves into two classes, the first consisting in scientific papers and researches, which, while developing a great many interesting facts in connection with the properties of carbon and other substances in their 2024 relations to electric currents and the like, do not in any way describe, and are not claimed by anybody to describe, any such structure or combination as constitutes the invention set forth in complainant's patent, and therefore, while these references are interesting as matters of information and to aid in explanation, they have no force and weight whatever if considered in the light of anticipations. The other class consists of patents which either have no reference at all to the subject-matter of the patent in suit; being patents for arc-light regulators, or the manufacture of electrodes for arc lamps, or for incandescent lamps with metallic conductors, or are incandescent lamps with conductors of hard carbon developing properties exactly the reverse of those called for in the invention of the patent in suit. As the experts for defendant have themselves considered these references less complete and appropriate than those which I have recently considered in detail, and as I have shown that not one of these references contains the invention of the patent in suit or anything like it, it seems to me that it would be a waste of time to enumerate these inferior references more particularly, and that it will be enough for me to say that I find them one and all either less relevant, or quite irrelevant to the invention of the patent in suit, as compared with those which I have above discussed individually.

21 Q. Do you agree with the statements made by Professor Cross in his answer to question 5 of his deposition in this case in regard to the meaning of the term "charcoal," in the art of electric lighting prior to 1880?

A. I entirely agree with Professor Cross that in the art of electric lighting prior to this date, the term "charcoal" was commonly used in a generic sense to indicate any sort of carbon used as the electrodes or pencils for the arc electric light. The fact of this use appears from the numerous quotations from patents which Professor Cross has given, and to which some others might be added, and also from the quotations which I myself have referred to in a previous answer. As I also there explained, the origin of this 2025 use of the word is a very simple and natural one, having many analogies. Charcoal being the first substance used to construct these pencils or electrodes for the arc light, the name continued to be used even when the material was changed, as it very soon was, by the substitution of gas carbon or artificially prepared electrodes. We have analogies to this in the use of such terms as that of "chalk," for the material employed in writing or drawing on a blackboard, this material now being, and having been for the last twenty-five years, no longer the mineral substance known as chalk, which is a natural carbonate of lime, but an artificially prepared sulphate of lime. So again the term "steel" is used for an instrument employed to sharpen a carving-knife, even when that instrument is made of china or of some mineral material. The name was at first proper, because the instrument was made of the metal steel. So we speak of a "chandelier," which, of course, strictly means a candle-holder, even though no candles are connected with it, but it is used for gas. So again the term "soda water," is applied to the familiar beverage in the preparation of which soda is no longer used. So again we speak of "galvanized" iron, meaning iron coated with zinc, though no galvanic treatment is now employed in its preparation, the coating being obtained by simple immersion of the iron in a bath of melted zinc. So again the word "pen" is now used for a steel instrument, though originally it meant a quill only, from the latin word *penna*, a quill; and undoubtedly the term "paper" is directly derived from papyrus, although the material paper is an essentially different one in its origin and structure as well as mode of manufacture from papyrus or what would strictly come under the name paper by derivation. The term "lead-pencil" would be another illustration of the same use of a word for a substance to which it was no longer applicable. The "leads," as they are still called, of lead-pencils are in fact made of graphite, which is simply one form of carbon and has absolutely no connection chemically or otherwise with lead.

2026 22 Q. Taking into account this usage in regard to the term "charcoal" in the art of electric lighting, should you say that either the Roberts patent, the Shepard patent, or Lodyguine's publication in the Journal of the Society of Arts referred to by defendant's experts would specifically or primarily indicate to a person skilled in the art as it stood prior to 1880, that carbonized wood in any form was to be employed in the lamps described?

A. I do not think that this word would indicate anything of this character any more than would the word "carbon." It would be in fact the simple equivalent of the word carbon in all respects.

23 Q. Do you agree with the opinion expressed by Professor Barker in his answers to questions 44 and 45, that the Shepard patent describes a semi-incandescent lamp and that a hard or mineral carbon would be superior to one made from a carbonized fibrous or textile material for such a lamp?

A. I entirely agree with Dr. Barker as to both these points.

24 Q. Taking this also into consideration, do you think that a person skilled in the art would understand from reading the Shepard patent that wood charcoal was to be employed, or that any advantages would be gained from the employment of wood charcoal rather than some other form of carbon in the lamp?

A. As I stated in a previous answer I think that the term "prepared charcoal or coke" used in reference to the little cone "D," might suggest that the little cylinder of charcoal enclosed within

the copper tube might be made of wood charcoal or some similar soft form of carbon, which, yielding more readily to the destructive action of such air or gas as might remain in the globe, would exhaust its injurious effect and so tend to preserve the little cone "D," whose preservation would be absolutely essential to the continuous operation of the lamp. This would, of course, only be an inference which might be drawn, and would not amount to anything
2027 like a direction or distinct suggestion that wood carbon was advantageous generally in an incandescent lamp, but, would, on the contrary, be founded on a consideration such as would involve that, for ordinary use in an incandescent lamp, wood charcoal would be undesirable, the supposed desirable feature being one which only existed in this lamp in view of its peculiar construction, by reason of which the destruction of the pencil of wood carbon was to be sought for rather than avoided.

25 Q. In the light of our present knowledge, has carbonized fibrous or textile material as distinguished from other forms of carbon any peculiar fitness for use as the conductor of an incandescent lamp, and if so, in what does such peculiar fitness consist?

A. In the light of our present knowledge we know that to produce such an incandescent lamp as has proved itself to be commercially successful, fibrous vegetable material possesses special advantages, which are, first, that it is readily formed or shaped or may be obtained already formed or shaped prior to carbonization, such forming or shaping including the shaping into an arch form. In the second place, such material after carbonization lends itself readily to the treatment known as "tempering" and "treating," whereby its mechanical strength and uniformity of electric resistance can be readily increased and controlled. Thirdly, such material, after carbonization, is found to have a very high specific electric resistance, which is of great importance and value in the production of an incandescent light although without importance and indeed, on the contrary, an undesirable property in the electrodes employed for an arc light. Fourthly, conductors of this material have been found to possess remarkable properties of mechanical strength enabling them to resist shocks and strains to which they may be exposed, such strength being combined with an elasticity which is specially developed and utilized when their shape is that of the arch or loop. Fifthly, by the use of such fibrous vegetable structures it is comparatively easy to produce conductors which init-ally are of substantially uniform resistance, such uni-
2028 formity being due both to equality of structure and of cross-section throughout their length, and to the purity of their material, namely, the absence of mineral matter, which, being as a rule of high resistance in comparison with carbon, would introduce, if present, great irregularity in this respect.

26 Q. Has carbonized fibrous or textile material, as distinguished from other carbon, any peculiar fitness for use in arc lighting or in semi-incandescent lamps?

A. Not taken as a whole. In other words some of its distinguishing properties would peculiarly unfit it for these uses and would more than neutralize any beneficial effect from such properties as might be advantageous in arc lighting. For example, it is desirable that the specific resistance of the electrodes should be as small as possible. If we could make electrodes with no resistance at all they would be perfect or ideal electrodes for this purpose. Therefore a high specific resistance is in every way an undesirable and injurious property. The capacity of shaping prior to carbonization is of no practical value in connection with arc lights because the materials used for those lights are very readily gotten into shape and usually are so shaped while in the condition of powders already carbonized, or in other words while in the condition of carbon powders.

Their dimensions, also, are such that the question of mechanical strength is entirely immaterial, since their size gives them abundant resistance to any shock to which they would ever be exposed. Uniformity of resistance, in the sense or to the degree in which we consider it in the case of incandescent conductors, is also entirely immaterial in the case of the electrodes for arc lamps, in which such differences, in this respect, as would be serious in the case of incandescent conductors, are quite immaterial. The advantage coming from a purity in the material is one that would have some effect in reference to the electrodes for arc lights, but can be secured in the manufacture of those articles far more readily than by the use of fibrous vegetable material, since pure carbon in the 2029 condition of lamp-black or other preparations, can be readily treated in the manufacture of these electrodes, and will then produce a product quite as pure as anything that can be obtained from vegetable fibre. As these electrodes are never employed in an arch form, of course the capacity of assuming such form would have no value in connection with them.

27 Q. Aside from low specific resistance, what is the quality particularly requisite in arc-light carbons?

A. Resistance to combustion, or, in other words, what we may describe as hardness in this connection. In other words, an extreme density by reason of which, even at very high temperatures the chemical action of the air can have only a minimum effect upon the electrodes.

28 Q. How would carbonized fibrous or textile material comply with this requirement?

A. Very badly as compared with what are known as hard carbons, structures such as those produced from gas coke and the like. One of the reasons why charcoal was very early abandoned as a material for the electrodes of electric lights was just this fact of its rapid combustion or consumption by action of the oxygen of the air, and it was to escape this that even the very early experimenters used pencils of gas coke in place of rods or pieces of wood charcoal.

29 Q. What sort of carbon would best fulfill the requirements of semi-incandescent lamps?

A. In this case also a hard carbon, or just such an one as would be used for arc lights, because here, likewise, the object would be to secure a material of very low specific resistance and of high chemical resistance, as we may call it, or power of resisting the chemical action of the oxygen of the air upon the material.

30 Q. In your answer to question 20, in what sense did you use the expression "superior powers of resistance" as applied to graphite?

A. I meant in that case what I have just called chemical 2030 resistance, that is, resistance to combustion or the attack of oxygen.

31 Q. Would it be practicable in your opinion to conduct the modern commercial business of arc lighting with pencils made of the carbonized fibrous or textile material referred to in the patent in suit?

A. It would not be. Such pencils would have far too high a specific electrical resistance, and far too low a resistance to combustion.

32 Q. Would a person skilled in the art as it stood prior to 1880, or to the making of the invention described and claimed in the patent in suit, have been led naturally from the existing knowledge in regard to arc lights and semi-incandescent lamps to adopt carbonized fibrous or textile material as the conductor of an incandescent lamp?

A. Decidedly not. On the contrary, I think that the state of the art in this respect would have led him in the opposite direction, and would have indicated to him that the desirable thing was a carbon possessing the characteristic properties of what I have indicated by the term "hard carbon," or such as is produced from gas coke and like materials.

33 Q. Assuming that the prior patents and publications referred to by defendant's experts contain instructions to make the incandescent conductor of an electric lamp of wood charcoal, would this in your opinion be equivalent to, or lead to the same result, as the instructions contained in the patent in suit? You may assume for the purposes of your answer that the instructions of the patent in suit are simply to make the conductor of carbonized fibrous or textile material.

A. I do not consider that the instruction to make the conductor of wood charcoal would in any way be the equivalent of the instruction in the patent in suit to make the conductor of carbonized fibrous or textile material, and the following of such instructions would lead, I think, to entirely different results. That is, 2031 the instruction to make the conductor of wood charcoal would cause the artisan following such instruction to go, as I may say, to the charcoal barrel or charcoal bin and select from that material such a piece as he might find best suited to his purpose. He would then proceed to shape such a piece of charcoal in the best manner he could, and he would, I think, have great difficulty in producing any conductor sufficiently uniform in electric resistance to be available in an incandescent electric lamp. I do not see how under any circumstances he could make a conductor having the arched form which would be at all available. On the other hand, the artisan to whom the instruction had been given to produce the conductor from fibrous or textile material would naturally and at once seek out among the uniform fibrous or textile materials such as appeared suited for the purpose, namely, as I have already pointed out, he would take pieces of cotton or linen thread, or of grass-like or reed-like materials, such as he would be familiar with as used in textile structures. These he would find it easy to shape into conductors which, on carbonization in the usual manner, would be substantially uniform in electric resistance, and nothing would be easier than the shaping of such material into an arched form. Therefore it seems to me that the instructions referred to would be entirely different, and would lead to results radically unlike.

34 Q. Professor Brackett states, in his answer to question 5, that the advantages of the arch or horseshoe form of incandescent conductor are present whatever may be the material, whether it is a metal or carbon. Are you of the same opinion?

A. I do not at all agree with Professor Brackett, but on the contrary feel confident that the advantages of the arch form would only be fully or adequately realized in such a material as the patent in suit indicates, namely, carbonized fibrous or textile material. Thus, for example, if the conductor were of metal, its natural flexibility and elasticity would be such as to allow it to bend or change its form without injury, even if it were not originally made into
2032 an arch-shaped form, and therefore the beneficial effect of the arch form as relieving the strain would not be utilized or realized. On the other hand, if the material were hard carbon, then on account of the brittleness of that substance the strains produced by expansion might be likely to cause fracture in the arch form quite as much as, or more than, in the form of a straight pencil, because in the case of a straight pencil the expansion and contraction would force a yielding or movement on the part of the supports, and would be equally distributed through the conductor, whereas, when this conductor was in an arched form, the same strain would have more tendency to rupture the arch than it would to move the supports in the previous case. If, however, the material were such carbon as is produced by the carbonization of a fibrous or textile material, then this material having in itself considerable elasticity and flexibility, would, if made into an arch form, so yield that the strains produced by heating and cooling would be equally distributed and produce no injurious effect such as would result with the same material if it were not in an arched form, when its flexibility would be likely to result in a buckling or sudden bending at a single point or a few points, by which excessive strain would be developed at those points, and tend to cause fracture. It is therefore my opinion that the valuable results obtained from the arched form, as far as the question of distribution and strain is concerned, would only be adequately realized by the fibrous material indicated in the patent and not either by a metallic conductor or one made of hard carbon.

35, 36 Q. Do you agree with the opinion expressed by defendant's experts that the advantages of the arch form in providing for expansion and contraction are not present in the lamp described in the patent in suit, but that the conductor there shown and described is as liable to fracture in the arch form shown as it would be in the form of a straight rod or pencil?

2033 A. I do not agree with them, if it is understood, as of course it should be, that the material of the conductor shown in the patent is the carbonized fibrous material. In that case, even in the form shown in the patent drawing, such material would have sufficient elasticity to derive beneficial effect from the arched form as there shown. Of course I do not understand that the patent in its description at all confines itself to what I may call so low an arch as that shown in the drawing. On the contrary, the patent itself speaks of this arch as being of an arch or horsehoe shape and also as being an arch or loop.

37 Q. Do you agree with Professor Brackett in the opinion expressed by him in answer to question 35 that in the modern incandescent lamp the advantages arising from the capacity of the conductor to contract and expand without breaking or disturbing the position of the fixed terminals, would be present whatever the form of the conductor, whether that of a loop or of a straight piece?

A. I do not. On the contrary, I feel sure that if, in a modern lamp, the conductor were arranged in a straight piece it would be very liable to be broken, because on expanding it would be liable to buckle or bend substantially at one point, or on shrinking be subjected to a strain which would fracture it by tension.

38 Q. The patentees, in the specification of the patent in suit, say that they have used conductors or burners of various shapes such as an inverted-V-shaped burner, and conductors of varying contours, with rectangular bends instead of curvilinear ones, but that they prefer the arch shape. As a matter of fact, are the other forms here referred to the equivalent of the preferred form or arch shape, so far as providing for expansion and contraction is concerned?

A. They are not, as a matter of fact, to any adequate degree, and would only be equivalent to the arch form as regards certain other advantages resulting from its use, such as the greater length of conductor which could be contained within an enclosing vessel of a given size.

2034 39 Q. Do you agree with Professor Barker that the inverted-V-shape burner here referred to is a semi-incandescent lamp?

A. I do not. The whole contest makes it perfectly plain that the reference here is simply to different shapes of a continuous conductor, and not to a radically different structure which would bring the lamp into a different class.

40 Q. Was the liability of the carbon conductor to fracture from the effects of expansion and contraction a recognized defect of the incandescent lamps having straight carbon conductors, which were known prior to 1880?

A. It was; and means of correcting this defect are set forth in some of the patents which have been referred to.

41 Q. What kind of means?

A. Arrangements as to the supports of the ends of the conductors by which these were made to yield so as to accommodate themselves to changes in length of the conductor.

42 Q. Do you know of any incandescent lamps used since 1880 having straight carbons, V-shaped carbons, or carbons of any shape except the arch shape or some modification of it?

A. I know of none except such as would come within the description of modified arch shape; such, for instance, as the Maxim lamps which were made with a paper carbon having the general shape of the letter "M," but so constructed that there were actually three arches in the conductor, the bends being rounded or arch shaped.

43 Q. Do you agree with Professor Brackett in the opinion expressed in his answer to question 6, and Professor Barker in the opinion he expresses in his answer to question 14, that the arch or horseshoe shape described and claimed in the patent in suit was old in carbon? Please consider in this connection Professor Brackett's answers to questions 5 and 9, and Professor Barker's answers to cross-questions 64 and 65.

2035 A. I do not agree with these gentlemen. The only reference that either of them is able to cite is that of the Konn patents, in which there is described a carbon conductor in a V shape, the V shape shown in the drawing being a very low or flat "V," that is, having a very wide angle at the apex, and of irregular cross-section. This I do not think in any way even approaches the suggestion of an arch shape or if it were followed would produce a conductor having any of the beneficial properties resulting from such arch shape. In addition to this state of affairs, which appears from the drawing, the Konn patent No. 3809 states that the light is formed at the angle at the bottom of the "V." This would indicate either that the cross-section of the "V" were extremely irregular, or that in some way there was a special resistance at this point by reason of which the light was there locally developed, and of course any such conditions would be inconsistent with the beneficial effects obtainable from an arched shape, such as is indicated in the patent in suit.

44 Q. Do you agree with Mr. Edison in the opinion he expresses in his answers to questions 432 and 467 to 470 inclusive, that while the quality of high specific resistance possessed by carbonized fibrous or textile material is advantageous for lamps of high resistance, it is not advantageous but rather the reverse for incandescent lamps of comparatively low resistance?

A. I do not at all agree with this statement, and was very much astonished when I first read it in Mr. Edison's deposition, and feel convinced that he could not have given much thought to what he was saying when he made this answer. In any system of electric lighting by incandescence it is desirable that as much of the resistance of the entire circuit as possible should be concentrated in the incandescent conductors of the lamp. Where these lamps are to be employed in parallel arc, it is important that the total resistance of each lamp should be very high, but when the lamps are used in series, it is desirable that the total resistance of each lamp should be relatively low; but, 2036 since the production of light must in all cases be proportional to the product, involving the resistance as one factor and the current as another, it is manifest that the specific resistance must in either case be high in order that there should be enough of it in a moderate length of the conductor to develop from the current employed the light energy which is desired. If, as Mr. Edison states, a high specific resistance was undesirable in an incandescent lamp when used in successive series, then, of course, such lamps might readily be made by the use of good conductors, such as the ordinary arc-light electrodes. The actual fact is that a high specific resistance is desirable in either form of lamp, and all that can truly be said in this regard as to difference, is that it is more important in order to meet certain mechanical conditions in the case of the lamps run in parallel series than it is with the lamps run in successive series. So far, there is a difference, but this is simply a difference of degree, and does not authorize any such broad statement as that which is contained in Mr. Edison's answers referred to.

45 Q. As a matter of fact, what sort of carbon is used in series lamps of relatively low total resistance which are in commercial use at present?

A. Exactly the same kind of carbon as is used in the lamps of high resistance, the difference being that the conductors are made shorter and thicker in the lamps of low resistance, and longer and thinner in the lamps of high resistance.

46 Q. Is it hard carbon or carbonized fibrous or textile material?

A. Carbonized fibrous or textile material.

47 Q. Please read Prof. Cross's answer to question 33, and state whether or not you agree with him in the opinion he expresses that none of the prior patents and publications put in evidence by the defendant describe or show the lamp structure of complainant's patent in suit, or any equivalent for it?

2037 A. I entirely agree with Prof. Cross in this answer, and, as I have already pointed out in great detail, I find in none of the patents or publications referred to by defendant's experts, except, of course, in the prior patents of Sawyer and Man referred to in the patent in suit, this part of the combination or invention set forth in that patent.

48 Q. Do you agree with the opinion expressed by defendant's experts that the lamp structure of the complainant's patent in suit has all the defects of the lamp structures of incandescent lamps described in the prior patents and publications in evidence, and that the said lamp structure would be wholly unsuitable for making a practically useful lamp for the purpose of electric illumination, and, moreover, that the low resistance of the incandescent conductor described in complainant's patent would make the lamp practically useless?

A. I do not agree with this opinion, but on the contrary, consider that the lamp structure of complainant's patent, by reason of its consisting wholly of glass, avoids serious defects found in previous structures, and is capable of producing a practically efficient incandescent electric lamp.

49 Q. Would it in your opinion be practically useful for any commercial purpose, and how would it in your opinion compare with such lamps as are described in the prior patents and publications put in evidence?

A. It would undoubtedly be useful for commercial purposes at the date of its invention, though of course it might not compete at the present day with the improved lamps now made. It would, I have no doubt, be very superior to any of the lamps made or described prior to the date of complainant's patent, though some of these, I believe, actually met with a certain amount of commercial success. Thus, for example, in the work entitled "Electric Lighting," by Hyppolite Fontaine, translated from the French by Paget Higgs, London, 1878, I find, on page 171, a reference to the
2038 Ladyguine lamp and to certain improvements made thereupon by Mr. Konn, also of St. Petersburg. On page 174 in reference to these the following statement occurs:

"Three of these lamps were introduced two years ago at the house of M. Florent, a merchant of St. Petersburg, and put in action with an 'Alliance' machine. Each carbon lasts about two hours with the exception of the first, which is consumed nearly immediately; the light is very agreeable, but its cost considerably exceeds that of gas. M. Florent, whom we have had occasion several times to see, has informed us that the great advantage he has found in the employment of electric lighting was its cleanliness. His storerooms contain much white linen that gas rapidly*ly* impairs and on which electricity exercises no injurious influence. The bleaching economized fully compensates the supplementary cost necessitated by an important introduction with but little regard to the light obtained."

It is manifest from this that, if a lamp in which the carbon only lasted two hours had a commercial value at this time in St. Petersburg, a lamp, such as that described in complainant's patent, which undoubtedly would last for 100 or 200 hours, would, under like conditions, have very much greater commercial value, and I see no reason why with the exercise of ordinary ingenuity and experience such as any workman acquires in the construction of apparatus, lamps such as those described in complainant's patent should not be made to last many times as long as I have indicated.

50 Q. Do you agree with the opinion expressed by defendant's experts that the inventors, Sawyer and Man, made no substantial advance in the art, or at least none that is shown and described in the patent in suit?

A. I do not. On the contrary I think that they made a very important contribution to the state of the art, this contribution consisting in the *the* introduction of a lamp having its carbon
2039 conductor made of fibrous or textile material, of an arch shape, and enclosed in an air-tight vessel constructed wholly of glass.

51 Q. Do you agree with defendant's experts that in view of

the prior patents and publications put in evidence by defendant, there is no patentable novelty in the inventions referred to in the first, second and fourth claims of the patent in suit?

A. I do not. On the contrary I think that those patents and publications show that the state of the art was far from anticipating the invention of this patent, and was really going in an opposite direction, and, so far from suggesting the combinations involved in this patent, rather suggested an opposite and different development which would have led away from the result here secured. As regards the first claim, there was nothing in the state of the art suggesting the production of an incandescent conductor for an electric lamp made from carbonized fibrous or textile material in any shape, and certainly not in an arch or horseshoe shape. Having reference to the second claim, there is nothing in the state of the art showing the combination of an incandescing conductor of carbonized fibrous material enclosed in a transparent, hermetically sealed chamber; and, as regards the fourth claim, there is nothing in the state of the art showing the combination of a chamber made wholly of glass from which all carbon-consuming gas has been exhausted or driven, electric conductors passing through the glass walls of said chamber and hermetically sealed therein, and an illuminating conductor consisting of carbon made from a fibrous or textile material having the form of an arch or loop.

52 Q. Do you agree with the defendant's experts, that the material and the form of the burner of the first claim are entirely independent of each other?

A. I do not. On the contrary, as I have already pointed out, I consider that the material and form are two elements which acting together produce a novel and useful result which would not be obtained or availed of where either of them existed separately. That is, the arch form would be of little or no value if the conductor were of metal or of hard carbon, and the fibrous or textile material would be of much less utility if employed in a conductor not having the arch form. 2040

53 Q. Do you agree with defendant's experts that there is no combination between the particular kind of burner referred to in the fourth claim and the enclosing chamber made entirely of glass, referred to in the same claim?

A. I do not. On the contrary, I consider that hereby we get a result by the concordant action of two elements, which result requires for its development the united effect of both elements. Thus, the conductor of fibrous material here described, in order to render available the special advantages which it possesses, must be protected very thoroughly from the access of air, and therefore must be enclosed within a chamber wholly of glass, by which means alone such thorough protection would be attainable.

54 Q. Defendant's experts express the opinion that in order to make the incandescent lamp at all practical for any useful purpose, a radically new departure was necessary, which consisted essentially in making the incandescent conductor of very high resistance, so that the requisite amount of electrical energy would be conveyed to

it on small wires which could be sealed into the glass, and that this radically new departure was first disclosed in the "Herald" article in evidence, and in Mr. Edison's patent No. 223,898. Do you agree with them in this opinion?

A. I do not. As regards the novelty of the idea that incandescent lamps should be made with conductors of very high resistance, this does not originate with Mr. Edison because it is shown in a series of patents taken out by Lane-Fox in England in 1878 and the early part of 1879. The patents are respectively numbered 3988, 4043 and 4626 of 1878, and 1122 of 1879. They show and explain a system in which incandescent electric lamps were 2041 to be used with very long conductors of fine platinum wire sealed into glass vessels, and, curiously enough, the electro-motive force necessary to run these lamps is stated to be 100 volts, which is exactly the electro-motive force which was stated by Mr. Edison to be the desirable one, and just about that actually used to-day by his company in their lamps run in parallel arc.

Adjourned to Tuesday, April 16th, 1889, at 11 a. m.

The four patents of Lane-Fox to which I have referred form a very remarkable series when we consider their date and the completeness of the system which they express. They show that their author had clearly and prominently in his mind all the general conditions which experience has proved to be desirable in a practical application of electricity for domestic lighting. Taking them in their order, for example, we have, first, that of October 9th, 1878, where, in the provisional specification, we have fully set forth a method of parallel arc distribution such as would be carried out in lighting up a town and the necessity of a high electro-motive force which implies a correspondingly high resistance in the incandescent lamps. This last is stated in the following words: "The electro-motive force of the electric conducting mains should be kept as nearly as possible constant at say 100 volts or British Association units of electro-motive force."

In the specification as issued, we find also as follows.

"In order to produce a light, I pass the electric current through a thin strip or wire of some suitable material for the purpose. I prefer to use an alloy of platinum and iridium. The electric lamp in which the light is produced therefore consists of two conductors insulated from one another, having this strip or wire between them and in contact with each.

"The material or alloy employed should be capable of standing as high a degree of temperature as possible without fusing, volatilizing or falling to pieces. It should also have a high specific 2042 resistance. The higher the temperature to which the material can be raised, the more economical will be the light produced, that is, the light will be greater in proportion to the force or energy expended, inasmuch as the radiant energy proceeding from the surface of the material will be more and more luminous as the temperature increases.

"In order that the electric force may be conveyed at a high tension, that is, have high electro-motive force so that there may not be very great loss from the resistance of the conducting mains or conductors, I make the lamp which I use of an alloy of platinum and ir*r*idium of lengths of fine wire so that I may get high resistance without having a large extent of luminous surface."

In this patent, at figures 1 and 2, are shown drawings of lamps in which glass chambers are represented, through the substance of which the conductors are passed and then terminate in very long fine wires, which by their incandescence, on being heated, develop the desired light.

The next patent is dated October 12th, 1878. In this patent I find in the specification the following statement:

"Figures 1 and 2 of the annexed drawings represent an electric lamp in which the luminous surface which I will term the bridge, is made of asbestos or similar non-conducting material saturated or impregnated with some refractory conducting material such as carbon or ir*r*idium. A, is the bridge held up by metal chips, B B, which are attached to the conductors C C. These conductors pass through the top D, of a flask E, which is hermetically sealed and is filled with nitrogen gas. The luminous portion, *a* to *a'*, of the bridge is of higher resistance than the rest."

The drawings 1 and 2 show structures which in appearance are remarkably like many of the incandescent electric lamps of to-day.

The next patent is dated November 14th, 1878. In the provisional specification, near the beginning, I find as follows:

2043 "In order to obtain light from an electric current I make use of a sheet of platinized or ir*r*idized or carbonized asbestos or other suitable material supported between two conducting terminals of platinum or other suitable material; and in order to preserve the incandescent substance in a good condition and prevent its deterioration, I enclose the whole in a glass or other suitable transparent vessel or cover *through which the platinum supports are fused*." (The italics are my own.) "This vessel or cover is then exhausted of air by means of a small tube leading from it and it may then, if thought desirable, be filled with some gas or vapor which has no action on the material used for producing the light. * * * The length and thickness of the spiral will depend on the intensity of the light required and the electro-motive force available. The ends of the spiral should be united to these wires with some hard solder. The spiral is then enclosed in a globe or flask-shaped glass vessel whose neck is sufficiently large to admit it, and the neck should then be closed up round the different supporting wires so as to seal them in and make the whole vessel air tight. A small tube projecting from some part of the neck, is then connected with a Sprengel air pump or other exhausting apparatus. The air is the*m* removed as completely as possible and the tube sealed up, some gas being previously admitted, if desired into the vessel, as before described. The neck of the vessel may be fixed to some suitable holder or support, and the projecting platinum wires should be connected to proper terminals.

"According to another method or arrangement for obtaining light by the incandescence of carbon or other suitable material, the said material is enclosed as before described in a glass vessel from which the air is exhausted or which is filled with any suitable gas and the terminals are, as before described, fused into the glass vessel at the lower end of the neck when it is sealed up; or the glass may be made in any way by which it can be readily opened when desired and be again hermetically sealed."

2044 This patent also contains full directions as to the laying of main wires and distribution of currents through a town district, and also shows means for measuring and regulating the flow of electricity.

Lastly, the fourth patent, dated March 20th, 1879, of which there is only a provisional specification. In this document a method is described of preparing incandescent conductors which are to be used in such a system of lighting as has been described in previous patents, the materials to be employed being plumbago, as a good conductor, and magnesia, zirconia, or the like, as a bad conductor. Such materials are to be mixed in such proportions as will give a specific resistance in accordance with the electro-motive force employed in producing the light. An electro-motive force of 140 volts is alluded to, and a resistance of 300 ohms, or British Association units is likewise spoken of. The method of mixing and forming these materials into incandescent conductors is then described at some length, and finally I find the following statement:

"The parts before described are hermetically enclosed within a globe or other form of glass or other suitable material, through one portion of which the conducting wires are hermetically carried. From this globe all trace of oxygen, carbonic acid gas, water and any gas, or vapor capable of attacking or affecting the materials of the luminous bridge when at a high temperature must be removed."

Turning to what Dr. Barker says in the last paragraph of his answer 3, when recalled, and in his answer 4, it appears that all the features which he sets forth in these answers as characterizing what he has called the "radical new departure" in the method of constructing incandescent electric lamps, and which he there attributes to Mr. Edison, are found fully developed in this series of patents of Lane-Fox which considerably anticipated the date of the Herald article and the two Edison patents referred to by defendant's experts.

2045 Referring to what Dr. Barker says about this new departure, I should say that while it was quite true that the conditions he has mentioned were of the greatest importance in the process of incandescent lighting in parallel arc, they played no such part in the process of electric lighting in successive series, and therefore this should be borne in mind, lest an erroneous impression might arise from giving attention exclusively to one method, and omitting the other.

55 Q. Is it necessary in your opinion, that the conductor would be made of very high resistance, as stated by defendant's experts, in order to make a successful incandescent lamp, even according to modern standards?

A. It is certainly not, where the lamps are to be used in successive series.

56 Q. Are incandescent lamps used commercially in that way at the present time?

A. They are, very extensively.

57 Q. Would the series lamps so used, such as the Thompson-Houston, the Bernstein, and the Heissler, to which you have referred, come within Dr. Barker's definition of the alleged radical new departure, as lamps in which the necessary electric energy required to give the light is conveyed to the lamp in the form of a maximum of tension and a minimum of current?

A. They would not, since, as a matter of fact, their resistance is very low, and the current strength employed with them relatively very large.

58 Q. Do you agree with the opinions expressed by Dr. Barker in his answers to questions 2 and 3, when recalled, that the Geissler tube construction of chamber was not, and has not at any time been, known as a substitute or equivalent for the enclosing chamber of electric lamps like that shown and described in the patent in suit, and that the Geissler tube construction of chamber is not applicable to, or useful in, the construction of lamps like that described in the patent in suit, or of any incandescent lamps 2046 that were known prior to the publication of Mr. Edison's lamp construction in December, 1879?

A. I do not agree with Dr. Barker, because, in the first place, the Geissler tube construction, as applied to an incandescent lamp, was substantially shown as long ago as in the King lamp, where the upper terminal of the incandescent conductor was attached to a platinum wire fused, or hermetically sealed, through the upper end of the glass chamber. The Geissler tube construction is also fully and completely pointed out in the Lane-Fox patents to which I have recently referred; and in one or more of Prof. Crookes's radiometer experiments, an arrangement was used which was, in effect, an incandescent electric lamp of precisely and exactly what we understand as the Geissler tube construction. One of these structures is shown and described in the Philosophical Transactions for 1874, page 513, and another in the Philosophical Transactions for 1876, page 351. The first of these structures is very closely like that of the patent in suit, and the second completely that of the Geissler tube. The substantial equivalency of these two methods, as well as the advantage of the Geissler tube structure over the other, is fully recognized in these papers of Dr. Crookes's, as for example, in the following passage in the Philosophical Transactions for 1876, page 520:

"83. The cement which I have found best for keeping a vacuum is made by using together eight parts of white rosin and three parts of beeswax. For two hours this cements perfectly, but at the highest exhaustion it leaks in the course of a day or two. Ordinary or vulcanized India-rubber joints are of no use in these experiments, as with the vacuum they allow oxygenized air to pass through as quickly as the pump will take it up. Whenever possible, the glass tube should be united by fusion, and where this is impracticable, mercury joints should be used."

I think Dr. Barker must have overlooked the existence of these various prior publications when he says that he does not know that the Geissler tube construction of chamber was, or is, or has 2047 at any time been, found as a substitute or equivalent for the enclosing chamber of electric lamps like that shown and described in the patent in suit. I also do not agree with him as to his opinion that the Geissler tube construction would not be applicable or useful in such an incandescent lamp as is shown in the patent — suit, for, in my opinion, any good glass-blower would have no difficulty in construing a lamp having all the substantial characteristics of the features shown in the patent in suit, in the Geissler tube manner; or, in other words, by sealing the conductors directly into the walls of the chamber, sealing the different parts of the chamber directly to each other, and applying an exhausting tube which could be hermetically closed or sealed off after the lamp was finished.

59 Q. In his answer to cross-questions 5 and 6, Prof. Barker says in substance that he thinks that a wire a millimeter in diameter is the largest size which could be successfully sealed into the glass in regular commercial work. In other parts of his examination he says that he does not think that this would be of sufficient size to convey the current for such carbons as were used in incandescent lamps made prior to 1880. What is your opinion in regard to this?

A. I do not agree with Dr. Barker, as to this matter for the following reasons: Carbons of 1¾ millimeters and 2 millimeters in thickness, appear to have been used in incandescent electric lamps as early as 1874, as I judge from an article in the Telegraphic Journal and Electrical Review, published in London, May 25th, 1874. Now as the conducting power of platinum is many hundred times as great as that of carbon, it is manifest that a platinum wire one millimeter in diameter would readily carry sufficient current to heat to incandescence a carbon rod whose diameter was only about twice as great, without risk of the platinum wire being itself unduly heated.

60 Q. Defendant's experts say that they do not think that it would be practicable either to seal on the base plate of the lamp of the patent in suit by fusion of the glass, or to seal the conductors 2048 into the glass by fusion. What is your opinion in regard to this? Please read Prof. Barker's answers to Q. 20 and 21, and Prof. Brackett's answers to Q. 13 and 14 and X Q. 86 to 100, inclusive, and X Q. 108 to 117, as well as his testimony when recalled?

A. It is manifest that these gentlemen have founded their opinion on the assumption that the details of the structure as represented in the drawings of the patent were to be literally followed as to such points as the precise thickness of the glass, the flatness of the base plate, and the size, shape and material of the conductors. If these assumptions were correct, their conclusions would be legitimate, but of course any intelligent glass-blower would know that when he desired to seal conductors directly through glass, those conductors must be made of platinum and of moderate dimensions; also, that when two portions of a glass chamber were to be sealed together, their thickness must likewise be moderate and that a large flat surface must be avoided when the glass of which it was made was thin, by replacing it with a curved surface, by which its resistance to atmospheric pressure would be made adequate. With such modifications as these, which would present themselves as matters of course to any skilled glass-blower, there would be, I am confident, no difficulty whatever in making a structure which would be, in all essential or substantial particulars, the same as that shown in the patent in suit, by the Geissler tube method, that is, by sealing the conductors directly through the glass and uniting the parts of the chamber to each other by fusion I have in my own possession many Geissler tubes very much larger than the chamber of the lamp represented in the patent in suit, which have evidently been produced by the usual Geissler tube method, and which have maintained their vacuum entirely unimpaired for twelve years or more.

61 Q. Of what sort of carbon would the preferred form of the filament described in the Edison patent No. 223,898, put in evidence by defendant, be composed?

A. Hard carbon, or such as I have described by that name,
2049 that is, such carbon as was formerly manufactured and used
for the electrodes of arc lamps. The preferred form described in this patent No. 223,898 of 1880, is made by preparing a putty-like mixture of lamp-black and coal tar and then taking this into a helix and carbonizing it in a closed crucible. This would be in material and mode of preparation precisely identical with the arc-light carbons which have been described in a number of the patents and publications already introduced and frequently referred to in this case.

62 Q. Has the Edison Company, or any one else so far as you know, made use of this kind of carbon in commercial incandescent lamps since 1880?

A. Not to my knowledge.

63 Q. Are you familiar with the different styles of incandescent lamps in commercial use in this country?

A. I am.

64 Q. What sort of carbon has been used in the Edison lamps which have been put into commercial use?

A. As far as I am aware, carbon made from bamboo only, except in the case of the steamship "Columbia" built for the Oregon Railway and Navigation Company, on which I saw incandescent lamps furnished by the Edison Company and made with paper carbons.

65 Q. Referring now to the testimony of defendant's experts in regard to the structure and general peculiarities of fibrous materials; were the various peculiarities which they describe known prior to 1880 or have they been discovered since?

A. They were all known prior to 1880.

66 Q. Were the general characteristics of the structure of bamboo known prior to 1880?

A. They were.

67 Q. Was it known that the structure of bamboo was very dense and homogeneous, and that its fibres were parallel, so that it could be readily split into very fine strips without cutting across the fibres?

A. It was.

2050 68 Q. Prof. Barker says in his answer to question 15, that bamboo is not a material properly called textile; that he has never heard of its being used as such for textile purposes or for the manufacture of paper or any textile fabric, and Prof. Brackett says in his answer to question 1, when recalled, that bamboo is quite unsuited to be either spun or woven or to be made into paper. What is your opinion in regard to this?

A. My opinion as to these answers is, that they show a remarkable lack of general information such as would be acquired from encyclopedias and books bearing on such subjects more particularly. As a matter of fact, if there is one substance rather than another which particularly connects itself with the manufacture of paper, that substance is bamboo. The earliest paper of the world which deserves the name of paper strictly, namely, a product made by reducing vegetable fibre to a pulp diffused in water and then obtaining from this a sheet by the well-known method of the paper-maker, appears to have been made in China from bamboo, and is there so made at the present moment. The finest quality of paper, namely, what is known as "India paper," used for the production of proof impressions from steel engravings and the like, is stated to be manufactured from bamboo. I have made a series of extracts from different publications which I here submit, which show that bamboo is used in China for almost every conceivable purpose, including the manufacture of paper and numerous textile fabrics, such as cordage for boats, sails, baskets, bedding and the like. In this connection it may be interesting to refer to a few samples of textile or woven fabrics made from bamboo, which I obtained a few days since from Vantine, Chinese importer and dealer in New York, and here submit. One of them is a sort of tray in which the border as well as the rest appears to be made of split bamboo, the portion used in the border, being, I judge, identical with that employed by the Edison Company in the manufacture of their incandescent lamps, 2051 that is, the material inside of the hard silicious bark or outer surface. Another is an egg-shaped basket made of very fine fibres interwoven, and the third a small basket made of thicker strips, all being of the same substance, namely, the fibrous structure of the bamboo split into thin filaments. There are also a number of United States patents describing the preparation of bamboo so that its fibres may be used in the manufacture of paper or for textile purposes generally. These patents are:

No. 41627, February 16th, 1864, to Philip Lichtenstadt.

No. 68363, September 3d, 1867, to Charles Heaton.

No. 70474, November 5th, 1867, to Robert W. Russell and Thomas Howland.

No. 87295, February 23d, 1869, to Louis S. Robbins and John A. Southmayd.

69 Q. Should you consider such structures as the baskets and other articles to which you have referred, and of which you have produced samples, textile fabrics?

A. Certainly. The word textile comes from the Latin *texto*, "I weave," and means woven. Weaving in its earlier stages was a process of interlacing strips or fibres such as is exhibited in these baskets, and is seen in mats and other like products.

70 Q. Do you understand that the use of comparatively fine strips of bamboo for weaving baskets and such objects was common prior to 1880?

A. Extremely common. I imagine there are few households, where some article of this sort does not exist.

71 Q. Prof. Barker in his answer to question 50 says that the reference to electric light in the Guaduin patent, in his opinion, includes the incandescent light as well as the arc light, as both forms were well known at that time. Do you agree with him in this?

A. I do not at all agree with Dr. Barker, because, though it is true that some incandescent electric lamps had been made and exhibited as early as 1876, the art had certainly reached no 2052 such development as would warrant its being referred to in the manner found in this patent. The words of the patent are "for the manufacture of pencils for electric lighting." This would clearly and directly convey the idea that the electric lighting referred to, was a well-known commercial business. This was true at the date named, of arc lighting, but not at all of incandescent light*n*ing.

72 Q. What sort of carbon would be produced by the process described in the Gauduin certificate of edition of April 7th, 1877, and would it, in your opinion, be substantially the same as the carbonized fibrous or textile material of the complainant's patent in suit?

A. The words of the patent referring to this matter, are as follows: "I convert this wooden object into a hard and compact carbon, conserving its primitive form, by drying it, suitably impregnating it with tar, pitch, bitumen, rosin, essence and oils of coal, in carbon of hydrogen, sugar, carmel, or other matters possessing anal*a*gous properties. I distill it slowly so as to expel the volatile bodies; I impregnate it anew and redistill it as many times as necessary, and finally heat it to a high degree of temperature in a reductive atmosphere."

The product produced in this way would be substantially hard carbon, such as was used from an early period for the electrodes of arc lights, and would have in it nothing peculiar to, or characteristic of, the wood from which it was only in small part formed. It would certainly have none of the properties which would characterize the product of complainant's patent, namely a carbon conductor made from vegetable, fibrous or textile material.

73 Q. Referring now to the description of the Ladyguine lamp in

the London Journal of the Society of Arts, what kind of carbon do the contemporary publications show to have been used by Ladyguine and his associates in their lamps?

A. The material, I think, was plainly the hard carbon
2053 made from gas coke and the like, commonly used for the
electrodes of arc lamps, and this, I think, appears very clearly from the statement of the contemporary patents taken out by the members of the firm of Kosloff & Co., mentioned in this article as those who are interested in this lamp, these patents appearing in the name of Konn and Kosloff. These patents are fully referred to by Prof. Cross in his answer to Q. 7, and I will therefore not repeat what has been already sufficiently explained. In the translation of Fontaine by Paget Higgs, published in 1878, to which I have already referred, I find the following on page 172: "M. Ladyguine was the first who had the idea of replacing the platinum wire in these combustion experiments by small bars of carbon (coke) anal*a*gous to graphite, that is to say a good conductor, and thus resolve the problem of electric lighting."

These conductors are then repeatedly referred to as "carbon" until near the foot of the next page, where I find this expression: "The retort carbons, E, to the number of five, are placed between two small plates which crown the rods."

This very clearly indicates that the carbon used in these experiments and exhibitions was hard carbon, to which I have above referred.

In reference to the same experiments, in the Telegraphic Journal of May 25th, 1874, the conductors of the lamps are constantly referred to as "carbon rods," which I think conveys clearly the same impression.

74 Q. Prof. Barker says he thinks the stopper of the globe of the Shepard patent must have been made of glass. Do you find anything in the Shepard patent which indicates whether the material of the stopper was glass or not?

A. Yes, I find a reference to the fact that the wires passed through it must be insulated, which clearly implies that it was not glass, since insulation would be entirely unnecessary in that case. The words are:

"The stopper B, of this globe, is very carefully luted, and
2054 two insulated polar wires, P and N, of about 2 millimeters in
diameter, are passed through it."

Adjourned to Thursday, April 18th, 1889, at 10.30 a. m.

NEW YORK, *April 18th*, 1889.

Met and adjourned till Monday, the 22d inst., at 10.30 a. m.

NEW YORK, *April* 22, 1889.

Met pursuant to adjournment. Present, Mr. Curtis for complainant, and Mr. Dyer and Mr. Donnelly for defendant.

Complainant's counsel offers in evidence Blue Book copies of British patents granted to St. George Lane Fox, No. 3988, dated October

9, 1878; No. 4043, dated October 12, 1878; No. 4626, dated November 13, 1878; and No. 1122, dated March 20, 1879; and the same are marked respectively "Complainant's Exhibits Lane Fox British Patent No. 3988, of 1878;" "No. 4043, of 1878;" "No. 4626, of 1878;" and "No. 1122, of 1879."

Defendant's counsel admits that the original Blue Books of each of the said British patents were published in 1879, but not earlier than six months after their respective dates, and consents to the use of a typewriter copy of the patent No. 4626 of 1878 in place of the Blue Book, subject to the correction of any errors that may be found therein.

2055 Complainant's counsel also offers in evidence pages 513 and 514 of the Philosophical Transactions of the Royal Society of London for 1874, published at London in the same year, and the same is marked "Complainant's Exhibit Philosophical Transactions No. 1;" also sections 171 to 177, inclusive, on pages 350 to 352 of the same publication for 1876, published at London in 1877, and the same is marked "Complainant's Exhibit Philosophical Transactions No. 2." It is agreed that a copy of said extracts may be used in place of the original books, subject to the correction of any errors that may be found therein.

Complainant's counsel also offers in evidence the various extracts from publications produced by Dr. Morton and referred to in his answer to question 68 as follows:

The Penny Encyclopedia, vol. 17, p. 207, which is marked "Complainant's Exhibit, Penny Encyclopedia Extract;" Chambers' Encyclopedia, vol. 1, p. 654, which is marked "Complainant's Exhibit, Chambers' Encyclopedia Extract;" Rees' Encyclopedia, American edition, vol. 3, article "Arundo," which is marked "Complainant's Exhibit, Rees' Encyclopedia Extract;" Ure's Dictionary, published at London in 1860, vol. 1, pp. 248 and 249, which is marked "Complainant's Exhibit, Ure's Dictionary Extract;" Dictionnaire Technologique, published at Paris in 1822, vol. 2, p. 512, and vol. 15, p. 255, which is marked "Complainant's Exhibit, Dictionnaire Technologique Extracts;" Engineers' and Mechanics' Encyclopedia, published at London in 1849, p. 139, which is marked "Complainant's Exhibit, Engineers' and Mechanics' Encyclopedia Extract;" Nicholson's Encyclopedia, American edition, published at Philadelphia in 1819, vol. 2, article "Bamboo," and vol. 9, article 2056 "Paper," which are marked "Complainant's Exhibits Nicholson's Encyclopedia Extracts;" Encyclopedia of Chemistry, published at Philadelphia in 1880, by J. B. Lippincott & Co., article entitled "Paper from Bamboo," on pages 533 and 534 of vol. 2, which is marked "Complainant's Exhibit Encyclopedia of Chemistry Extract;" Chemistry, Theoretical, Practical, etc., by Dr. Sheridan Muspratt, published at New York, by Virtue & Yoston, part of page 642, which is marked "Complainant's Exhibit Muspratt's Chemistry Extract." Defendant's counsel admits that the books referred to were published and circulated at the respective dates of publication above mentioned and that Muspratt's Chemistry was published and circulated prior to 1880.

It is agreed that the copies of said extracts may be used in evidence with the same force and effect as the original books, subject to the correction of any errors that may be found therein upon the production of the original books and the addition of any further extracts from the same article which defendant may desire to add.

Complainant's counsel also offers in evidence Patent Office copies of letters patent No. 41627, granted to Philip Lichtenstadt, February 16, 1864, which is marked "Complainant's Exhibit Lichtenstadt United States Patent;" No. 68863, granted to Charles Heaton, September 3, 1867, which is *which is* marked "Complainant's Exhibit Heaton United States Patent;" No. 70474, granted to Robert W. Russell and Thomas Howland, November 5, 1867, which is marked "Complainant's Exhibit Russell and Howland United States Patent;" No. 87295, granted to Louis S. Robbins and John A. Southmayd, February 23, 1869, which is marked
2057 "Complainant's Exhibit Robbins and Southmayd United States Patent."

Complainant's counsel also offers in evidence the bamboo tray and baskets produced by Dr. Morton and referred to in his answer to question 68, which are marked respectively, "Complainant's Exhibit Bamboo Basket No. 1," and "Bamboo Basket No. 2," and "Bamboo Tray."

Complainant's counsel also offers in evidence an article entitled "The New Electric Light," printed on pages 202 and 203 of the Telegraphic Journal and Electrical Review for May 15, 1874, published at London during the year 1874, and the same is marked "Complainant's Exhibit Telegraphic Journal Article."

Defendant's counsel consents that a copy of the said article may be used in place of the original book, subject to the correction of any errors that may be found therein.

Complainant's counsel admits that the book entitled "Eclairage a' L'Electricite', par Hippolyte Fontaine," and the book entitled "Electric Lighting, by Hippolyte Fontaine, translated by Paget Higgs," marked in evidence after answer to cross-question 225 of the deposition of Charles R. Cross, were printed, published and circulated on the dates shown by their title pages respectively, viz., 1877 and 1878.

75 Q. Do you, upon looking over your deposition, desire to make any explanation or correction of any part of it, and if so, please make such statement as you desire to make in this regard.

A. In looking over my deposition, I noticed a statement in answer 34 that, while correct in view of what I had in mind in making the answer, may not be correct in reference to other
2058 considerations which did not occur to me at that time. What I refer to is contained in the following words:

"On the other hand, if the material were hard carbon, then, on account of the brittleness of that substance, the strains produced by expansion might be likely to cause fracture in the arch form quite as much as, or more than, in the form of a straight pencil, because in the case of a straight pencil the expansion and contraction would force a yielding or movement on the part of the supports, and would be equally distributed throughout the conductor, whereas, when this conductor was in an arched form, the same strain would have more tendency to rupture the arch than it would to move the supports in the previous case."

When making this statement, I was regarding the problem as one of a straight column, or beam, under compressive strain, as compared with a bent column, or beam, under like strain, and, under such conditions, what I have stated would be correct; but if the actual problem is one in which, as compared with the column or beam, which in this case represents the conductor, the supports are substantially unyielding, and therefore the beam or column must change its form under the applied stress to a limited degree; in that case, I think that the arch form would be less liable to break than the straight bar, even though the material of which it were made were as rigid and brittle as the ordinary hard carbon, but, of course, the advantage secured by the arch form would be much less with a brittle material than with a more tough and flexible one. This last condition is that which I think would be controlling in the case of such lamps as we are now considering; and therefore, taking everything into consideration, I think that the arch form would have some advantage over the straight bar, even with a conductor made of hard carbon.

Adjourned till Tuesday, the 23d inst. at 10.30 a. m.

2059 TUESDAY, *April 23d*, 1889.

Met. Present, counsel as before, and the cross-examination of Prof. MORTON was commenced by Mr. DYER, as follows:

76 X Q. You have given a considerable importance by you- answer 6 and other answers to the use of the word textile in the patent in suit. Please state where you find that word used in the patent in suit and also in the original application.

A. In the patent in suit I find the word "textile" used in three places. In the first place, it occurs in the specification on line 23, page 2, in the following sentence:

"The advantages resulting from the manufacture of the carbon from vegetable fibrous or textile material instead of mineral or gas carbon are many."

In the next place, I find it in the first claim which reads:

"An incandescing conductor for an electric lamp of carbonized fibrous or textile material and of an arch or horseshoe shape, substantially as hereinbefore set forth."

And I also find this word near the end of the fourth claim where it occurs in the following context:

"Consisting of carbon made from a fibrous or textile material having the form of an arch or loop substantially as described, for the purpose specified."

In the application, I only find this word in the fourth claim which reads as follows:

"An incandescing arc made of carbonized fibrous or textile material."

77 X Q. Does the word occur at any other point than these you have mentioned either in the patent or the original application?

2060 A. It does not.

78 X Q. What specific material, if any, in your opinion is named in either the patent or original application to which the term "textile" could be properly applied?

A. Nothing more specific than the word "textile" itself, which under the circumstances is, I think, abundantly specific without further qualification, except so far as it is qualified by the terms "vegetable fibrous."

79 X Q. There is, then, no specific material mentioned which is properly textile material?

A. Not as I understand it.

80 X Q. Throughout your deposition, you have given the "intelligent artizan" the credit of quite an extensive knowledge, prior to 1880, of the art to which the patent in suit relates. What class of men had you in mind?

A. I do not think that I have credited my "intelligent artizan" with any more knowledge than would be possessed by any good workman who had been accustomed to the construction of philosophical apparatus, such as the electric light regulators for the arc light, who was familiar with the operation of such apparatus, and had informed himself as to the state of the art in connection with incandescent lighting by reading the more important patents and publications prior to 1880, which have been put in evidence in this case, and it is such a man as this that I have had in mind.

81 X Q. Where would he be instructed by the state of the art "that the carbon conductor must be of uniform structure and conducting power throughout its length," as stated by you in answer 6?

A. Among other sources of information on this subject, he would have the information derived from various patents and publications which refer to the importance of purity and uniformity in structure in the carbon rods or pencils used in electric lighting, as well as by such knowledge of general principles as he would naturally possess, which lead necessarily to the same conclusion.

2061 82 X Q. Where is the information or knowledge to be found?

A. In the ordinary text books on electricity, which give instruction as to the fact that the heat developed in a conductor varies with its resistance and the like.

83 X Q. I intended to refer more particularly to the "uniform structure" which you think the intelligent artizan would have been instructed by the state of the art to employ. Where would he have found this instruction?

A. In these very same books, as well as by his own observations in connection with the operation of arc lights, as these would teach him that variations in structure involved variations in resistance, and therefore irregularities in heating.

84 X Q. Where would he find the instruction or information which would lead him to bend the fibrous material into the arch shape before carbonization, rather than produce that shape by cutting?

A. From the utter impossibility of obtaining this form in any other way when he was operating with the ordinary textile material, and from the exercise of ordinary intelligence when he was operating with vegetable fibrous material less definitely textile or quite removed from the class of textile materials as generally understood.

85 X Q. Then you consider that the reference to textile material, in the patent in suit, would be of importance in controlling the artizan as to the method of cutting vegetable fibrous materials generally?

A. It would be, because it would start him of necessity on the right track and render it impossible for him to go wrong.

86 X Q. Suppose he started with paper instead of a textile material. Properly speaking, what would the information conveyed by the state of the art lead him to do as to cutting?

A. It would make no difference what he started with as to what he would do or find himself instructed to do, provided he had read the entire patent, in which case having been not only instructed by the reference to textile material how to prepare 2062 his carbon loop, but in a sense absolutely restricted to a single method, he would naturally and as a matter of course without the necessity of any thought or reflection, have applied the same method to the paper material, if he elected to operate upon that first. If, however, he had not read the entire patent, but only that part referring to paper, then ordinary intelligence, requiring little or no aid from anything in the state of the art, would lead him to select a paper of fine material and uniform structure, and to cut the same into an arch shape before carbonizing it.

87 X Q. What is the single method to which he would be absolutely restricted in a sense?

A. Taking or selecting his material in the form of a thread or cord of uniform cross-section, and bending the same into an arched form before carbonizing it.

88 X Q. That is, as I understand you, the direction contained in the patent to use textile material, would so firmly impress the artisan that such a thing as thread was the proper material to start with, that he would in making the carbon from any of the vegetable fibrous material contemplated by the patent, first cut the straight strip of the material and bend it into the arch form before carbonization. Have I correctly stated your view?

A. You have, though I should add that the references to fibrous material would in certain cases confirm this suggestion, in other words, would lead him to bend rather than cut a material when bending would manifestly secure the continuity of its fibre which cutting would destroy.

89 X Q. Is it not a fact that the patent in suit shows the carbon as wider in a vertical direction than horizontally?

A. It is.

90 X Q. Would not the most natural way of constructing a carbon of the dimensions shown in the patent be to cut the material out in the shape of an arch rather than to bend the material in the direction of its greatest thickness?

2063 A. If these dimensions were to be exactly followed, and there were no controlling consideration, that is so. In other words, if this carbon were to be made out of paper, it would be natural under these conditions to cut it out in the arch form and not to bend it, because in the case of paper the continuity of the fibre would be equally preserved in either way, but if the material operated upon were a distinctly fibrous substance like bamboo, for example, then I think the expediency of preserving the fibre would lead any one to bend it and not cut it into the arch shape.

91 X Q. But you think that the direction to use a textile material would be more controlling as an indication of the method of shaping the conductor than the shape and size illustrated in the drawing of the patent in suit?

A. I think it would convey more instruction, or be a better guide, because it would apply generally to a great variety of conductors, whereas the figure in the patent would only illustrate a single one.

92 X Q. You have stated in answer 6 that Dr. Barker "points out very correctly that there are many kinds of paper and also of wood which would not answer for the construction of an incandescent electric lamp," but you think "that this would be equally manifest to an intelligent artisan:" where would the intelligent artisan find this matter made manifest by the state of the art?

A. By that part of the state of the art which informed him that the incandescent conductor for an electric lamp must be continuous and uniform in cross-section and in conducting power or resistance.

93 X Q. That is, if he understood the general electrical principle that the heat is due to the resistance and hence to have a uniform heat and light throughout the length of the incandescent conductor, there must be uniform resistance?

A. Yes, and in addition to this that imperfections in uniformity would lead to the rapid destruction of the conductor.

2064 94 X Q. And you think that the intelligence of the artisan could have been relied upon before 1880 to apply this general principle, so as to enable him without experiment to select from the vast realm of vegetable fibrous materials the proper ones for the successful manufacture of an incandescent conductor?

A. It would undoubtedly have enabled him to select a number which would have been efficient, but, of course, I do not mean that either then or now the intelligent artisan, or anybody else, could pick out with certainty all the materials that would operate successfully and reject only those which would not.

95 X Q. That is, as I understand you, he would probably select

materials all of which would not be operative and would discard the inoperative ones by experiment?

A. No, that is not at all my meaning. What I do mean is, that he would select a number which would be certainly operative, but would reject the great majority of vegetable fibres, among which there might be some which would be operative, if used.

96 X Q. He would know the condition of uniformity required for an incandescent conductor, and would know enough about the kind of carbon which would be produced by carbonizing the different vegetable fibrous materials, to enable him to select without experiment at least some vegetable fibrous materials which would give on carbonization what he would know without experiment to be a suitable conductor. Is that a correct statement of your views?

A. No, not at all. He would know that his carbonized conductor must have a substantial uniformity, and the patent would have informed him that he would find among fibrous vegetable or textile substances, materials which, when carbonized, would give him an efficient conductor. Without having any knowledge as to the kind of carbon which would be produced by carbonizing the different vegetable fibrous materials, he would feel assured that to produce 1065 a uniform conductor he must start with a uniform uncarbonized structure, made of vegetable fibrous material. This would lead him to select only the vegetable fibrous materials which were conspicuously fibrous and uniform, and so selecting, he would uniformly succeed without the necessity of rejecting anything by experiment, so long as he contented himself with the most promising substances, and did not venture into the field of uncertainty by operating with those possessing the indicated properties in an inferior degree.

97 X Q. How would he be able to select, unless he was acquainted with the uniform character of the carbon, which would result from the carbonization of the fibrous vegetable material?

A. His selection would not be guided directly by any knowledge as to the carbon produced, beyond the general knowledge that the structure of the carbon resembles the structure of the thing carbonized. He would, therefore, simply select fibrous materials which were uniform in their structure, and give them shapes uniform in cross-section and preserving the fibre uninjured as far as possible. Having done this, he would have complied with the directions of the patent, both expressed and implied, and could then look forward with confidence to a satisfactory result, not because he himself knew beforehand that such result must follow, but because the patent had instructed him that if he proceeded in this manner he would secure the desired result.

98 X Q. You have stated in answer 6, in substance, that defendant's experts assume that for a practicable incandescent lamp, an extremely fine or thin fibre is essential, but that you think that modern practice in electric lighting shows that a very fine fibre is by no means necessary or desirable. In support of this position you refer to certain low-resistance lamps, viz., the Edison "municipal lamps, lamps used in the Heissler system, and the complainant'

2066 Exhibit Thompson-Houston Lamp and Bernstein Lamp, all of which lamps you say are used in successive series. How long have low-resistance lamps of the character mentioned by you, been commercially manufactured and used, so far as you know.

A. I think that I saw some of these low-resistance lamps at the Franklin institute electrical exhibition about five years ago.

99 X Q. That was the beginning, as I understand you, of their commercial manufacture and use, as you recollect it?

A. As far as my personal knowledge and recollection goes, it was.

100 X Q. Complainant's Exhibit Defendant's Lamp is a high-resistance lamp, with a fine or delicate carbon, and is not a low-resistance lamp, such as those as are referred to in cross 98?

A. Yes, you are correct.

101 X Q. In answer to question 14 you state that the hydrocarbon treatment, you believe, is not universally used. What fact had you in mind in making that statement?

A. It has been stated to me that the Edison Company, in this country, did not use that treatment, although they employed it abroad, and I have also been informed that the United States Company only applied it to a portion of their lamps.

102 X. Is the hydrocarbon treatment referred to by you, the treatment described in the patent of Sawyer and Man No. 211,262?

A. It is substantially.

103 X Q. In answer to question 15 you have analyzed the original application of the patent in suit. Am I correct in assuming from that answer that, in your opinion, the word "arc" as used in the original specification and claims is descriptive of the shape of the incandescent conductor?

A. You are correct.

2067 104 X Q. Was it not the practice at the date of the application for the patent in suit, viz., Jan. 9, 1880, to copper-plate the carbon pencils or rods used in arc lighting; in other words, to cover the carbon with a coating of metal?

A. It was done frequently, but was by no means universal.

105 X Q. I understand you to have expressed the opinion that the powdered plumbago referred to in the original specification was probably intended simply to give the carbon an improved appearance by making its surface glossy, which you consider equivalent to blacking a cooking stove, and quite the same thing, because significantly plumbago is used as the polish in each case. How do you account for the fact that the specification speaks of using the powdered plumbago only in connection with carbonized paper?

A. Because, I presume, the patentees had as a matter of fact in making the experiments alluded to in this place, treated their paper carbons in this way, and not the other ones.

106 X Q. Don't you think that the wood carbon or charcoal conductors, as well as the conductors of ordinary gas carbon, would also need polishing?

A. They might have needed it, but might not have lent themselves so readily to its application, being possibly more frail or more brittle.

107 X Q. Do you think there would be any substantial reason why the wood or charcoal carbons and the gas carbons should not be polished, and would not their appearance be improved in the same manner by polishing?

A. I think it likely that there would be much danger of injury to the wood carbons in the effort to polish them, as they were probably of a delicate structure, and that, in the same way, the brittleness of the hard carbons might have rendered it dangerous to attempt polishing them. It is not unlikely that such polishing would have given a better appearance to all the carbons produced by these inventions at that time.

2068 108 X Q. Is it an ascertained fact that there would be any difference between paper carbon and wood carbon in respect to the ease with which they could be polished, if anybody desired to polish them?

A. No, it is only on my part a conjecture. The paper carbons would probably be flat and the wood carbons would probably be round in cross-section. This would render the polishing of the paper ones easier, as it seems to me.

109 X Q. Taking carbons of the size and shape shown in the drawing of the patent in suit, do you think there would be any material difference in respect to the ease with which the carbons could be polished in the manner you have indicated whether they were made from paper or from wood?

A. Not necessarily, but I think it likely that the carbon represented in the drawing is a paper carbon, and that if any one desired to make a carbon from wood, they would make it relatively longer and more slender and of a round section, in which case, as I have already indicated, it would be more difficult to polish it.

110 X Q. In the continuation of your answer 15 (on April 12, 1889), you state, in criticising Dr. Barker's answer to question 40, that Dr. Barker might be correct in his statement, that the mere mention of carbonized paper in the application, by itself, does not indicate that the inventors intended to employ a fibrous material shaped before carbonizing, or that a successful result would necessarily follow a process of construction founded on such meagre suggestion, but that you think the answer of Dr. Barker is based on incorrect assumptions. Why are Dr. Barker's assumptions incorrect, in your opinion?

A. Because they include, as I understand it, the assumption that the mere mention of carbonized paper, by itself and unsupported and explained by other statements in the application, is a proper subject for criticism or discussion in any effort to understand the meaning of this document or to find out what it reveals to the public in connection with the art to which it relates.

2069 111 X Q. What material fact did Dr. Barker omit in his assumption?

A. The material fact that the application states that the carbonized conductor is to be made of fibrous vegetable or textile material and to have an arch form.

112 X Q. Do you agree with Dr. Barker that the mere mention of carbonized paper in the application, by itself, does not indicate that the inventors intended to employ a fibrous material shaped before carbonizing, or that a successful result would necessarily follow a process of construction founded on such meagre suggestion?

A. To a certain extent. In other words, if this reference to carbonized paper was the only thing in the patent bearing upon the selection of material and the treatment of the same, we should certainly have an entirely different document from any now before us, and one in which it would probably be impossible to find all that you have stated in your question, although some of the items at least would be there, such as the indication that a structure formed substantially of the chemical compound cellulose, and peculiarly well adapted to shaping prior to carbonization, was one of the elements of the invention.

113 X Q. You have stated in answer to question 15, in criticising Prof. Brackett's answers 25 to 30 inclusive, that the earlier Sawyer and Man patent No. 205,144, describes a lamp structure or enclosing chamber which you find "to contain everything that is indicated in the patent in suit and to correspond accurately with the language of this final patent."

Is the lamp chamber described in the old patent 205,144, in terms as "made wholly of glass"?

A. It is not described in such words, but it is described as a structure to which such words might be appropriately applied.

114 X Q. You state in the same answer that the earlier patent 205,144 describes fully various methods of sealing in the electrodes. Where do you find that description?

2070 A. I find the following description:

"Through the stopper B are drilled two holes, Fig. 7, through which pass the bolts Q Q, protected or not by a cloth or paper lining. These bolts are tubes and their function is of the greatest importance. The bolt heads are accurately fitted to the upper surface of the stopper, and under them, coated with balsam or some cement, are thin paper or tin-foil washers *l, l*. The nuts *n, n*, are accurately fitted to the under surface of the stopper, and under them are similar washers *l, l*, similarly prepared. Thus arranged the bolts are permanently fixed to the base, and when the lamp is charged with the artificial atmosphere required, the binding posts *n, n*, whose set-screws are *o, o*, similarly guarded by washers *l, l*, are set up upon the bolts' ends, whereby the lamp is hermetically sealed."

It is to this that I had reference, these bolts being in fact the electrodes or conductors of the lamp.

115 X Q. Is that a description of more than one method of sealing?

A. It is, in so far as it suggests alternative arrangements as to the lining or the apertures, the use of paper or tin-foil washers and the employments of various cements.

116 X Q. Do you consider that these changes make any substantial difference in the method of sealing?

A. No substantial differences. They are all, as I understand, known equivalents of each other.

117 X Q. In your answer to question 17 you state that you consider "that the original application contains very clear and distinct instructions, leading, first of all, to the selection of material which would be of necessity already shaped prior to carbonizing." Am I correct in understanding that you refer to the instruction to use textile material?

A. You are correct.

2071 118 X Q. Am I correct in understanding that without that instruction it is your opinion that the original application would not with certainty lead "to the selection of material which would be of necessity already shaped prior to carbonizing?

A. It would not of necessity refer to a material shaped in all its dimensions before carbonization, but by its mention of paper, it would refer to a material which was of necessity shaped in one dimension, and which would so naturally suggest the propriety of shaping in the other dimensions before carbonizing, that I do not think any directions in that respect would be needed, since any intelligent artizan, in attempting to carry out the invention with paper, would, as a matter of course, so shape his conductor before carbonizing it.

Adjourned till Wednesday, the 24th inst., at 10½ a. m.

WEDNESDAY, *April 24th*, 1889.

Met; present, counsel as before, and the examination of Prof. MORTON was continued as follows:

119 X Q. In answer to cross 78, you refer to the qualification of the word "textile" by the terms "vegetable fibrous." Where do you find such qualification in the original application?

A. I find the qualification, in the first place, by the word "fibrous," used in connection with "textile" in the 4th claim, where it speaks of "carbonized fibrous or textile material." I find the suggestion that the textile material is limited to "vegetable," and does not include animal textile material, suggested by the fact that the only fibrous substances mentioned or alluded to in the patent are vegetable ones.

120 X Q. Is the term "vegetable" or "vegetable fibrous" found at any point by you, in the original application?

A. It is not.

2072 121 X Q. Are not animal materials conspicuous examples of what are ordinarily known as textile materials?

A. They are.

122 X Q. Are not animal materials also conspicuous examples of fibrous materials?

A. Some of them are.

123 X Q. Is not the mineral substance asbestos a fibrous ma-

terial, and would it not also be, properly speaking, a textile material?

A. It is unquestionably a fibrous material, though hardly what would be called in the ordinary sense, a textile material, being too brittle for any ordinary textile treatment, but aside from this, it is entirely excluded from consideration, because, as every one knows, a carbon conductor could not possibly be produced by heating it, nor could it be in any sense carbonized. This being a patent for an electric lamp having a carbon conductor, it is of course, unnecessary to consider in connection with it, substances incapable of producing such conductors.

124 X Q. Asbestos is made into paper as well as into an inferior kind of cloth or fabric, is it not?

A. It is, in a sense, as also is glass, which suggests another difficulty, that asbestos, being a non-conductor of electricity like glass, is manifestly ruled out as a material for producing incandescent carbon conductors.

125 X Q. Referring to your answer to cross 91, am I right in assuming that the drawing of the patent in suit, in your opinion, shows a conductor cut into the arch form rather than bent into that form?

A. That is my opinion; in other words, I think it shows a paper carbon which had been cut into an arch form and then carbonized.

126 X Q. If a carbon conductor of the shape and size of that shown in the drawing of the patent in suit were given its form after rather than before carbonization, that is to say, were made from a
block or mass of vegetable fibrous carbon or ordinary gas
2073 carbon, would it be cut into the arch form from the mass of
carbon, or would it be cut into a straight strip and bent into
that form?

A. From what I know of the properties of the various forms of carbon referred to in your question, I should say that a piece of carbon of such size and shape as is shown in the drawing, could not be produced by bending after carbonization, but must have been made by cutting and not by bending.

127 X Q. You have stated, with reference to the English patent of Greener & Staite No. 11076, of 1846, that the prisms or cylinders are designed for arc lights or arc incandescent lights. Have you fully considered the construction described, in which hollow cones of platinum are employed? Kindly do so, and state if you desire to modify that portion of your answer 20 referring to this patent.

A. I had considered this portion of the patent prior to making the answer referred to, but on looking at it further I should like to modify my statement by saying that I think the use of the prepared carbon cylinders referred to in this part of their patent might be consistent with their action either in the arc incandescent or true incandescent manner. If the ends of the prepared carbon cylinders were not conically shaped so as to fit the platinum cones, I think the action would be substantially arc incandescent; but if they were so shaped as to fit those cones, and thus secure a large surface of contact, then the operation might be of the purely incandescent sort.

128 X Q. You have stated, in connection with the Roberts English patent that it does not contain—

"The remotest suggestion as to the employment of a fibrous or textile material which might be shaped prior to carbonizing."

Do you consider shaping of the material prior to carbonizing essential to the production of the incandescent conductor which you consider covered by the patent in suit?

A. Not always. In other words, if the substance employed
2074 were paper, then the conductor of the patent in suit might be
shaped after carbonization, although, of course, this would be a very injudicious and unmechanical method of carrying out the process of construction indicated in the patent.

129 X Q. Why do you make a distinction between paper and wood carbon?

A. Because in the case of paper, the uniform and yet non-continuous arrangement of the fibres renders it easier to produce a conductor of uniform resistance by shaping into an arch form after carbonizing, whereas, in most cases, this would be impossible with wood carbon. I did not, however, intend to state that paper was the only substance in which shaping before carbonization might be dispensed with, but only to cite it as a conspicuous illustration.

130 X Q. What then did you mean by your statement quoted in cross 128.

A. I meant that while the patent in suit not only suggests, but substantially directs any one who is attempting to carry out the invention, to execute the same by shaping the material prior to carbonization, the Roberts patent gives no such suggestion. At the same time I do not consider that the claims of the patent in suit are so framed as to be limited to this particular method of preparing the carbon conductor, although it would be unquestionably the best as well as the most easy of application.

131 X Q. Then you do not consider it a material defect of the Roberts patent as an anticipating patent that it fails to suggest, in your opinion, a material which might be shaped prior to carbonizing?

A. Yes, I do. In other words, this suggestion or instruction is, I believe, of the utmost importance, because it enables one skilled in the art to so carry out the invention of the patent in suit as to secure success with certainty; but after he had availed himself of this instruction, and had so learned how to produce the desired re-
sult in this way, he might then find it possible in certain
2075 cases to secure a similar result by a variation from this order
of proceeding such as has been indicated.

Adjourned for lunch.

Resumed after lunch.

132 X Q. I understand your view to be that, although it might be possible to produce a practical incandescent conductor by shap-

ing after carbonization, yet it was necessary that the art should first be informed that such a conductor could be produced by shaping before carbonization, before the proper results could be ascertained to enable one to produce the conductor by shaping after carbonization, and that, while you do not wish to take the position that the claims of the patent in suit are limited to a conductor shaped before carbonization, yet you consider it an essential feature of the contribution to the art by the patent in suit that a proper conductor could be obtained by shaping the material before carbonization?

A. There are many points in the view you have stated with which I agree and some, such as the use of the word "essential," in which you do not quite express my views, and therefore I think I can best answer your question by stating exactly what I do think in reference to the subject indicated.

In the first place, it should be remembered that this is a patent for a product, in other words, for a thing made, and not for the process of making it. The thing made in this case is (confining ourselves at present to the particular part of the structure we have been talking about) a conductor for an incandescent electric lamp, consisting of a carbonized fibrous or textile material, having an arch form. Now, in order to produce this thing, the natural, easy and direct way, if we start with the material indicated in the patent and end with the product claimed therein, is to shape such
2076 material before carbonizing it, but at the same time, it is manifestly possible in some few cases that we might start with a material coming within the limits of the class indicated, and produce the product, having substantially the advantages which it would have possessed if made in the natural and easy way, by changing the order to the extent of carbonizing the fibrous material first and shaping it afterwards. Now when this method is followed, provided the conditions are such that the article produced has substantially the characteristics which would have distinguished it when made in the manner directly and naturally suggested by the statements of the patent, I should say that such product was the product set forth in this patent, and the production of which constituted the addition to the state of the art contributed by this patent.

133 X Q. Then all carbons from vegetable fibrous material would not be the conductor of the patent, but only those having certain characteristics; where do you find the characteristics pointed out in the patent in suit?

A. The characteristics which I consider must be possessed by a carbon conductor in order to make it the conductor of the patent in suit, are such as distinguish a conductor made in accordance with the indications of this patent, that is, made from vegetable fibrous material, shaped before carbonizing and having an arched form. It is therefore, as I understand, not necessary that they should be pointed out specifically in the patent in suit, since they will be manifest to any one who, following the direction of the patent, produces the product in question. It is a fact, however that some of the characteristics are pointed out in the patent in suit in the passage which begins with line 100 on page 1, and continuing to the end of line 13 on page 2; also beginning at line 21 of page 2, and continuing to the middle of line 30.

134 X Q. Where do you find, in the original application, any indication of shaping before carbonization?

2077 A. Chiefly in the 4th claim which reads, "an incandescing arc made of carbonized fibrous or textile material," although I find that the reference in the 3d claim to carbonized paper and the reference to carbonized paper covered with powdered plumbago in the specification, strongly suggest the same thing, because the textile material would be of necessity shaped prior to carbonization; the fibrous material would almost of necessity in the hands of an intelligent person, and the paper likewise almost as certainly.

135 X Q. Then you gather this instruction from the materials referred to in the original application, and not from any direct statement in that application. and in this connection, I understand you, you give special weight to the word "textile"?

A. That is so, from the materials, and from the statement that the conductor is to have an arch form?

136 X Q. The rest of the knowledge would be supplied by the "intelligent artisan" acquainted with the art prior to the invention of Sawyer and Man?

A. It would be.

137 X Q. You have referred to Dana's Mineralogy as defining lignite. Is not the following also found in Dana upon the same topic:

"The term brown coal is, however, applied generally to any coal more recent in origin than the era of the great coal beds of the world, although it may not have any distinct remains of a woody structure, or burn with an empyromatic odor. The name lignite has sometimes the same general application, though without strict propriety."

A. I find the quotation you state in an edition of a work entitled "Manual of Mineralogy, by James D. Dana, A. M.," published in New Haven, 1876. This appears so be a much smaller work than the one from which my quotation is taken, although they are published within a year of each other. There is, however, no substantial difference between the statement above quoted, and that 2078 in the larger edition before referred to by me. In my edition, the author states that the term "lignite," while often applied to brown coal, generally, is sometimes restricted to masses which still retain the form of the original wood. The statement is made in the edition just quoted, that the broader statement is without strict propriety. In both editions, however, all the matter comes under the general heading, "mineral coal."

138 X Q. In Braude and Cox's Dictionary of Science, Literature and Art, I find the following statement under the head Lignite:

"The varieties of brown coal which show distinct marks of having been formed of trunks of trees, are conveniently separated from the rest under the name of lignite. As distinguished from brown coal, the most remarkable lignites are those of the Rhine.

* * * * * * *

Lignite splits and tears, while brown coal of the best kinds falls to powder."

I also find in Johnson's Encyclopedia, under the head "Lignite," that—

"The name originally given to bituminized wood, lignite, is applied to woody tissue in which the process of bituminization has begun, however modern it may be. * * * Changed wood is called lignite."

Do you agree with these statements?

A. I do entirely, and find that they support my previously expressed opinion that lignite was a variety of coal, and a substance universally regarded as a mineral, notwithstanding the fact that with many other varieties of coal, and even the diamond, were universally believed to be of vegetable origin, and often contain traces of the vegetable structures from which they were formed.

139 X Q. Are you acquainted with the appearance of the various known lignites?

A. I am not. I have seen one or two specimens, but I have never given it any special study.

2079 140 X Q. Is it not a fact that the piece of lignite which I now show you is evidently woody tissue in which the process of bituminization is so modern that the material is substantially a vegetable and not a mineral?

A. The specimen you hand me has a wood-like appearance, just as many specimens of asbestos and other fibrous minerals, but I notice that its fibrous structure has been pretty thoroughly destroyed, except in appearance, and that if a fragment is broken off, it is readily crushed to powder between the fingers. I think a mineralogist would say that it was a mineral, simulating, but not possessing, a vegetable structure.

The specimen of lignite referred to is offered in evidence by defendant's counsel, and the same is marked, "Defendant's Exhibit, Specimen of Lignite, April 24, 1889."

141 X Q. You have expressed the opinion, in answer 49, that the lamp of the patent in suit, "would last for 100 or 200 hours." Is that opinion based to any extent upon differences in the lamp structure, compared with those which existed in the earlier lamps?

A. Partly on that, and partly by information which has come to me in vsrious ways from others.

142 X Q. Then it is your opinion that the lamp structure of the patent in suit is an apparatus differing in important particulars from the lamp structures of the lamps which existed before the invention of Sawyer and Man?

A. It is.

143 X Q. You have referred to a statement in Fountaine's work on Electric Lighting to the effect that in a certain commercial use of the Konn lamp, the carbons, with the exception of the first, lasted about two hours. Did that statement refer to the life of all the carbons in each lamp or only to the life of each of several carbons?

A. It referred to each of four, that is each of these that were left after one of the four had been burnt almost at once.

2080 144 X Q. What then was the total burning time of such a lamp according to Fontaine's book?

A. Eight hours.

145 X Q. I hand you the American Gas Light Journal for 1879, vol. 30, and call your attention to a paper entitled "Lecture upon the electric light," delivered Oct. 17, 1878, before the American Gas Light Association by Prof. Henry Morton, Ph. D., pres. Stevens institute, Hoboken, N. J., beginning at page 2 and continued at pages 27, 51, and 74. Are you the author of that paper?

A. I am.

146 X Q. Was it delivered by you on the date stated in the introduction to the paper, and was it published in the American Gas Light Journal continuing through the numbers dated, Jan. 2, 1879, Jan. 16, 1879, Feb. 3, 1879, and Feb. 17, 1879, as appears by the volume handed you?

A. A lecture on that general subject was delivered by me on the date stated, and prepared the matter published in this journal subsequently and such matter was published at the various dates referred to. There was however, a great deal published in addition to what was actually said at the lecture, since I was desired by the editors of the joarnal to make this report as complete a discussion of the subject as I could.

The article referred to is offered in evidence and the same is marked Defendant's Exhibit Morton's Paper on the Electric Light, April 24, 1889.

It is stipulated by counsel for complainant, that a copy may be marked in evidence in place of the journal itself, subject to correction, with the same force and effect as if the journal itself were marked in evidence.

147 X Q. In respect to your qualifications as an expert, as expressed in your answer to the 2d question, have you not also had much experience as an expert in litigated cases, especially those relating to patents?

2081 A. I have.

148 X Q. When did you begin, and about what has been the amount of your occupation in this way?

A. The first case that I was called upon to act in was on the subject of canvas and rubber hose, about 17 years ago, since which time I have been called upon in a number of cases each year, probably by this time aggregating more than a hundred.

149 X Q. Did you testify as expert for the defendants in the case of Holliday and others *vs.* Pickhardt and others, in the southern district of New York, and reported in the 29th volume of the Federal Reporter, beginning at page 853?

A. I did.

150 X Q. Are you the Prof. Morton referred to in the opinion of

Blatchford, C. J., in the same case, published at page 147 of vol. 12 of the Federal Reporter?

A. I am.

Adjourned till Thursday, the 25th inst., at 2.30 p. m.

New York, *April* 25, 1889.

Met pursuant to adjournment.

Present: Mr. Curtis, for complainant, and Mr. Donnelly for defendant; and the cross-examination of Dr. Morton was continued as follows:

—. Do you remember the fact that on or about the 22d of December, 1879, you wrote a letter which was addressed to the editor of the Sanitary Engineer, and which was published in that paper about that date, in which, among other things, you disparaged certain statements which had previously thereto been published in the New York Herald concerning Mr. Edison, and also in your letter spoke in high praise of Mr. Edison's ability and of the work he was doing as an inventor in electric lighting?

2082 A. I have a general recollection that, at the request of the editor, I wrote him a letter about electric lighting matters at the time indicated, but I cannot say that I have now any clear recollection as to the contents of said letter. I have no doubt, however, that I spoke well of Mr. Edison because I have always thought well of him, and my personal relations with him have always been agreeable.

151 Q. Have you a copy of that letter in your possession, either here or at home, as published, and if so, will you please furnish the examiner with a copy of the same, so that it may be filed in evidence in this case?

A. I have such a copy at home, and will furnish it with pleasure.

152 Q. Do you remember of writing a letter to the New York Tribune, which was published in that paper Nov. 25, 1880, in which you spoke of the comparative merits of the Maxim and Edison incandescent lamp?

A. There was an interview published at that time. I cannot say that I now recall its substance, but have no doubt of its publication, and if I have a copy of it I will be glad to furnish it to the examiner.

Complainant's counsel consents that copies of the letter and interview above referred to as being published in the Sanitary Engineer and the New York Tribune may be furnished by Prof. Morton and filed in evidence, and used with the same force and effect as originals.

The same, having been furnished by Prof. Morton, are filed in evidence and marked Defendant's — Sanitary Engineer Letter and Interview, April 24, 1889.

Defendant also offers in evidence Morton Interview, N. Y. Tribune, Nov. 25, 1880, April 24, 1889, W. T. F., S. E.

2083 THURSDAY, *April* 26, 1889.

Met. Present, counsel as before, and the examination of Prof. MORTON was continued as follows:

Redirect:

153 R. D. Q. Referring to the opinion of the court on motion for preliminary injunction in the case of Holliday *v.* Pickhardt, 12 Fed. Rep., p. 147, which has been put in evidence by defendant—were the Exhibits A and B, therein referred to, substantially identical as matter of fact?

A. They were.

154 R. D. Q. What was Exhibit A and what was Exhibit B?

A. Exhibit A was a portion of the ordinary commercial acid magenta, manufactured in Germany by Cairo under his patent, and sold by Pickhardt & Kutroff, the defendants in the suit. Exhibit B, as a matter of fact, was also a portion of commercial acid magenta probably manufactured by Reed, Holliday & Co., in England, and sold by their representatives in this country.

155 R. D. Q. Did the fact of what B actually was, appear when the proofs were taken for final hearing?

A. It did. An analysis of that material showed that it contained 7.37 per cent. of chlorine, the commercial product sold by the agent of Reed, Holliday & Sons, which I examined, showing 7.63 per cent. of chlorine, the other constituents being substantially identical in the two substances. It also appeared, from the testimony of Prof. Seeley taken for final hearing, that in the process used by him for the preparation of the material which he introduced as this Exhibit B, he used no chlorine, and that no chlorine could have existed in the product of the process used by him. Prof. Seeley also in his testimony in the same connection, admitted that the material put in by him in connection with his affidavit above referred to might have been the commercial acid magenta of Reed, Holliday & Sons.

2084 156 R. D. Q. And upon the issues in that case, which were decided by Judge Wallace on final hearing in favor of the complainant and against the views of yourself, Prof. Chandler and others, was there a very large amount of testimony taken on both sides, and did much of it relate to difficult questions of chemistry?

A. There was an immense amount of testimony taken, much of which was of a highly recondite, chemical character.

157 R. D. Q. Is the accounting under the interlocutory decree in that case still proceeding?

A. It is.

HENRY MORTON.

Subscribed and sworn to before me this 26th day of April, 1889.

WM. T. FARNHAM,
Special Examiner and Notary Public.

2085 NEW YORK, *April 18th*, 1889.

Met pursuant to adjournment.

Present: Mr. Thomas B. Kerr, of counsel for complainant, and Mr. Walter K. Griffin, of counsel for defendant.

Testimony of Oliver B. Shallenberger.

OLIVER B. SHALLENBERGER, a witness on part of the complainant, being duly sworn, testifies as follows in answer to interrogatories by Mr. KERR:

1 Q. State your name, age, residence and occupation.

A. Oliver B. Shallenberger, age 29 years, Rochester, Penna.; electrician.

2 Q. What has been your electrical experience?

A. I commenced the study of electricity in 1880 with particular reference to its practical applications, my first work being in connection with the construction of incandescent lamps. I made experiments during the winter of 1880 and 1881 with a view to carrying out the instructions contained in the Maxim specification for an incandescent lamp issued about that time, and gained some experience in carbonization of paper and the requirements of the carbon for incandescent lamps. I continued the study of electricity at intervals until the latter part of 1884, at which time I connected myself with the Union Switch and Signal Company of Pittsburgh, and subsequently with the Westinghouse Electric Company as chief electrician, and have had during the five years since that time general supervision of the electrical work carried on by the company. A large amount of my time has been devoted to the study of incandescent lamps being immediately connected with their production on a commercial scale, averaging several thousand lamps a day for a portion of the time. During the last year and a half I have been associated in experimental lamp work with Mr. Alexander de Lodyguine of St. Petersburg, and have obtained much useful information through him. We have jointly carried on an extensive series of experiments with the object of perfecting, as far as possible, the incandescent lamp of the Westinghouse Electric Co., involving careful comparative tests of 2086 lamps of various types. I have recently carried out a series of experiments, assisted by Mr. Frank S. Smith and others, for the purpose of determining the practical usefulness of the Sawyer and Man lamp when constructed according to the directions furnished in the specification of the patent in suit. I have also investigated the general subject of the carbonization of fibrous materials, particularly of vegetable origin, and have carefully observed the fitness of carbons so obtained for use in incandescent lighting.

3 Q. Please state whether you had any other directions for the experiments referred to in your last answer than those furnished by the patent in suit.

A. My information was entirely derived from the specifications of the patent in suit, and from prior patents granted to Sawyer and Man to which reference is made in the patent in suit.

4 Q. Will you please produce samples of the lamps made by you in accordance with the patent in suit and describe the same, both as to construction and any tests or uses you made of them, fully and in detail; and also any other lamps of the same character made by you in addition to those which you produce in evidence?

A. I here produce six lamps, five of which are mechanically constructed in exact accordance with the drawings and description in the patent. The five lamps are marked "Complainant's Exhibit Pittsburgh Sawyer-Man Lamp No. 1 Paper Carbon," together with the Exhibits Nos. 2, 3, 4 and 5 and are constructed mechanically as nearly like the patent in suit as possible. The carbon is supported by two carbon clamps, except in lamp No. 2, in which the clamps are of platinum; these clamps are supported on a disc as shown in the drawings, and insulated from each other; the supports for the clamp extend through the disc, and are electrically connected to copper conductors of corrugated form, which extend to the base of the lamp. The latter consists of a plate of glass having two openings about 2087 a quarter of an inch in diameter through which the tubular bolts pass. These bolts are constructed as shown in figure 5, of the patent in suit, which is as follows: A tube about three-eighths of an inch in diameter is turned off at one end to a diameter sufficient to allow it to pass through the holes in the plate leaving a flat flange to bear against the lower surfaces of the plate, the smaller end of the tube which projects inside of the lamp is threaded for attachment to the ends of the corrugated conductor. The thicker end which projects outside of the lamp is provided with an air-tight valve by means of which the opening in the tube may be closed. A cap is provided to screw over the projecting end of the tube when the lamp is finished. The glass plate is ground to fit accurately against the flanges of the tube bolts, so that without cement of any kind the joint is practically air-tight. These tube bolts serve the double purpose of ducts through which the air may be exhausted, or nitrogen admitted, and of conductors for supplying current to the carbon. Surrounding the carbon and conductors leading to it, and reaching down to the base plate is a tubular glass bulb provided with a flange at its lower extremity of the same external diameter as the base plate, this flange is ground perfectly flat, as is also the surface of the base plate, so that when the two are placed together they will form a practically air-tight joint in the same way as the tube bolts. Two brass flanges are placed above and below the joint between the base plate and the flange of the bulb, and these are drawn together by iron screws, the pressure being softened by paper washers placed between the metal and the glass. The joints are made air-tight and permanent by a thin coating of fir balsam applied previously to the assembling of the parts, and the base is protected by a brass cap of substantially the form shown in the drawing. The lamp marked "Complainant's Exhibit Pittsburgh Sawyer-Man Lamp No. 6," is constructed in substantial accord with the specification of the patent in suit, but is

modified in the details of the base; instead of the base plate
2088 as shown in the drawing, a bottle stopper is used which is ground to fit accurately on the internal surface of the mouth of the globe. Through this stopper two holes pass for the admission of the tube bolts. The latter are of the same construction as previously described, except that instead of being formed of one piece they are composed of a platinum tube to which the thicker flanged portion is attached, the object of employing the platinum is to obtain nearly the same expansion in the tube as in the stopper and so maintain a tight joint. The clamps in which the carbon conductor is held in this lamp are of platinum; in other respects than those mentioned, it is constructed like the drawing figure 5, of the patent in suit. Each of these lamps was submitted to a test and the following records show briefly the result.

Lamp No. 1. Carbonized paper cut into arched form after carbonizing, tempered by heating in very attenuated hydrocarbon gas, bulb contains an atmosphere of nitrogen tested for one hundred and thirty-two hours and fifty minutes at proper incandescence, and is still in good condition as may be judged by the appearance of the carbon and absence of blackening in the interior of the globe.

Lamp No. 2. Paper carbon with platinum clamp. Globe exhausted to highest attainable vacuum. Tested for one hundred and thirty-one hours and twenty minutes. Carbon now in good condition, no blackening of the bulb, vacuum at the end of test good.

Lamp No. 3. Willow carbon. Atmosphere of nitrogen. Run at about sixteen candles for one hundred and fifty-six hours and three minutes. Is now in as perfect condition apparently as when started; no blackening of bulb; carbon perfectly bright and clean.

Lamp No. 4. Silk carbon vacuum lamp. Run for two hundred hours. No visible change in the appearance of the carbon. No blackening of the bulb. Exhausted April 2d. Vacuum tested April 17th and showed remarkably high exhaustion.

2089 Lamp No. 5. Silk-thread carbon. Nitrogen atmosphere. Burned for one hundred and thirty-eight hours and is still in perfect condition. Charged with nitrogen April 5th. Tested April 17th, at which time it showed evidence of perfect nitrogen atmosphere of low pressure.

Lamp No. 6. Bottle-stopper lamp. Carbon of piazava, platinum clamps. Exhausted to high vacuum. Thirty candle power. Was run for twenty-four hours and twenty minutes at about twenty candles and is now in perfect condition, both as to vacuum and condition of carbon.

In addition to these lamps I have tested the following which are not offered in evidence:

Lamp No. 7. Paper carbon; charged with nitrogen April 4th; ran forty-three hours and fifty-two minutes at fifteen candle power; broke at the clamp from imperfect contact.

Lamp No. 8. Nitrogen atmosphere at low pressure. Paper carbon; ran thirty-eight hours and forty-five minutes; broke from defective carbon.

Lamp No. 9. Paper carbon, nitrogen atmosphere; ran forty-seven hours and fourteen minutes. This lamp was charged with nitrogen at about half an inch pressure on March 28, and when tested April 17th showed the atmosphere to have remained constant as nearly as could be ascertained. This lamp was run at twenty candle power which required a high temperature with consequently short life.

Lamp No. 10. Paper carbon *in vacuo*; ran forty-two hours and thirty minutes at about sixteen candle power; accidentally forced to about one hundred candle power which probably was the cause of its short life. Was exhausted on April 2d, and showed very high vacuum when tested on April 17th.

In addition to these lamps several others were made or partly
finished and were not successful for various reasons. Two lamps
were forced so high as to break the globes, several were
2090 cracked at the flange or base plate and work was discontinued
on them for that reason. It was considered easier to make
up new parts than to hunt out the mechanical defects in the old
ones.

Adjourned to meet April 19th, 1889, at 10.30 a. m.

APRIL 19, 1889—10.30 a. m.

Met pursuant to adjournment. Present: Thomas B. Kerr, of counsel for complainant, and Walter K. Griffin, of counsel for defendant, and the examination of the witness OLIVER B. SHALLENBERGER is continued:

5 Q. Please state fully and in detail the operations of carbonizing the carbon conductors, and of filling the lamps, or exhausting the same, referred to in your answer to question 4.

A. The material of which the carbon conductors were made was usually paper and that chiefly employed was a sort of bristol-board having a thickness of about .013″ and blotting paper about .03″ in thickness, the latter was sometimes pressed and was soaked in a solution of sugar before carbonizing. The blanks for carbonizing were punched out in the form of rings or horseshoes from $\frac{1}{8}$ to $\frac{1}{16}$ inches in width and with a radius of about $\frac{3}{8}$ of an inch. These blanks were placed in paper boxes surrounded by powdered carbon and placed in graphite crucibles the whole being filled also with the powdered carbon. A cover was then placed on the crucible and roughly cemented in place. This crucible was then heated in a gas furnace for six or eight hours and allowed to cool before removing the carbon.

Carbons were also made of willow which was cut into thin slips
.05″ square, which were bent into horseshoe form after soaking in
hot water over the end of a carbon block. They were then allowed
to dry and packed in powdered carbon for carbonization as
2091 described with reference to the paper carbon. One carbon
was prepared by cutting out from a piece of carbonized paper a
horseshoe strip about an eighth of an inch wide. The carbon in lamp
Exhibit 6 was made from a grass called piazava, a piece of which

was bent around the end of a carbon block to give the required form and was carbonized while on the block and surrounded by powdered carbon.

Carbons of silk, such as are used in the Westinghouse Electric Company's ordinary lamps were also employed, such carbons being taken from stock and treated as is usually done in the preparation of those carbons. The latter carbons were used for the purpose of comparing the condition of carbons whose characteristics are well known when used in the Sawyer-Man lamp of the form shown in the patent in suit, with that exhibited in lamps of modern form.

All of the carbons, so far as I recollect, were tempered and lightly treated in an attenuated atmosphere of hydrocarbon gas, for the purpose of consolidating the fibres, filling the pores and rendering uniform the resistance throughout the length. This process was carried out as described in the patent No. 211,262 of Sawyer and Man granted prior to the issuing of the patent in suit. The amount of deposited carbon was in most cases barely sufficient to brighten the surface and did not cause any perceptible thickening when measured by a thousandth *guage*. A noticeable decrease of resistance was produced, however, by this process owing to absorption of the gas within the pores of the carbon without increasing the external dimensions. The tempering and treating process is substantially as follows: The carbon to be treated was mounted on two electrodes having suitable clamps attached to their extremities, and supported on a horizontal plate to which communicated tubes leading to the exhaust pump, gas reservoir, and mercury *guage*. A bell glass was placed over the carbon thus mounted resting at the bottom on a rubber ring so as to make an air-tight joint. Communication was then established with the air pump until the mercury gauge showed the highest exhaustion attainable when
2092 hydrocarbon gas was admitted, and allowed to flow in sufficient quantity to lower the pressure about one-half or three-quarters of an inch. The atmosphere in which the treatment was carried on was therefore highly attenuated, and contained very little gas as compared to the amount contained in the same space at atmospheric pressure. The object of this arrangement was to enable the operator to reduce the treatment to as small an amount as was thought desirable, and consistent with the proper consolidation and rendering uniform the resistance.

In order to determine the effect of the presence of a small amount of hydrocarbon gas within the receiver, several carbons were treated, or tempered, in an atmosphere of nitrogen. The result being a very decided consolidation and solidifying of the fibres so that the texture became much more firm and the carbon more readily handled. It was evident, therefore, that the tempering process and treating are simply merged into each other by the heating of the carbon in an atmosphere of hydrocarbon gas, and that the disposition of carbon occurs very largely within the pores of the fibrous material. The relative amount of internal and external deposit is regulated very readily by varying the pressure of gas in which the process is carried on, a large amount of gas and considerable pressure producing a thicker external coating with less absorption of gas within the fibres. By reducing the pressure to about one-half inch the internal treatment or absorption of gas within the pores may be carried on to such an extent as to diminish the resistance of the carbon to one-half of its original reristance in the case of most fibrous materials, and in the case of blotting paper can be reduced to one-tenth of the original resistance. The physical condition of blotting paper is very noticeably changed during this process so that instead of being soft and easily pulled apart, as it is before treatment, it becomes tough, elastic and metallic in its properties, without any change in external dimensions. Nothing better 2093 illustrates the wonderful adaptability of the fibrous structure for the purpose of producing lamp carbons that this property of absorbing and decomposing hydrocarbon gas, so as to render the quality of the material exactly such as is most desirable for the purpose.

In marked contrast to the foregoing an experiment was made to determine the effect of heating a piece of Carré carbon in exactly the same way and in the same gas in which the treatment of the fibrous carbons was carried out. A piece of carbon pencil two inches long and .0185″ in diameter was placed on the treating clamps and subjected to the passage of a current sufficient to heat it to a brilliant white heat for one minute. The resistance before this process was 17 ohms, and a measurement immediately afterward showed a resistance of 17.5 ohms, the diameter remaining the same. The two resistances were considered as substantially agreeing inasmuch as the lengths measured were not very accurately taken, possibly. It may be as well to add by way of explanation, that Carré carbons are made by a process similar to that used in the manufacture of arc-light carbon, that is, by mixing powdered carbon with some suitable viscous carbonaceous material, such as coal tar, then forming into cylinders or pencils, and baking at a high temperature. The result is an amorphous mass of hard carbon having no fibrous structure, quite brittle and therefore incapable of bending into a new form after being manufactured. It was found that the treating process when applied to such a pencil of carbon, although a slight change in the appearance of the surface was produced, did not change in any way the internal condition. The pencil remained as brittle as before, and as shown by the foregoing figures, was not changed in resistance. A piece of fibrous carbon produced from a siip of piazava one and seven-eighths inches long, and of an average diameter of .3″ had a resistance before treating, of 40 ohms, and after being heated for one minute in gas of the highest attainable attenuation was reduced to 30 ohms without perceptible increase in diameter.

A semicircular carbon of blotting paper .021″ in thick- 2094 ness and .055″ in width before treating, had a resistance of 143 ohms. After treatment for three minutes in attenuated gas, the dimensions were .021″ thickness and .053″ in width, and the resistance was reduced to 3 ohms, or only one-eleventh of the untreated resistance, and with certainly no increase in cross-section.

This illustrates in a marked degree the adaptability of a fibrous carbon to the treating process, and it is my opinion that without the treating process, the availability of carbon as a material for the conductors in incandescent lamps is certainly very limited.

The exhaustion of the lamps was effected by attaching lead tube to the bottom of the tube bolts which passed through the base of the lamp, and connecting by a rubber tube to the mercury pumps. The lamp was then exhausted in the ordinary way, and occluded gases were driven off by passing the current through the carbon, then the valves were closed and the tubes removed and the caps screwed in place. The exhaustion was tested by observing the character of the discharge through the bulb when placed between the poles of an induction coil of high electro-motive force. There was nothing unusual about this part of the process of making the lamps.

Such lamps as were filled with nitrogen were manipulated substantially as described in the Sawyer and Man patent No. 205,144. The nitrogen was prepared and purified over melted sodium according to the directions found in Stillman's patent 225,730. In general this process is as follows: The nitrogen is generated by heating a solution containing am-onium chloride and potassium nitrite. The resulting gas is passed through Wolff's bottles containing pyrogallate of potassium, caustic potash solution, ferrous sulphate and sulphuric acid. The gas thus generated and purified is collected in suitable rubber bags, and when used for filling lamps is again purified to render it as free from all contamination with other gases as possible. The order in which these reagents were used in my process of filling the lamp was as follows: Ferrous sulphate
2095 pyrogallate of potash, caustic potash solution, sulphuric acid,
dry caustic potash, dry phosphoric anhydride, and finally melted sodium. The melted sodium removes the last traces of oxygen and acts as a convenient indication of the purity of the gas by remaining untarnished when the proper degree of purity is reached.

The lamp to be filled with nitrogen was connected by lead pipes to rubber tubes attached as before described, and the gas was passed through until a proper degree of purity was reached. Before introducing the first nitrogen the air was withdrawn by attachment to a mechanical pump to facilitate the process and prevent the admixture of air with the nitrogen. In some cases the lamp was previously exhausted on a mercury pump.

Counsel for complainant offers in evidence the lamps referred to by the witness in answer to question 4 as those produced by him as follows, to wit:

"Complainant's Exhibit Pittsburgh Sawyer-Man Lamp No. 1, Paper Carbon. W. T. F., S. E."

"Complainant's Exhibit Pittsburgh Sawyer-Man Lamp No. 2, Paper Carbon, W. T. F., S. E."

"Complainant's Exhibit Pittsburgh Sawyer-Man Lamp No. 3, Willow Carbon, W. T. F., S. E."

"Complainant's Exhibit Pittsburgh Sawyer-Man Lamp No. 4, Silk Carbon, W. T. F., S. E."

"Complainant's Exhibit Pittsburgh Sawyer-Man Lamp No. 5, Silk Thread Carbon, W. T. F., S. E."

"Complainant's Exhibit Pittsburgh Sawyer-Man Lamp No. 6, Piazava Carbon, W. T. F., S. E."

6 Q. Please state whether you know of any other fibrous material suitable for making the illuminating conductors of incandescent lamps, and, if so, please name them.

A. There are a number of woods suitable, in my opinion, for carbonizing for the purpose of forming a conductor for incandescent lamps, such as ash, hickory, linwood, linden, birch, poplar, willow tree, yew, elm, tulip, and other woods having suitable 2096 straight fibres, or fibres which may be easily split without too much cutting across from one fibre to the other. There are a great many suitable grasses, such as ixtl or Mexican grass, piazava, manilla, flax, hemp, dog's grass, etc., and such fibrous growth as the stem of the palm-tree branch, or large leaf, rattan, broom-corn, bamboo, palmetto, and such textile materials as cotton thread, linen thread, linen twine, silk thread, jute, and the like. This list could be indefinitely extended.

7 Q. Please state whether you have made any incandescent lamps containing illuminating conductors made of any of these materials, and if so, produce specimens of such lamps, and state whether you made any tests of the same, and if so, describe such tests.

A. I have recently prepared and tested lamps with carbons made from the following materials:

1, ash; 2, hickory; 3, linwood; 4, broom-corn; 5, piazava; 6, palmetto; 7, rattan; 8, ixtl fibre; 9, manilla fibre; 10, hemp cord; 11, linen thread; 12, bamboo paper.

Owing to the limited time available for the preparation of these lamps it has been impossible to give all of them exhaustive life tests, but such of them as have been tested for a considerable time have given extremely satisfactory results. Lamp No. 4, in which the carbon is of broom-corn, was tested for seventy-eight hours, fifteen minutes at ten candle power, and shows no perceptible deterioration. Lamp No. 1, which has an ash carbon, was tested for the same length of time, and is in equally good condition. Lamp No. 2, in which the carbon is of hickory, was run at 16 candle power, as was also the ash carbon, and for the same length of time. This carbon, although not as bright throughout its length as the two previously mentioned ones, is still in excellent condition; neither of these three lamps shows any sign of blackening on the interior of the bulb. No. 3, which contains a linwood carbon, is very similar to the ash carbon in all its characteristics, both carbons being quite uniform in resistance before treatment, and 2097 showing much the same behavior during the treating process.

The carbon in lamp No. 7 is of rattan, and remains in good condition after a test of 21 hours and 35 minutes. This fibre is easily prepared and formed into shape before carbonization, and is of uniform resistance before treatment. No. 5 was tested 23 hours and 15 minutes, and is still in good condition. No. 10 has a carbon made from a piece of ordinary hemp twine, and is in perfect condition after running 23 hours and 15 minutes. All of the carbons mentioned were particularly adapted for moderately low e-ctromotive force, and in the lamps actually made, ranged from about 20 to 50 volts. Lamp No. 12 contains a carbon of bamboo paper, specimens of which were obtained by Mr. Broadnax, and were given to me for the purpose of testing for carbonization. It is undoubtedly well suited as a material for making incandescent carbon. The manilla, ixtl and palmetto fibres are particularly well adapted for lamps of low candle power or high electro-motive force. Lamp No. 11 was tested for 24 hours at 16 candle power, 109 volts, and is in good condition. No. 9 was tested at 10 candle power, 83 volts, and is evidently a very suitable material for high-resistance filament. No. 8, in which the carbon is of ixtl, gives 16 candle power at 80 volts, and is, perhaps, the best material in the above list, so far as I have determined for a high-resistance filament of low candle power. No. 6 contains a palmetto carbon giving 5 candle power at 31 volts, this would be equivalent to 16 candle power at about 95 volts if the fibre were made proportionately long. A test of 23 hours developed no defects. In all of these lamps the treating was so slight as to cause no perceptible thickening of the carbons, being barely sufficient to consolidate the fibres and render the resistance uniform throughout.

The selection of these materials was made without any previous tests and all of the material selected and considered suitable for carbon were practically successful; several of them were suggested by Mr. Alexander de Lodyguine as having been used successfully
by him in the manufacture of lamps commercially, the others
2098 were tried simply because a knowledge of their characteristics
made it seem probable that they would make good carbon.
I have no doubt that many others equally suitable could be easily found by any one by the exercise of a fair amount of judgment.

Counsel for complainant offers in evidence the lamps mentioned in the last answer as follows:

Complainant's Exhibit Ash Lamp, W. T. F., S. E.
Complainant's Exhibit Hickory Lamp, W. T. F., S. E.
Complainant's Exhibit Linwood Lamp, W. T. F., S. E.
Complainant's Exhibit Broom-corn Lamp, W. T. F., S. E.
Complainant's Exhibit Piazava Lamp, W. T. F., S. E.
Complainant's Exhibit Palmetto Lamp, W. T. F., S. E.
Complainant's Exhibit Rattan Lamp, W. T. F., S. E.
Complainant's Exhibit Ixtli Lamp, W. T. F., S. E.
Complainant's Exhibit Manilla Fibre Lamp, W. T. F., S. E.
Complainant's Exhibit Hemp-cord Lamp, W. T. F., S. E.
Complainant's Exhibit Linen-thread Lamp, W. T. F., S. E.
Complainant's Exhibit Bamboo-paper Lamp, W. T. F., S. E.

8 Q. From your experience in the manufacture of lamps in accordance with the patent in suit, what is your opinion of the ability to make good practical lamps of that construction, either with an atmosphere of nitrogen gas, or with a vacuum?

2099 A. The result of my work in the making of these lamps has been to demonstrate beyond any doubt the entire practicability of such a lamp structure. The matter that at first was considered of the greatest difficulty in beginning the work, namely, the preservation of an air-tight joint at the base of the lamp, proved to be one which was easily overcome by the exercise of ordinary care and good workmanship in the preparation of the parts, and by proper attention in the assembling of those parts. It was found that each lamp could be made tight enough in the factory to be practically tight when the parts were simply put together dry, relying only on the intimate contact of the flat surfaces for the joint. On several occasions I so placed the parts together, and partially exhausted the lamp when it was found that a sufficient exhaustion was maintained within the lamp in this way to firmly hold the base plate in place for an hour or so, in fact, this method was used frequently during our work to test the accuracy of the workmanship on the lamps as they came from the factory. It is quite evident when the matter is looked into with a little care that there is no serious difficulty in this part of the work, the joints depend entirely upon the intimate contact of flat surfaces, not only between the flange at the bottom of the globe and the base plate, but also between the flanges of the tube bolts and the base plate. Nothing is easier in the line of mechanical work than to grind surfaces practically flat, assuming that suitable appliances are employed for the purpose. It is well known that two heavy metal blocks may be so accurately ground together that when placed in intimate contact with each other, the air is so perfectly excluded that it is possible to lift both blocks by picking up either one of them, the atmospheric pressure holding them together as one piece. It is entirely unnecessary to attain any such degree of perfection in the contact of the joints in an incandescent lamp, since the coating of balsam used on the surfaces fills up any minute irregularities, and the result is that when two surfaces are pressed together the air is excluded
2100 and a perfect joint is obtained. A sort of molecular adhesion comes into action in addition to the external pressure of the atmosphere, holding the surfaces together with great force, so that when once placed together it is nearly or quite impossible to remove one from the other by a direct pull.

The only other air-tight joints required are the small valves in the tube bolts, and these again are easily made tight by grinding in place in the ordinary way; such valves are so common as to require no explanation. The application of a small amount of balsam around the valves when they are finally closed is sufficient to insure their tightness.

All of the particulars referred to above, as will be seen, are simply matters of ordinary care in the putting together of the parts, and are such matters as any careful workman, as for instance, an instrument-maker, would attend to as the result of his experience. The operations are, however, so simple that they could be readily learned by any person of average intelligence in a short time.

It is in my opinion more difficult, if any difficulty is supposed to

exist in producing a tight joint, to produce a vacuum lamp than one filled with an inert gas, since the joints are then subjected to the severest possible test. As will be seen by referring to the record of the tests of these lamps as it has already appeared in my testimony, the exhaustion of such lamps as were run *in vacuo* did not deteriorate in the least, even in cases where the carbons burned out within forty or fifty hours, most of the failures were due either to defective carbon, or overrunning the lamp for the sake of producing a brilliant effect. It was not thought that there would be any difficulty in obtaining a sufficiently good carbon, or in fact, in employing such carbons as are now used in incandescent lamps, if the lamp could be made perfectly tight, such proved to be the case, and little time was spent on the production of any particular kind of paper carbon as it is a matter of common knowledge that paper carbons have been and still are used commercially with perfect suc-
2101 cess. A number of carbons were, however, prepared of various kinds of paper, including bond paper, cardboard and blotting paper. Most of the lamps prepared contained carbons of cardboard which was found to be easily prepared and convenient to use. The carbons in Exhibits 4 and 5 are of silk thread prepared, carbonized and treated as for ordinary lamps made for the Westinghouse Company. One of these lamps is exhausted to as high a vacuum as possible and the other contains nitrogen. The purpose in the preparation of these lamps was to give as severe a test as possible to the tightness of the joints, since any leakage whatever, would very noticeably affect the surface of these carbons of small diameter and cause them to burn out. No signs of burning out were shown at the end of 200 hours in the case of the exhausted lamp, and 138 hours in the case of the nitrogen lamp, after which tests they were removed from the circuit, and immediately packed and brought here for the purpose of entering as exhibits. These lamps were run during their test at about the same temperature as other lamps undergoing test at the same time, and which were the same as used commercially at the present time.

9 Q. Please state how the cost of the Sawyer-Man lamps having the mechanical construction, shown in the patent in suit, if made on a commercial scale, would compare with that of the ordinary incandescent lamp of the present day.

A. The comparative cost would depend very greatly on the amount of light obtained from the lamps in question; the cost of the two kinds of lamp approaching more nearly in lamps of higher candle power. By far the greater number of lamps, however, are of 10, 16 and 25 candle power as used commercially at the present time, so that it will be proper first to consider a comparison of such lamps. I am informed that the cost of producing ordinary incandescent lamps is roughly between twenty and thirty-five cents, according to the exact style of the lamp, the current carried in its incandescent carbon, and consequent size of the platinum wires.
2102 It is customary after such lamps are burned out to throw away the remaining part since the value of the remaining material would be hardly greater than the cost of shipment and

remodelling necessary before they could be again utilized. As a purely commercial matter it has been found that this is the most feasible form of lamp to use. I refer to the form in which platinum wires are sealed in through the glass, as in the old Geisler tubes and radiometers, and experimental apparatus of Crookes and others, well known prior to the invention of Sawyer and Man. The view taken by Sawyer and Man in their work was that a lamp should be so constructed that when the carbon should become destroyed by use the other parts of the lamp might be returned, taken apart, and refitted with a new incandescent conductor for another period of use. Bearing this in mind, it does not appear strange that they were willing to depend upon a more expensive form of lamp than might be obtained by utilizing the knowledge of the day in the sealing of wires through the glass. On the other hand, the expense of producing a lamp of the exact form shown in the patent in suit would not be so great as to prohibit its use on a commercial scale, even if it were not generally returned for remounting. From my experience with such mechanical work, I would estimate that lamps of the Sawyer and Man form, as shown in the patent in suit, could be produced complete in quantities of, say 1,000 or more per day, at a cost of between eighty cents and one dollar each. Of this cost sixty to eighty cents would be that of the permanent mechanical portions of the lamp, allowing twenty cents as outside estimate on the cost of taking apart, preparing and mounting a new carbon, putting together and re-exhausting. I believe it quite possible that on a large scale the cost would not be more than one-half of this amount.

In the case of the larger lamps, of say from 50 to 150 candle power, it is evident that little would be added to the cost of 2103 the lamp of the old Sawyer-Man form, since the changes would be more in weight of material used than in labor, as compared with the small lamp. A lamp of the modern type, however, with the Geisler seal involves a greatly increased amount of labor by the glass-blower, as the size is increased, and runs up rapidly beyond the amount I have estimated, as the cost of the old Sawyer-Man form.

To summarize briefly: lamps of the old Sawyer-Man type could be refitted for use an indefinite number of times at a cost not differing greatly from that of supplying modern incandescent lamps, as is habitually done by the various electric light companies and without very greatly increasing the investment for the installation of a plant in the first place. The cost of installation of an incandescent light plant may be placed at from fifteen to twenty-five dollars per lamp as now practiced commercially. Even an addition of one or two dollars in the amount of this investment would not seriously change the commercial value of the lamp since renewals of carbon would cost practically the same, or less, than the present renewal of the entire lamp.

10 Q. Please state the effect upon incandescent lamp filaments or carbons of the Sawyer-Man hydrocarbon treatment process?

A. I have already referred incidentally, in my answer to question 5, to the effect of such treatment and would refer now to that answer as a part of the answer to the present question. I would emphasize particularly the importance of the tempering process, or internal treatment as distinguished from external treatment or the deposition of a shell of carbon on the surface of the fibrous carbon proper. It is the internal treatment which is by far the more important, since its action is to consolidate the entire mass, rendering the resistance uniform throughout the cross-section, and filling up any slight imperfections that may exist. This action is therefore to render the carbon more homogeneous and dense, at the same time changing in a very remarkable way the elasticity and mechanical strength of the carbon. Incidentally, the resistance of the carbon is decreased by this 2104 process without any increase in the diameter. The resistance, however, of the untreated carbon when prepared of a fibrous material is so high as to admit of such reduction without interfering with the high actual resistance of the filament even though its specific resistance may be lowered. It has been stated that the process of hydrocarbon treatment is substantially building up a filament of deposited carbon on a core of small diameter and of any substance sufficiently good to act as a frame-work or support for the carbon so deposited. While such a method might be used with some success and has I believe been accomplished by certain makers of incandescent lamps, it is distinctly the reverse of the process as employed in the preparation of fibrous carbon in accordance with the Sawyer-Man specification, as I understand it, and have practiced it. The difficulty in building up a carbon in this way is that the deposited shell is of very low specific resistance, while the core is of high specific resistance, the result being an unequal division of the current when the lamp is in operation, and a much larger part of the current passing through the deposited shell and consequently forcing it beyond its proper proportion of work. In the manufacture of incandescents, as I am familiar with the work, any such building up of the outer surface is carefully avoided, and the diameter of the filament is not sensibly changed by the process. I here produce several specimens of carbon conductors prepared for use in incandescent lamps showing the condition of the carbons before and after treatment.

Exhibit Linen-thread Carbon shows specimens of thread of the same size treated and untreated. It can be readily seen by inspection of the exhibit that there is no perceptible thickening of the treated carbon, and yet, the resistance has been reduced by tempering and consolidating the fibres and internal treatment independent of the microscopically thin external deposit from 525 ohms in the untreated specimen, to 260 ohms, in the treated one. These resistances it may be well to note, refer to the entire filament 2105 as prepared for treatment, the length of which was an inch or more greater than the specimens here shown. The relations between the two resistances per unit length is, however, the same, that is, the untreated resistance is about double the resistance after treatment, and this without noticeably changing the thickness.

The Exhibit "Piazava Carbon," shows the result of treating a more dense material, and while the reduction in resistance is not carried so far in this case, yet the effect is sufficiently marked. The resistance before treatment was 36 ohms, while that after treatment was 26, and that without perceptible increase of diameter.

Exhibit "Linen Twine" shows a specimen of the material before carbonization, the untreated carbon, and the same after treatment. There is no measurable difference in diameter, but the resistance is reduced by the treating process from 55 to 17 ohms. The untreated specimen shown has a slightly higher resistance than had the carbon subjected to treatment, namely, 63 ohms.

The Exhibit "Silk Carbon," shows the result of treating a piece of carbonized silk .005″ in diameter, as ordinarily done in the commercial production of carbons for incandescent lamps. The resistance of a loop of this carbon when measured before treatment is 1,050 ohms. After treatment, the same piece measures 315 ohms, the length and diameter remaining the same.

I have referred in my answer to question 5, and in some detail, to one of a number of experiments I have made to ascertain the effect of attempting to treat Carré carbon such as is used in certain lamps of European manufacture. I have also there described the character of this carbon as to structure, and indicated the method used in its manufacture. I here offer in evidence a specimen of this carbon, which is in fact the identical one used by me in the experiment referred to in answer to question 5. I produce it for the purpose of showing that it is externally treated so as to present about the same appearance as the fibrous carbons offered 2106 in evidence, and that such a deposit does not cause a reduction in the resistance. This is direct evidence to the effect that the fibrous carbon absorbs and decomposes within its pores the hydrocarbon gas during the process of treatment, and is therefore specially fitted to be used in connection with this process. The proof lies in the fact that the fibrous carbons may be reduced to from one-half to two-thirds in resistance without change of diameter, while the Carré carbon when subjected to the same conditions is practically unaffected.

Counsel for complainant offers in evidence the carbons mentioned in the last answer as follows:

Complainant's Exhibit Linen Thread Carbon, W. T. F., S. E.
Complainant's Exhibit Piazava Carbon, W. T. F., S. E.
Complainant's Exhibit Linen Twine Carbon, W. T. F., S. E.
Complainant's Exhibit Silk Carbon, W. T. F., S. E.
Complainant's Exhibit Carré Carbon, W. T. F., S. E.

11 Q. Have you examined the Patent Office model of the patent in suit, and if so, will you please state the dimensions of the carbon contained within?

A. I examined this model on the 30th of March of this year, and measured with a thousandths *guage* the dimensions of the carbon.

The thickness I found to vary slightly, the average being .043″. The width at the top of the loop is .075″. The condition of the carbon was such that it was impossible to tell exactly the width of the arc, but judging from the position of the clamps and their distance from each other, it was about $\frac{7}{16}$ of an inch. The shape of the cross-section was not quite rectangular, but was slightly 2107 rounded at the corners and somewhat wider at one side than the other. Its appearance was such as to indicate that it had been made of treated blotting paper. The carbon in the model had been broken before I saw it, so that it was impossible to get all the dimensions accurately. It seemed to be of about uniform cross-section throughout its length.

12 Q. Please state the circumstances under which you saw the model.

A. I saw it in the office of Mr. L. E. Curtis, 120 Broadway, New York, on the date previously mentioned, in the custody of Mr. Emery, of the United States Patent Office, who brought it to New York for inspection.

13 Q. Can you produce a carbon for an incandescent lamp of the same form and dimensions as that of the model of the patent in suit? If so, please do it.

A. I here produce a carbon which I have made, having very nearly the same cross-section as that in the Patent Office model. The thickness of this carbon is .040″, and the width is .080″. These dimensions give very nearly the same cross-section as that of the Patent Office model. The length of this carbon, however, is somewhat greater, as it was made to fit clamps standing somewhat farther apart in the lamp than those in the Patent Office model. It was made shortly after I saw the Patent Office model, the object being to reproduce as nearly as possible the original carbon and ascertain how it would operate in one of the lamps we were then constructing; as the mechanical parts for these lamps were finished, it was made of a sufficient length to fit. The current would not be practically changed by this alteration in length. This carbon was put into a lamp, which, for some reason, probably a loose-tube bolt, leaked when it was first put on the pumps, and a day or two afterward, when placed in another lamp, was exhausted on the pumps and current was passed through it for a sufficient length of time to satisfy me that the lamp would be perfectly practicable with a carbon of that size. In attempting to tighten the 2108 flanges at the bottom of this lamp while it was on the pump I cracked the bottom flange and could not make it air-tight after that. Such accidents as this are not unusual in any experimental work; but this was particularly unfortunate, as it occurred when I had no further time to correct the trouble.

Counsel for complainant offers in evidence carbon mentioned in witness' last answer as Complainant's Exhibit Blotting Paper Carbon Like Carbon in Patent Office Model.

14 Q. Please state what kind of clamps the Patent Office model has.

A. The clamps were of carbon faced with platinum foil at the parts where contact occurred with the ends of the carbon conductor.

15 Q. How closely did you give your personal attention to the construction and tests of the lamps which you have referred to in your examination, and to the carbonizing of the various materials, samples of which carbons you have offered in evidence?

A. I devoted almost my entire attention to this work during the time it was being carried on; was present at nearly all of the tests; did much of the work with my own hands; and was constantly present observing the progress of the work, and personally supervising such as I did not do myself. I personally carried out one or more times each of the several operations in the preparation and mounting of the carbons, setting up the lamps, exhausting or filling with nitrogen, measuring of the electrical energy consumed and connecting in circuit for test. I did not, however, do all of this work in every instance, but depended entirely upon the supervision of Mr. Frank Smith, when I could not be present. There was no time during the progress of the work, when I did not see or have direct information of all the operations carried on.

16 Q. Who was your assistant in this work?

A. Frank S. Smith, who is in charge of all the experimental work in the lamp department at Pittsburgh.

2109 17 Q. Did you ever visit the works of the Sawyer-Man Electric Company in New York in regard to the manufacture and trial of similar lamps? If so, for what purpose?

A. I first learned of the work at the Sawyer-Man factory in this direction on March 6th of this year, at which time I saw preparations for filling lamps with nitrogen and several of the partly completed lamps. I visited the works two or three times after this and saw some of the lamps burning.

18 Q. Please state whether you gave any directions about the experiments at the Sawyer-Man factory.

A. Yes, I gave directions on one visit to Mr. Packard to try some of the lamps that were then running with a little more current to see how they would stand it. I helped Mr. Packard adjust the current until the lamps appeared quite bright in daylight in a well-lighted room. Mr. Packard thought it was rather a severe strain on the lamps, and said so at the time; but I told him to let them go and see what would happen.

Adjourned to meet Monday, April 22nd, at 10.30.

New York, *April 22nd*, 1889.

Met pursuant to adjournment.

Present: Thomas B. Kerr, Esq., of counsel for complainant, and Walter K. Griffin, Esq., of counsel for defendant.

19 Q. Please state how the lamps you saw at the Sawyer-Man factory were burning?

A. They were burning at a fair incandescence.

20 Q. Please state what is the object of the use of nitrogen gas in an incandescent lamp, and what its comparative utility is?

A. The use of a vacuum in the enclosing chamber surround-
2110 ing an incandescent carbon is the best means of preserving
the carbon from deterioration. It is practically impossible, however, to obtain by any known means an absolutely perfect vacuum, the nature of the process being such that a little of the original atmosphere, whatever that may have been, is always left. It is quite evident that if the means of obtaining a vacuum are imperfect it is much better that the residual gas should be some inert gas, such as nitrogen than an active agent like oxygen. The air of our atmosphere being composed of nitrogen and oxygen leaves as the residual gas after exhaustion a small amount of each of these gases, and if the exhaustion is not very high, enough oxygen remains to cause rapid injury to the carbon. It is manifestly much better that all of the remaining gas should be nitrogen than a mixture of nitrogen and oxygen; hence nitrogen becomes a useful means of obtaining a sufficiently low exhaustion so far as oxygen is concerned, and is necessarily present even when it is not purposely introduced into a lamp, since it is a constituent part of the atmosphere. It is possible without the use of a vacuum pump to displace the air from the lamp and substitute nitrogen for it, in which case the use of nitrogen takes the place of the vacuum pump.

The use of an atmosphere of nitrogen of any considerable pressure in a lamp, reduces the efficiency of the lamp, and is therefore not desirable if its use can be easily avoided and without danger of the introduction of oxygen. If, however, there is any doubt as to the ability to obtain a practical vacuum, there is no question that the safest means is to fill the lamp with nitrogen and then withdraw as much as the apparatus obtainable will admit.

21 Q. Is the use of a nitrogen atmosphere in an incandescent lamp fatal to its practicability?

A. Not by any means. I have made successful lamps containing an atmosphere of nitrogen, and run them for several hundred hours at ordinary incandescence. The action of nitrogen on incandescent
carbon is a matter upon which, I believe, chemical science
2111 up to the present time gives little or no information. It has
never been proven, I believe, that carbon and nitrogen can be combined directly, and without the aid of other elements. It is certain that if there is any action of the nitrogen on the carbon it is very gradual and does not prevent obtaining a useful commercial life in an incandescent lamp having a nitrogen atmosphere.

22 Q. I call your attention to the patent in suit. Is the carbon conductor there shown of the same size as the carbon conductor in the Patent Office model compared to the size of the globe in each case?

A. I find by measuring the drawing and lamp globe that I consider to be the same size as the Patent Office model, that the lamp is there shown in general at about full size. By measuring the carbon as shown in the drawing I find its width to be .085″ and its thickness to be .0 6″. My measurement of the carbon in the Patent Office model gave for its dimensions .075″ in width, and .043″ in thickness, the cross-section being somewhat less than the product of these two, owing to the rounding of the corners. Neglecting the rounding of the corners, the cross-section of the carbon shown in the drawing is 1.72 times the cross-section of the carbon in the Patent Office model, and including the rounding of the cor-ers in the estimate, the cross-section would be very nearly 2 to 1. That is, the area of the carbon in the drawing is about double that of the carbon in the model. Fig. 2 is not on exactly the same scale as figures 3 and 4, the carbon therein being draw- relatively a little larger.

23 Q. What effect has the running of an incandescent lamp above candle power upon the life of the carbon?

A. The effect of increasing the current through a given lamp carbon is to shorten its life. The shortening of the life of the lamp for even a moderate increase in the amount of light given is very marked, and to double the amount of light obtained from a given lamp would shorten its life to less than one-tenth part of what it would be at normal candle power.

2112 24 Q. From your experience with Sawyer-Man lamps made in exact accordance with the patent in suit, what is your opinion as to their durability?

A. The life of such a lamp could probably be made as great as that of modern incandescent lamps assuming the same dimensions of the carbon in each case. If the carbon is short and thick, as in some of the lamps made by Sawyer and Man, the mechanical strength of the carbon would be increased, but at the same time the loss of electrical energy due to the rapid conduction of heat away from the carbon would be of some disadvantage and consequently, the expenditure of energy to obtain a given amount of work from the carbon would be greater. Allowing this increase of energy to be made, the life of the carbon would not be seriously affected, and, indeed, might be greater in the case of a thick carbon than a thin one. The relative life of two incandescent lamps can hardly be considered apart from their relative efficiencies; that is, their comparative light-giving power in proportion to the energy expended, and the point I wish to make clear is that a carbon requires more energy in proportion to the light it gives when the length is quite small as compared to its cross-section owing to the conduction of heat at its contact, than does a long thin carbon where this loss is comparatively small.

25 Q. From your experience in the manufacture of lamps like the patent in suit, what is your opinion of the amount of difficulty and trouble you had in making such lamps as compared with any other new line of work in connection with electric lamps or other electrical appliances.

A. The results of our work were uniformly satisfactory compared with similar work of a new character. The number of failures was small compared to the successes, when it is considered that all of the work was new to those who had it in charge.

26 Q. You have put in evidence certain lamps having the usual form of bulb and provided with carbons made from various
2113 woods and textile materials—twelve in all. Are these the only specimens of those particular kinds of lamps which you made and tested?

A. No; these lamps are only about one-fourth of the whole number, all of which were subjected to the same test as these offered in evidence. Of the entire number made only two have been burned out, one of these having been tested at about double its normal candle power, and the other was defective. Of the lamps not tested for durability only two or three of all those made were at all noticeably inferior to the others. This I consider quite remarkable as most of the materials were then carbonized for the first time in my experience. They showed remarkable adaptability for the purpose.

27 Q. Please explain your remark in answer 5, "that without the treating process the availability of carbon as a material for conductors in incandescent lamps is certainly very limited."

A. I meant that only a small number of fibrous and other sorts of carbon would be available in their most useful form without some form of treatment. A great number of vegetable fibrous materials make very good carbons after proper treatment that would not be at all uniform in resistance without treatment; while others, such as hard-carbon pencils and such textile and fibrous materials as thread, paper, bamboo and the like, are useful without treatment.

28 Q. State whether in the manufacture of the Pittsburgh Sawyer-Man lamp, in evidence in this case, any processes or materials not know prior to January, 1880, were used?

A. None to my knowledge.

29 Q. State whether or not a workman skilled in the use of such appliances necessary to make said lamps, could, in your opinion, have made the Sawyer-Man lamps you have put in evidence by the use of the appliances known and at his command prior to January, 1880?

A. I have not the least doubt but that he could.

30 Q. Will you please produce and offer in evidence some
2114 of the raw material used by you in the manufacture of
carbons for the experimental lamps offered in evidence by you?

A. I will, and now do produce specimens of the following substances:

Linwood, rattan, piazava, ixtl or Mexican grass, and bamboo paper. I also offer a piece of split bamboo, such as is at present used in the manufacture of commercial lamps.

Counsel for complainant offers in evidence the specimens of raw material mentioned in the last answer, as follows:

Complainant's Exhibit Linwood, W. T. F., S. E.
" " Rattan, W. T. F., S. E.
" " Piazava, W. T. F., S. E.
" " Ixtl or Mexican Grass, W. T. F., S. E.
" " Bamboo Paper, W. T. F., S. E.
" " Split Bamboo, W. T. E., S. E.

Adjourned to meet at 2.30 p. m.

31 Q. There seems to be some ambiguity about your statement of the lamps made by you in the first part of your answer to question 4. You speak of five lamps being constructed in exact accordance with the drawings and description of the patent, and then refer to five lamps as being constructed mechanically as near like the patent in suit as possible. Please state whether these are the same lamps referred to in the first sentence, and if so, what you mean by the words "as near like the patent in suit as possible," after saying they were constructed in exact accordance with the patent?

A. The five lamps referred to were five of the six referred
2115 to in the first sentence, and I simply meant to reiterate in
the second sentence what was said in the first, and make it clear that the mechanical construction was as nearly a copy of the patent drawing in all essential details as possible.

Direct examination closed.

Cross-examination by Mr. GRIFFIN:

32 X Q. What experience had you in the subject of electric lighting by incandescence prior to 1880?

A. None.

33 X Q. When did your first acquaintance with the art of electric lighting by incandescence begin?

A. My first acquaintance was the experiments I have referred to, in the winter of 1880 and 1881, in the physical laboratory in the Naval Academy at Annapolis, Maryland.

34 X Q. Under whose directions and for what purpose were these experiments then made, and how long did the same continue?

A. They were not made under any one's direction, but I was allowed to use the laboratory there in connection with my work as a student, and I obtained a copy of the Maxim specification describing his process of carbonizing paper. I undertook to see if I could do it.

35 X Q. How many lamps did you successfully make?

A. I had only one lamp globe, and the attached mounting devices. I had several of the carbons I had tested in it, none of which, that I remember of, were particularly successful.

36 X Q. Just the college experiments of a young man of 20, were they not?

A. They were hardly the sort of experiments that were usually made by students at the academy, and would not have been made
had I not been personally interested in the subject.

2116 37 X Q. While you were with the Union Switch & Signal
Company, what was your experience in the manufacture of incandescent lamps?

A. I was engaged as assistant electrician at the time with Mr. Stanley, and carried out much of the experimental work he did at that time on incandescent lamps. I was almost daily engaged in some work of this kind.

38 X Q. What class of incandescent lamps was the signal Co. manufacturing.

A. Silk lamps of Mr. Stanley's type. The switch & signal company had at that time an electric lighting department.

39 X Q. When did you begin to make experiments on the silk-carbon lamps, and when did these experiments end?

A. My own experiments in this type of lamp began with my connection with the switch & signal company which was in the fall of 1884. They have not yet ended, and my work has increased in this direction ever since that time.

40 X Q. When the signal company first began experiments with the silk carbon, whose process of manufacture were they using?

A. I was not there at the time, but I believe they were using Stanley's process.

41 X Q. In what letters patent can I find a description of this Stanley process?

A. Patent No. 323,372, to Wm. Stanley, Jr., and Edward P. Thomson, dated July 26th, 1885, described a method of preparing such carbons. How closely it has been followed I do not know.

42 X Q. Describe generally said process.

A. The process there described consists principally in the chemical treatment of silk thread by the action of a sulphuric acid solution containing sugar and water, followed by drying at a sufficiently high temperature to drive out the water without vaporizing the sulphuric acid, and subsequently carbonizing at a high temperature in a furnace.

2117 43 X Q. And your experiments in connection with this process or modifications thereof have continued up to the present, have they not?

A. Yes, only that my immediate work has not been the actual treating and carbonizing as there described so much as testing lamps that I knew were produced by this general method and by other methods to determine their efficiency and other points of value.

44 X Q. When was the use of silk carbon adopted commercially by the Westinghouse Electric Company?

A. The use of silk as a material for making the lamp carbons grew up with the company: that is, it was the material used at the organization of the company.

45 X Q. How many letters patent have been taken out other than the Stanley patent, for the processes of preparing or manufacturing the silk carbons?

A. I don't know the exact number. Several such patents have been taken out.

46 X Q. And the object of the experiments of the company and yourself has been to improve the preparation and manufacture of these silk carbons up to the degree of perfection at present attained by you?

A. Yes, that is the case.

47 X Q. In reaching the present degree of perfection the company has had to expend a great many thousand dollars, has it not?

A. Yes, it has.

48 X Q. During the time you were first manufacturing those silk-carbon lamps did you not find that a large number of the lamps gave

out, were inefficient in a commercial sense; that is to say, did you not find that their life was very short?

A. Yes, even after we had a great deal of experience in the manufacture of silk carbons.

49 X Q. And this non-success it was your endeavor to overcome by continual experiment, was it not?

A. Yes.

50 X Q. During your connection with the signal company
2118 and the Westinghouse Company you have been a frequent
inventor and patentee of various appliances used in a system of incandescent electric lighting, have you not? And, if so, please indicate generally the number and nature of your inventions.

A. I have made several inventions during my connection with the Westinghouse Electric Co. I think 60 or 70, for some of which I have been granted patents, and most of them have been upon matters pertaining to the generation and distribution of electricity for electric lighting.

51 X Q. Who is Mr. Lodyguine, mentioned in your second answer?

A. He is the same inventor and experimenter to whom some patents have been granted for electrical devices. He resided formerly in St. Petersburg, now in Paris, and is at present in the United States.

52 X Q. Please state the numbers of the prior patents to Sawyer and Man which you for any purpose consulted in order to derive information for your experiments on the Sawyer-Man lamp.

A. No. 205,144 and 210,809.

53 X Q. What patent did you consult for the method of treating the carbon adopted by you?

A. No. 211,262, dated January 7th, 1879, to Sawyer and Man.

54 X Q. In treating any of the carbons did you surround or saturate them by a carbon or hydrocarbon liquid?

A. They were surrounded by hydrocarbon vapor or gas.

55 X Q. What pressure on the air pump was indicated corresponding to the tension of this hydrocarbon gas during the period of treatment?

A. All the treatment was done at very low pressure, say below half or three-quarters of an inch.

56 X Q. That is to say you only had from about $\frac{1}{48}$th to $\frac{1}{64}$th or less of an atmosphere?

2119 A. Yes, that is substantially correct.

57 X Q. As I understand you, your object in treating in this attenuated atmosphere of hydrocarbon gas was to obtain a deposition of artificial carbon within the substance of the material without increase of exterior diameter, or superposition of artificial carbon upon the outside of the material, except to a very slight extent.

A. Yes, so that there could be no question as to the kind of carbon which composed the filament; in other words, I did not want a carbon made up of an internal core and an external shell.

58 X Q. And that carbon composed of an internal core and an external shell was what you sought to avoid, was it not?

A. It was, exactly.

59 X Q. And you sought to introduce the foreign or deposited carbon within the internal core or cavity of the vegetable material used by you?

A. I sought to produce an elastic metallic condition of the carbon characteristic of treated fibrous carbon. The question as to whether gas is internally deposited, or whether the new condition of the carbon is the result of electrical heating in the presence of the hydrocarbon gas, did not enter into the question. What I wanted was a treated carbon that had the characteristics described by Sawyer and Man as the result of treating, and which nobody could accuse of being principally composed of built-up carbon.

60 X Q. And when you treated the pencils of carbon in order to show the difference of effective treatment upon vegetable carbons, the pencils of carbon, you used the same method of treatment which consisted in heating those materials in a highly attenuated atmosphere of hydrocarbon gas, is that not so?

A. That was the principal experiment; but not the only one. The particular carbon offered in evidence was treated in this way.
I also treated others at different pressures of gas with differ-
2120 ent currents, and for longer and shorter times, but found
that while I could deposit an external shell, I could not
render the carbon tough and elastic without thickening it.

61 X Q. But all the methods of treatment adopted by you, were methods of treatment with hydrocarbon gas, were they not?

A. Yes, I do not pretend to say that there may not be some means of changing the physical properties of hard carbon.

62 X Q. This treatment of the carbons in the attenuated carbon gas, was it done before or after the carbons were mounted in position in the lamp?

A. It was done before mounting.

63 X Q. What treatment were the carbons subjected to after mounting and before the lamps were sealed?

A. They were heated to drive off occluded gases.

64 X Q. In what atmosphere were they heated to drive off the occluded gases?

A. Some *in vacuo*, some in nitrogen.

65 X Q. How did the process of treating the carbons adopted by you differ as to its means and apparatus from the method adopted for the treatment of carbons commercially by your own or the connected companies at the present day?

A. I decline to answer that question unless instructed to do so by my attorney, as it involves methods and processes which I cannot make known.

64 X Q. Without asking you to reveal trade or manufacturing secrets, or to give me the full particulars of the method adopted by you in the preparation of the carbons used in your experiments on the Sawyer-Man lamps, I would like to know whether that method of treatment was the same or different from the method of treat-

ment adopted commercially by your company and the connected companies at the present day?

A. While the general process was more like than unlike the 2121 present methods, it is necessary to say that a large number of improvements have been instituted in the methods of treatment; some of which are at present availed of, and which were not indicated definitely in the Sawyer-Man patents. Any such methods as were thought to be in the nature of improvments on the Sawyer-Man method as described in the patent were carefully avoided, and only such precautions adopted as would naturally be presented to any one of average skill and ability.

65 X Q. As I understand you, in treating your carbons for these experiments, you avoided the manufacture of a hard dense carbon, and endeavored to preserve the elasticity and flexibility of the original vegetable carbon as much as was possible; and in order to avoid the accusation of adding a foreign carbon to the incandescent burner?

A. Yes, that is substantially the case. I was particularly anxious to avoid building up a solid mass of deposited carbon independent of the fibrous structure.

66 X Q. And by securing the internal deposit of artificial carbon, you lowered the electrical resistance of the burner to varying extents, depending upon the porosity of the substance treated by you?

A. Yes, that was the case, and I might add, depending also upon the susceptibility of the fibre of the material used in each case for consolidation and tempering, as it is termed in the specification.

67 X Q. And you found that blotting paper, by reason of its loose-matted nature and extreme porosity, allowed the deposition internally of a larger proportion of artificial carbon, and consequently evidenced the greatest diminution of resistance by reason of the treatment?

A. The reduction of resistance in the blotting paper seemed to be partially due to the internal deposition of carbon and partly to some other action of consolidating the fibre, I do not know exactly in what proportion.

68 X Q. And how far this other action of consolidating the 2122 the fibre is affected or controlled by the simultaneous deposition of carbon within the blotting paper, you cannot say?

A. No. All I can say is, that I have succeeded in notably reducing the resistance and hardening and toughening blotting paper when heated in an atmosphere of nitrogen. This I have already mentioned in direct testimony.

69 X Q. When in the art was the process of treating carbon by heating the same in an attenuated atmosphere of hydrocarbon gas, as pursued by you in your treatment of these carbons, introduced?

A. That method is the one described in the patent to Sawyer and Man in which I did not find any specific directions as to the pressure of gas, leaving it to be inferred that the operator can use such pressure as he finds necessary for his purpose. My purpose in this work was to obtain the advantages obtained in the Sawyer and Man specification for the hydrocarbon treatment of a fibrous carbon, and avoid producing any effect which might be construed as something apart from the just claim of the patent in describing the effects as applied to fibrous carbon only.

70 X Q. What specification do you refer to?

A. No. 211,262, and the patent in suit.

71 X Q. Again I ask you when the process of treating the carbons in an attenuated atmosphere of carbon gas was first introduced or known in the art?

A. That I do not know.

72 X Q. And so far as you know is it not true that the present method of treating by hydrocarbon gas in an attenuated atmosphere is a part of all the processes at present adopted?

A. I believe the hydrocarbon gas used where hydro*n*carbon treatment is employed in the manufacture of carbons, is usually more or less attenuated.

73 X Q. And is not the advantage of that attenuation the
2123 fact that it permits the access of the gas to the internal pores
of the carbon, and the gradual deposition under control of
artificial carbon within those pores?

A. I believe those are the principal advantages

74 X Q. Do you find this process described anywhere in the art prior to January 5th, 1880, except as you may find the same described in the Sawyer-Man patent 211,262?

A. No, I do not know of any such description.

75 X Q. Referring you to the specification of that patent, does not that specification direct specifically that the treatment is to be in a carbon liquid and not in a carbon gas?

A. I find in the patent in question, commencing at the next to the last line on the 2d page, the following statement: "But the carbon prepared by our process before it is put in the lamp does not blacken the inner surface of the globe or lamp charged with nitrogen when heated by the current to drive out occult gases during the ingress and egress of the nitrogen, because in that case there is no carbon gas present, and of course, no deposit; and we desire also, to point out the fact that the consolidated homogeneous carbon of our invention may be produced by the electroplating process as well as by the electrical heating of a conductor in a carbon gas or liquid." I consider this ample evidence of the intent of the patentees to employ gas in the treatment of the carbon, and consider it always a matter of judgment as to what pressure of gas should be used. The use of hydrocarbon liquid produces a more rapid effect and is more likely to be superficial, which, I would point out again, I wished to avoid for the distinct purpose of maintaining a fibrous structure and a surface which could be seen to be that of a fibrous material by ca*u*sual inspection.

76 X Q. And you exercised the degree of judgment known to you in the year 1889, did you not?

A. I most certainly did.

77 X Q. Do you find anything in letters patent 211,262,
2124 which directs or points you to the use or treatment of vegetable carbon?

A. No, I do not now recall anything in that patent.

78 X Q. It speaks of the treatment of pencils of carbon, hard carbon, does it not?

A. I do not find in the patent referred to, any limitation to hard carbon. I see beyond the middle of the second column of the 1st page, the following statement: "A pencil of carbon immersed in a hydrocarbon liquid, and heated to an extremely high temperature by the voltaic current, is not itself attacked, but decomposes the surrounding matter, the carbon of which enters and fills up its pores to an extent impossible except with matter in a very attenuated state." I have carefully experimented with the behavior of hard carbon in hydrocarbon gas, and in spite of persistent effort to do so, have failed entirely to produce any evidence of absorption of gas within the interior of this carbon. I have varied the conditions in every way I could think of to produce this result; the carbon always remained granular in fracture, easily broken, and presenting none of the characteristics of what we may term internally treated fibrous carbon. I take this as distinct evidence of the fact that the carbon pencil referred to in the patent in question could not have been of hard carbon, or it would not have been referred to in that way. Sawyer and Man employed carbons in the form of a pencil for some time after the use of fibrous carbon, hence I see no reason to believe that the description was intended to limit the process to hard carbon.

79 X Q. All this little history of what Sawyer and Man did, or did not do, you find set forth in the specification of letters patent 211,262?

A. I find the quotation that I made in my last answer contained therein; but not the remainder of my answer.

80 X Q. Now again I ask you whether the letters patent 211,262 does not specifically direct the use of a liquid, and just as specifically warn the reader against the use of a hydrocarbon gas,
2125 except as that gas exists within the hydrocarbon liquid immediately in contact with the incandescent carbon?

A. The patent, as I read it, while it does direct that the hydrocarbon liquid may be used, contains no warning against treating in the presence of hydrocarbon gas.

81 X Q. That is your impression derived from a study of the patent?

A. I certainly interpreted no part of the patent in that way. That is my impression.

82 X Q. As I understand you, you never used this Sawyer and Man process to create a homogeneous exterior deposit, but confined your treatment to filling up the pores?

A. None of the lamps offered in evidence contained carbon so treated. I, of course, do not wish to be understood as saying that there is no external coating whatever.

83 X Q. How many of the lamps presented by you in evidence

have the metal clip or U-shaped plate or holder at the bases of the arch-shaped carbon interposed between the carbon and the clamps as shown in figures 3 and 4 of the patent in suit?

A. Two of them have sheet platinum interposed as indicated in the drawing: Pittsburgh Sawyer-Man Lamp No. 1, and Exhibit Stillman Lamp.

Adjourned to meet April 23d, at 10.30 a.m.

New York, *April 23d*, 1889—10.30 a. m.

Met pursuant to adjournment.

Present: Thomas B. Kerr, of counsel for complainant, and Walter K. Griffin, of counsel for defendant.

84 X Q. Which of the materials mentioned in the patent 211,262 as operating satisfactorily, to wit: naphtha, turpentine, beeswax, balsam, and most oils, did you employ in treating the carbons in these experiments?

2126 A. In these particular experiments ordinary natural gas was used, as it was found to be a proper and good substitute for the vapor of hydrocarbon liquids.

85 X Q. When was natural gas first used for this purpose to your knowledge?

A. It had been frequently used during the past winter, and has been made use of in an experimental way before that time.

86 X Q. What is the earliest date, of which you know, of the use of that gas for these purposes?

A. I do not absolutely know any date. I believe we were using natural gas at least a year ago; but I cannot fix the date exactly.

87 X Q. I fail quite to understand part of your 10th answer as to the difficulty in building up a carbon by the superposition of a deposited shell. Will you kindly explain the reason of that difficulty so that the court may be able to understand it?

A. The statement may in form be a little confusing; I did not mean to say that there was any difficulty in building up a carbon in this way; but meant to have it understood that there would be difficulty in getting the best results from a carbon so built up, owing to the fact that the deposited carbon is of much lower specific resistance than that of the fibrous core. The division of current would therefore be unequal between the two, and for a given quantity of current passing over the carbon the outer shell would be carrying an unnecessarily large proportion, and the core would carry, perhaps, only a small part of what it was capable of doing. It seems evident that in order to best utilize the entire cross-section of a carbon the distribution of current throughout that cross-section ought to be about uniform.

88 X Q. And as I understand you, it is the object of the modern
manufacturer of carbons for incandescent lamps to secure as
2127 nearly as possible a uniformity of resistance throughout the
carbon and at all points of its cross-section.

A. So far as I am informed I agree with you.

89 X Q. And so far as there is a deposition of an external shell, this tends to prevent the attainment of such uniformity?

A. Yes, I think that is true.

90 X Q. So that experience has shown that the deposition of an external shell is a disadvantage?

A. I would not say generally that it is a disadvantage, because it may be very useful as a means to a certain end where its advantages would greatly overbalance its disadvantages. Some forms of series lamps, for instance, are built up, I believe, in this way to a considerable extent, and with very satisfactory results. To that extent I must qualify my former answer.

91 X Q. But in filament lamps, such as Complainant's Exhibit Defendant's Lamp, I understand you that experience has shown that the existence of an outer shell is a detriment to the life of the lamp?

A. I am not quite sure, after giving the matter a little more careful thought, that this point is recognized by manufacturers of incandescent lamps; but I believe that it is really the case, that a thick outer shell is a disadvantage for a high-resistance lamp.

92 X Q. Exclusive of the Edison Company, do you know any manufacturer of incandescent lamps using vegetable or fibrous carbons of any kind, who does not treat the carbons either by internal nor external deposition?

A. I have never seen a commercial incandescent lamp that I felt sure was not treated, judging simply by its appearance. Such information is very difficult to get.

93 X Q. Referring to the Sawyer-Man patent 211,262, is not the process there described a process for building up the carbons by the external deposition of deposited car*p*on upon the carbon pencils?

2128 A. Yes, such a process is clearly indicated, but I do not see that the patent confines itself to that process.

94 X Q. Do you find anywhere in the patent a description or direction of any method except the method of depositing carbon upon the exterior surface together with the incidental filling of the pores of the material necessarily incident as a stage in the process of arriving at the deposition of this exterior carbon?

A. I find in the second paragraph of the second col*l*umn a fairly complete statement of what the process is considered to be by the inventors. The results of heating the carbon in a suitable hydrocarbon atmosphere are there stated to be the decomposition of the surrounding matter, "the carbon of which enters and fills up its pores to an extent impossible except with matter in a very attenuated state, and deposits a perfectly homogeneous layer, generally of a bright gray color, upon the exterior surface." So far I would say that the filling of the pores by the decomposition of attenuated gas within the carbon is the important feature of the process, the incidental deposition of carbon upon the surface being a necessary consequence of such treatment. By the process as described up to this point I believe the best results are obtained for lamps of moderate candle power for high electro-motive force; but, if it is desired to produce a thicker carbon, the size may be increased, as further described in the same paragraph, by allowing the external coating to become as thick as desired. I would therefore say to complete my answer to this question that I agree substantially with your statement of the case except that I would reverse the relative importance of the external and internal treatment for the reasons that I have indicated.

95 X Q. And you do that because your knowledge at the present time informs you that internal deposition is useful and external deposition detrimental or injurious, is that so?

A. I think I have stated clearly in my answer to a
2129 previous question that for some purposes internal treatment
is desirable, and for others external treatment may be equally so.

96 X Q. Does not the Sawyer-Man patent describe the continuous deposition of an external shell which may be made of such a thickness that carbon pencils may be cut from the material of the shell itself?

A. Yes, I believe the description of the process fully covers that method of producing carbons also?

97 X Q. Before beginning the construction of the lamps at Pittsburgh, how many visits did you pay to the Sawyer-Man factory in this city in relation to the subject-matter of these lamps?

A. One.

98 X Q. With whom were you in consultation there?

A. With Mr. Packard and Mr. Robertson.

99 X Q. Did you not request Mr. Packard or Mr. Robertson later on to send you the results of their experience, and a statement of any difficulties they had experienced?

A. That is my recollection.

100 X Q. And they sent such information?

A. I remember one occasion, and there may have been one or two others, on which they informed me of progress, and I made suggestions with regard to the work.

101 X Q. Subsequently to your beginning your experiments, were you at the New York factory as to this matter?

A. About three times, I think. I went to the factory every time I came to New York, as I had charge of that work in a general way, as well as my own.

102 X Q. What parts, exactly, were sent to you from the New York factory? I mean of the Sawyer-Man lamps?

A. One complete model, which had been prepared after the instructions of Mr. Man, and which I wanted as a pattern to furnish the form to our detail department. A number of glass globes, most
of them imperfect, and some glass plates in about the same
2130 or worse condition. None of these things were used, except
as patterns, and with the possible exception of one or two of the glass parts that were tried before we got others.

103 X Q. How many glass plates did you send to the Sawyer-Man factory in New York? Was it not four dozen?

A. I don't remember. I sent them all I thought they could possibly need, as the glass-makers turned out an ample supply.

104 X Q. How many globes did you send?

A. I am sure we sent a dozen of the last lot I had finished up, because I thought they were good ones.

105 X Q. How many lots did you have finished up?

A. There were two lots, the first of which was defective owing to a misunderstanding of the glass manufacturer.

106 X Q. How many were there in this first lot?

A. I didn't count them, but I should judge about 50.

107 X Q. And how many in the second lot?

A. The second lot consisted of 50 or 100, I don't remember which. I ordered more than I thought we could possibly need, as I did not wish to be interrupted by a stoppage of supply. The number has entirely escaped me.

108 X Q. How many glass plates did you have made?

A. About the same number as there were globes; I think, perhaps, one hundred and fifty.

109 X Q. How many sets of metal clamps or carbon-holders?

A. There were two sets of platinum clamps and 25 or 30 pairs of carbon clamps, as nearly as I can remember.

110 X Q. How many paper carbons did you carbonize?

A. I have hardly any idea. Our practice was to cut out a handful of paper carbons at a time and no particular count was kept of them. They were carbonized in the same way without counting.

111 X Q. How many times did you carbonize paper carbons?

A. Three or four times, I believe.

112 X Q. Do you remember the number of times?

2131 A. That is as nearly as I can remember.

113 X Q. How many blotting-paper carbons did you carbonize?

A. Oh, I suppose 200, possibly not more than half that number. We carbonized a great number of each kind before we were ready with the mechanical parts of the lamps, and then used such as we wanted afterwards.

114 X Q. Of the lamps No. 1 to 10 presented or referred to by you on direct, you state that certain of them had paper carbons. Was this bristol-board carbon?

A. Yes; they were all bristol-board, I believe.

115 X Q. Who did the carbonizing of the various materials used by you in these experiments?

A. I did part of it myself up to the point of placing the crucibles in the furnace, and watching the furnace and removing the carbons from it. Mr. Frank Smith did some of it, and afterwards some carbons were packed for carbonization by the man who has that work regularly in charge. That was after he had seen us do it and knew what we wanted done.

116 X Q. How many hands are employed by the Westinghouse Company?

A. The last time I inquired I think there were about 800 on the pay-roll of the factory.

117 X Q. And your factory has a complete outfit for most extensive manufacture in all mechanical and electrical details of all machines and appliances incidental to a complete system of electric lighting, has it not?

A. It is so considered, I believe.

118 X Q. And you have general supervision over all the electrical work done by the company, have you not?

A. Yes.

119 X Q. Of what department in the factory is Mr. Frank Smith in charge?

A. He is now in charge of experimental lamp-work.

120 X Q. How many hands are employed in that department?

2132 A. That would be very difficult to say, as the number varies very greatly from one time to another according to the needs of the work; but there are always about a dozen people engaged in such work.

121 X Q. You state that you have been associated for 18 months with Mr. Lodyguine, the well-known European electrician, and obtained much useful information through him. To what departments of lamp-work did that information apply?

A. To the carbon conductor.

122 X Q. What carbon conductors did he give you information about as having been successfully used by him in Europe?

A. Carbons prepared of ixtl, or Mexican grass, piazava, rattan, fibre of the large stem of the palm tree, linden, hemp, flax, jute, dogs-grass (Fr. Chien dent), nettle-thread, birch, poplar, ash, willow-tree, basket willow, cotton, manilla, broom-corn, yew, alder, elm, wild ask, aspen, tulip, and thistle-grass, besides others.

123 X Q. And it was for purposes of such information that your company employed or imported Mr. Lodyguine, was it not?

A. He came in the first place to negotiate the sale of certain patents, and has remained to develope those inventions. I obtained this information from him only recently; that is, in full.

124 X Q. I understand that in preparing the paper carbons, you cut them out with circular punches or dies and that in preparing the willow carbons you cut them first in long strips and then steamed them until they were sufficiently soft and pliable to enable you to bend them round a suitable shaped carbon block and to fix them in that position before carbonization. Is that so?

A. Yes.

125 X Q. The silk carbons used by you were silk carbons made and treated by the various processes used in the commercial
2133 lamps of to-day by the Westinghouse Co., were they not?

A. Yes.

126 X Q. Why didn't you cut out the willow carbons with a circular die or punch?

A. It did not occur to me to do it, and I had no willow wide enough to do that with if I had wanted to.

127 X Q. In what form was the willow given to you?

A. It was in the form of splints such as basket-makers use, and some of the pieces had been subsequently split up into smaller pieces.

128 X Q. When was the first time you ever used piazava in an incandescent lamp?

A. I never used it until I tried it for the purpose of this examination. I had seen it before, however.

129 X Q. You stated something in your direct examination as to the use of nitrogen gas. Do you know of any commercial lamps to-day in which nitrogen gas at or near atmospheric pressure is used?

A. No.

130 X Q. Do you know of any commercial lamps to-day which have an attenuated atmosphere of nitrogen gas?

A. Well that depends a little on the view taken of the question. The intention is, I believe, to remove as far as possible all traces of nitrogen, oxygen and other gases of the atmosphere. All lamps, however, contain a highly attenuated atmosphere of these gases, since it is utterly impossible to remove it.

131 X Q. In other words, you do not know of any lamps having attenuated atmosphere of nitrogen gas except as such gas is present necessarily in an attenuated atmosphere of air?

A. I do not know of lamps of any other sort, although I believe a certain German lamp, whose name I have forgotten, contains some such gas.

132 X. Q. You stated in answer to question 21, that you have made successful lamps containing an atmosphere of nitrogen.
2134 To what extent were those lamps exhausted?
A. They were exhausted to pressures varying from a little over half an inch to about an eighth of an inch mercury. I have filled lamps at about atmospheric pressure also; but they were not the ones referred to in that answer.

Adjourned to meet at 2 p. m.

133 X Q. Are not the incandescent lamps universally adopted at the present day, lamps in which an atmosphere of air is exhausted to the highest possible degree of tenuity?

A. I believe so.

134 X Q. Do you know of any commercial lamp which is, or for some years has been, in use, in which the glass globe is composed of two separable pieces, as distinguished from a glass globe the parts of which are fused together so as to become a continuous mass?

A. No, I do not.

135 X Q. Have you any knowledge of the stopper lamps, consisting of a glass globe and separable glass stopper ground to fit the same, which were at one time put on the market by the American Electric Light Co. of New York City?

A. I have not.

136 X Q. Turning to the Sawyer-Man lamps presented by you, please make a sketch showing definitely the construction of the stop-cock in the base of those lamps?

A. In answer to your question, I would prefer to offer in evidence a lamp that was broken, and which shows the condition of the lower part of the lamp before it is exhausted. The attached lead tubes are the same as were used in our work for the purpose of filling and exhausting. The valves in this lamp are the same as were used in all of the lamps of this form made by us.

137 X Q. What is the size of the aperture in the bottom tube? Is it uniform with the aperture shown at the end of the tube just above the glass plate?

A. Yes, it is of that diameter throughout its length.

2135 138 X Q. And the stopper is of very much larger diameter than the tubular aperture through which the nitrogen flows?

A. Yes, it is.

139 X Q. And the stop-cock is made cone-shaped, being less in diameter at one end than at the other, is it not?

A. Yes.

140 X Q. Look at the drawings of the patent in suit and state how the size of the gas tube in your lamps compares with the size of the gas tubes shown in the drawings in the patent.

A. That in the drawing in the patent is larger, I think, than the one used in our lamps.

141 X Q. The gas tube in figure 5 is about twice the diameter, even in that reduced figure, of the gas tubes in your lamps, is it not?

A. Yes, it is.

142 X Q. And the glass globes, or bells, in your lamps, are of the same diameter as shown in figures 3 and 4 of the patent?

A. It is substantially.

143 X Q. If figure 5 were drawn on the same scale as figures 3 and 4, what would be the difference in diameter between the gas tubes of the size shown in the patent and the gas tubes used in your lamps?

A. The diameter of the tube in the drawing would then be about three times the diameter of the tube used by us.

146 X Q. And how does the diameter of the stop-cock used by you compare with the diameter of the screw used to close the gas tube in the drawings of the patent?

A. It is between two and three times the diameter, and would, if the drawing were full size, be, I suppose, one and a half to two times the diameter.

2136 147 X Q. So that, compared with the size of the gas tubes, your stop-cock is about six times as large as the relative sizes of the stop-screw and gas tube of the drawings of the patent in suit?

A. Yes.

148 X Q. The stop-screws in the drawing of the patent in suit are substantially of the same diameter as the gas tubes which they close, is that not so?

A. Yes, I believe so.

149 X Q. Whereas, the diameter of your stop-cocks is at least six times the diameter of the tubes that they close?

A. Yes.

150 X Q. And to the bottom of the gas tubes you fused lead tubes leading to the connections with the air-pump or nitrogen apparatus?

A. Yes.

151 X Q. And when the lamp was either exhausted or charged with nitrogen, did you insert the stop-cocks while the lamp was still under pumps or bags?

A. The stop-cocks were always in place. They were turned when it was desired to close off communication with the lamp. This was done while the lamps were still connected to the pumps or bags.

152 X Q. Did you then seal off the lead tube by fusing?

A. No, we found the valves were tight enough to hold without this.

153 X Q. How did you grind the stop-cocks to fit into the tapered cone which received them?

A. They were ground in the ordinary way by coating the surface with rouge, or some other suitable substance as was dictated to the workman by his experience in such matters. I saw the work being done at the time, but gave no special instruction, except that I wanted a valve which would be certainly air-tight.

154 X Q. And your direction to the workman was to make a valve or air-cock which should be perfectly air-tight?

2137 A. The instruction was hardly so general as that. I limited the form of the valve to an ordinary cone valve such as is fitted to gas bags.

155 X Q. Would the small screw shown in the patent, figure 5, be an efficient stop to insure a vacuum in the lamp?

A. I think it could be made so; but it is not a form usually employed for that purpose, nor was it, I believe, at the time the drawing was made.

156 X Q. But if the screw shown in the patent was as a matter of fact used to prevent the egress of nitrogen substantially at atmospheric pressure it might be sufficient, might it not, until such time as the lamp was further sealed?

A. Yes, I think it would also hold nitrogen, and much more readily than it would preserve a vacuum.

157 X Q. Having regard to its size and proportion in relation to the gas tube which it closes, it is not a form of stop which you would ever think of using as a means of retaining a high vacuum in a lamp, is it?

A. Yes, I would undertake to maintain a vacuum with a valve of that kind long enough to complete the seal; but I do not think it would be nearly so good as the cone valve. There would be much greater chance of failure.

158 X Q. Turning to the upper part of the lamp, I notice in your direct testimony, that you described the U-shaped clamp or holder within the larger clamp as a platinum clamp, or a bent piece of platinum. By what means do you arrive at the conclusion that that bent piece was platinum?

A. I saw it in the Patent Office model.

159 X Q. Do you understand that this clamping piece shown in the drawing of the patent is anything different from the clamping piece which you say forms part of the lamp sent to the Patent Office as a model lamp of the patent in suit?

A. The only difference that I know of is that the drawing
2138 shows a much thicker piece than the pieces of platinum used
in the Patent Office model. The purpose is evidently substantially the same.

160 X Q. What material are the large clamps in the Patent Office model?

A. They are made of carbon.

161 X Q. As I understand you, in only two of the lamps made by you, did you make use of these small pieces of platinum?

A. Yes, that is correct.

162 X Q. How many additional surfaces of contact at the clamps is caused by the presence of these platinum clips?

A. The number is doubled, I should say.

163 X Q. That is to say by the use of the platinum clips, there results twice the number of surfaces between which efficient electrical contact has to be made at the clamps as compared with the omission of the platinum clips?

A. Yes.

164 X Q. What is the law governing the production of heat at points of contact, such as points of contact between the carbon arch and the clamp, first, as regards the resistance of contact, and secondly, as regards the force or intensity of the current?

A. The general law would be that the production of heat varies directly as the resistance and directly as the square of the current where the resistance remains unchanged, leaving out all other considerations.

165 X Q. That is to say, taking two identical Sawyer-Man lamps which vary only as to the resistance at the clamps, the amount of heat developed at the clamps in one lamp as compared with that developed in the other, would vary directly with the resistance of those clamps?

A. Yes, with the same current.

166 X Q. Is it not also true that the heating effect upon
2139 any body by a radiant source of heat in air or *vacuo* diminishes
as the square of the distance between the source of heat and the body to be heated?

A. Yes.

167 X Q. So that a radiant source of heat at twice the distance has only one-quarter the effect it would have at unit distance?

A. Yes.

168 X Q. In all commercial lamps of the present day intended for use in multiple arc, as is Complainant's Exhibit Defendant's Lamp, is it not true that the carbons used are of great length compared with their diameter, so that they assume the filamentary character?

A. Yes.

169 X Q. In lamps intended for such use, what is the advantage in such great length and small cross-section?

A. The great length and small cross-section are attributable directly to the specific resistance of the carbon. It so happens that the specific resistance of carbon is such, that for a lamp intended to operate on a circuit of about 100 volts, the conductor of carbon must be quite long in proportion to its diameter. Had it so happened that the specific resistance of the carbon was one-tenth, say, of what it really is, a much longer and much thinner carbon would have been required. And if it had been ten times the actual resistance, a hundred-volt carbon would be moderately short and thick. I would therefore say, that great length and thinness are not so much an advantage of lamps intended for use in multiple arc as a necessary consequence of the conditions of the material of which they are made.

170 X Q. Again I ask you, what are the advantages, as a matter of fact, to the lamp itself by using a carbon of great length as compared with its diameter when using the lamps in multiple arc?

A. The advantage consists in the fact that a sufficiently high electro-motive force may be used to render possible the distribution of current without too great cost in conductors.

2140 171 X Q. Assuming the diameter of the carbon to remain the same, what would be the difference of heating effects produced at the clamps in the Sawyer and Man lamp by using in one case a carbon burner twelve times as long as in the other, the lamp in both instances being raised to the same candle power?

A. The long carbon having twelve times as great a surface would require a much lower temperature to produce the same total amount of light; that is, the light-giving power would be spread out, as it were, over a larger surface. In order to do this a much smaller current would be required in the long carbon than in the short one, while a higher electro-motive force would be required. The total energy required to give the same amount of light would be much greater; that is, the lamp would be less efficient; but the loss at the contacts themselves would be smaller owing to the reduced current.

172 X Q. Now assuming the other conditions the same, what would be the effect upon the heat produced at the clamps by diminishing the cross-section of the carbon burner so as to give the same illumination in both instances, the same illumination per unit surface?

A. That would still further reduce the heating at the clamps, provided the conditions at the contact were the same in each case; that is, assuming that the surfaces in contact remained the same. Since, however, the reduction in the cross-section of the carbon is usually accompanied by a reduction of the surfaces in contact, the comparison cannot be made in any such off-hand way as this. There is, however, no difficulty in so proportioning the contacts as to make a perfectly practicable lamp in either case.

173 X Q. Is it not a fact that experiments and practical use have shown that there is a degree of incandescence beyond which for the same material it is not profitable to go, and which, if exceeded, materially militates against the life of the lamp?

A. Yes.

2141 174 X Q. And is it not a fact that in manufacturing high candle-power lamps, very long carbons are adopted for use?

A. Yes, carbons of great length are sometimes used and sometimes carbons of very short length.

175 X Q. In multiple-arc lamps, are not the carbons of high candle power always used of great length?

A. Yes, I presume they would be so called as ordinarily used?

176 X Q. With which carbon will you have the least heating of the clamps by radiation, in a short carbon or in a long carbon of a loop form?

A. That depends so much on the exact construction of a lamp that it cannot be definitely answered in so many words. There is no difficulty, however, in making the clamps or contacts of either form such that the radiation would be so small as to not seriously affect the commercial value of the lamp. I think, as a matter of fact, however, taking commercial lamps as they go, that there is more loss from this source in very short carbon lamps, like the Bernstein, for instance, (see Exhibit Bernstein Lamp) than in long carbon lamps like the Edison lamp, both of which are commercially successful lamps, I understand.

177 X Q. The Bernstein is a series lamp, is it not, and not a multiple-arc lamp?

A. Yes, it is used in series exclusively, I think.

178 X Q. When was the Bernstein lamp introduced?

A. I don't know; more than five years ago, I think.

179 X Q. Taking a carbon burner or conductor of considerable diameter, have you not noticed that the electric current will take the shortest path or the path of least resistance from one clamp or holder to the other through that carbon?

A. More current will pass along the side of least resistance certainly.

2142 180 X Q. And if in any conductor there is a line of less resistance, more current will pass through this line of less resistance inversely as the resistance?

A. The current will divide itself inversely as the resistance, I believe that is what you intend.

181 X Q. And this variation of the current in different parts of the carbon conductor will render the conductor hotter at places of least resistance, the heat depending upon the current passing through that part of the conductor?

A. That depends altogether on how the parts of high resistance are located with reference to the parts of low resistance; but if they are in parallel throughout, and not in series, the statement is correct. If they were in series, the reverse would be the case.

182 X Q. And in so far as this difference of heating exists in the carbon conductor it has a tendency to dissociate the particles of carbon and shorten the life of the carbon as an incandescent?

A. That is so theoretically, at least in every lamp of the horseshoe-carbon type; but it requires very abnormal conditions, indeed, to develop it to a noticeable extent.

183 X Q. The larger and thicker the horseshoe carbon the greater the liability to this effect?

A. The shorter and thicker radially—yes.

184 X Q. So that in this respect a long fine filamentary carbon has an advantage over a short thick carbon?

A. Such may be the case, yes, if the shortening and thickening are carried far enough.

185 X Q. Look at the Packard Exhibit No. 6, and say whether the condition of the carbon in that lamp does not indicate to you that the intensity of the current has been greater on the inner circumference than on the outer?

A. It looks as if that might have been the case, and I know it was the case in one of the lamps I saw running at the 23d-street factory. The difference in color between the outer edge and inner edge was just noticeable when the lamp was burning.

2143 186 X Q. And the greater the difference between the length of the inner circumference and the outer circumference, the greater the proportion of current which will pass along the shorter inner circumference?

A. Yes, it would not do to make this difference too great for that reason. It would not, at least, make as good a lamp.

187 X Q. And in long thin carbons, such as used in the Complainant's Exhibit Defendant's Lamp, this difference of length between the inner and outer circumference is reduced to an almost inappreciable amount, is it not?

A. Yes, and even in a carbon like that the Bernstein lamp contains.

188 X Q. And the shorter the arch or circled the greater this difference between the length of the inner and outer circumference?

A. For the same width, yes.

189 X Q. So that a short thick, arch-shaped carbon would have this difference to a very much greater degree than a long slender carbon?

A. Yes, that is true; but unless the carbon is made very short or very thick radially, or both, the difference would not be great enough to amount to anything sufficient to affect the commercial use of the lamp.

190 X Q. What percentage of variation between the outer and inner circumference is, from your actual experience, allowable?

A. I never noticed in my own experience any lamp which showed that tendency, except the one last referred to and forming Packard Exhibit No. 6, although I have seen some very short arch carbons in use. I think the proportions in the Packard Exhibit No. 6 are about the limit in that direction, if the best result is aimed at. No doubt, however, a workable carbon could be made with even a greater difference than this.

2144 191 X Q. But your supposition that a workable lamp could be so made is not based on actual experience, but is simply an expression of your present opinion, which might be modified by experience, is that so?

A. Yes.

192 X Q. And as a matter of fact, you have not tested the carbon arch in which the proportional difference between the outer and inner circumference was greater than the Packard Exhibit No. 6?

A. In my opinion, the carbon in Pittsburgh Exhibit No. 1 shows even a greater difference between the outer and inner edge of the carbon, or certainly as great, and I am quite positive that in the case of Pittsburgh Exhibit No. 1 the peculiarity in respect to difference of temperature was not noticeable while the lamp was in operation, or I should have detected it.

Adjourned to meet April 24th, at 10.30.

New York, *April* 24, 1889.

Met pursuant to adjournment.

Present: Thomas B. Kerr of counsel for complainant, and Walter K. Griffin, of counsel for defendant.

193 X Q. What experiments did you make at Pittsburgh with your Sawyer-Man lamp to determine the electro-motive force or difference of potential in each lamp?

A. They were measured in the ordinary way in the photometer-room at various candle powers or degrees of incandescence.

194 X Q. What was this electro-motive force, as ascertained by your experiments?

A. It varied with each lamp, and was from 12 or 15 volts to about 30, the average being about 20 volts, I should say.

195 X Q. Do I understand that you measured the electro-motive force for the same lamp at different candle powers?

2145 A. Yes, we did that, but what I wanted to say was, that the different lamps were run at different electro-motive force.

196 X Q. What would be the effect of placing one of your Sawyer-Man lamps in a multiple-arc system, such as it used for the Complainant's Exhibit Defendant's Lamp?

A. There is no lamp among the exhibits suitable for as high an electro-motive force as that of the lamp referred to. If placed on the same circuit the Sawyer-Man lamp would require some additional resistance placed in series with it.

197 X Q. As a matter of fact, any of your Sawyer-Man lamps would be very rapidly destroyed if placed in a multiple-arc system such as used with the Edison lamp I referred to?

A. Yes, it would, if placed in such circuit without any resistance or other means of reducing its current to the proper amount.

198 X Q. That is to say, that with the same amount of current passing through the lamp in multiple arc, your Sawyer-Man lamps would very soon be destroyed?

A. The lamp would be destroyed owing to the fact that it would take a much greater amount of current from a circuit of a pressure sufficiently high to run a 100-volt lamp than it would be able to carry, owing to its low resistance. The current would not, however, be the same in the two lamps as your question would indicate, but the lamps would rather be subjected to the same electrical pressure.

199 X Q. And the lower the resistance of the lamp the greater its unsuitability for use in multiple arc in a circuit of higher electromotive force?

A. Yes, assuming that lamps of the same candle power are taken.

200 X Q. And if, as you say, you should introduce sufficient resistance to lower the difference of potential in the lamps to an amount suitable for your Sawyer-Man lamps or other lamps of low
resistance, you would by the fact of the introduction of such
2146 resistance, be wasting just so much electro-motive force con-
sidered as a source or means of incandescence?

A. Yes.

201 X Q. Is it, therefore, not true that in all practical purposes your Sawyer-Man lamp, or lamps of similar or lowered resistance are not practically adapted to be used in a multiple-arc system?

A. That would be assuming that the electro-motive force now used by the Edison Company is as low as could be practically so used for any commercial purpose. I do not believe this is the case.

202 X Q. Returning to the patent in suit, have you measured, or will you measure, the difference in a radius, and, consequently, in difference of length of inner and outer circumference, of the carbon shown in figures 3 and 4?

A. Subject to correction or more accurate measurement, I should say that the outer circumference is about one-third greater than the inner circumference.

203 X Q. Which is the easier mechanical job, the attachment of the radiators or conductors to the upper base plate as shown in figure 2 of the patent, or as shown in the figure as presented you?

A. I would say that there is very little difference except in case the workman did not have a suitable small wrench, in which case he could more easily tighten up the nuts as they are located in the exhibits, than where they are inside between the radiators, as shown in the drawing. I regard the difference as utterly insignificant.

204 X Q. He would require a special wrench or tool to get at the nuts when situated as shown in the patent?

A. I believe workmen of the kind employed on this sort of work usually have among their kit of tools a wrench suitable for this purpose. It would simply be a small narrow wrench of ordinary form, and of a proper size to fit the nut shown.

205 X Q. And suppose you gave the job of attaching the
2147 radiator to the upper base plate to a workman used to this
kind of work, without directing as to where he was to put the
nuts, would he not naturally use the easier method adopted by you or your workmen in your exhibits?

A. Yes, I should say he might very likely do so, although I have been quite often astonished at the inconvenient places in which instrument-makers will locate screws without any apparent reason.

206 X Q. As a matter of fact, the resistance in a circular carbon arc diminishes as the diameter of the arch diminishes, does it not?

A. Yes, other things being equal.

207 X Q. And if the aim and object was to get a carbon of low resistance, it would be preferable for that purpose to use a circular carbon of small diameter?

A. Diameter of the arc, yes. Small diameter of the arc itself would increase the resistance.

208 X Q. And so far as a circular carbon was of increased diameter, other things remaining the same, the effect of this increased diameter would be proportionately to prevent the attainment of carbon of low resistance?

A. If you still mean by increase of diameter, increase in the length of the carbon, that is correct.

209 X Q. And if the object of Messrs. Sawyer and Man in constructing the lamp shown in the patent was to produce a lamp of low resistance was it not the natural means of producing such low resistance to approximate the terminals holding the carbon clamp and so lessen the length of the arc of carbon?

A. Yes, that would be a natural way of accomplishing that result, but it might have been used for other purposes also and for reasons entirely outside of the resistance of the carbon.

210 X Q. But the construction shown in the patent in suit agrees with the construction naturally adapted for a low-resistance carbon, that is, a carbon of short length?

A. It was adapted for a carbon of short length and low resistance such as that shown in the drawing, and also for a carbon of
2148 greater length and comparatively high resistance, as for example those in Exhibits No. 5 and 6 presented by me, and for still longer and still thinner carbon.

211 X Q. The carbon shown in the patent in suit, if of the length shown in figures 3 and 4 and of the thickness shown in figure 4, would have a very low resistance, would it not?

A. Yes, very low for a lamp carbon.

212 X Q. And the distance between the terminals as shown in the patent, agrees with the mechanical construction which would be intelligently adopted for the use of the short thick carbon of low resistance?

A. Yes, it does.

213 X Q. What, in your opinion, would be the comparative resistance of the carbon shown in your Exhibits 4 and 5, as compared with the carbon of the dimensions shown in the patent in suit?

A. Roughly speaking the resistance of the lamps you have referred to, would be at least twenty or thirty times as great, I should say.

214 X Q. What, roughly, would be your estimate of the resistance of the lamp if constructed as shown in figures 3 and 4 of the patent?

A. I should not expect it to be more than an ohm or so, possibly two or three.

215 X Q. That includes the entire lamp resistance contacts and connections?

A. Yes, it was intended to include the entire circuit within the lamp as the question indicates.

216 X Q. And what would be the resistance of the carbon if constructed as shown in figures 3 and 4 of patent, and treated in the same manner that you treated your exhibits?

A. I should not suppose it would be so great as one ohm, and not very much less. In my former answer I placed two or three ohms as an outside estimate which I thought it would possibly exceed.

2149 217 X Q. Take your Exhibit Lamp No. 1, what is the resistance of the carbon in that lamp?

A. About nine ohms, measured cold, four and a half, hot.

218 X Q. Compare the size of carbon in your lamp, figure 1, with the size of the carbon shown in figures 3 and 4 of the patent in suit?

A. The drawing seems to show a carbon about one-third as long, about six or eight times as thick and approximately the same width as the dimensions of the carbon in my Exhibit No. 1. This would make the resistance from eighteen to twenty-four times as great in Exhibit No. 1 Lamp as in the drawing.

219 X Q. Are not the other exhibits as presented by you of a very much higher resistance than your Exhibit No. 1?

A. Yes, Exhibit No. 4 contains a silk carbon intended to be of moderately high resistance, considerable length and thinness, for the purpose of ascertaining the ability of such a carbon to live in a lamp of the original Sawyer-Man construction.

220 X Q. Assuming lamps of the same candle power and efficiency, is it not true that the longer the carbon is made the smaller the current required to operate it?

A. In a general way that is true.

221 X Q. With such lamps having carbons of similar sections, does not the sectional area increase as the squares of the side dimensions of the said section?

A. Yes.

222 X Q. Does not the current required increase nearly as the sectional area increases under the same assumption as to lamp construction as in the last two questions?

A. No. It is more nearly proportional to the diameter.

223 X Q. Take two carbons otherwise identical, one having twice the sectional area of the other, would it not take twice the current, under the previous assumptions, to heat this larger carbon to the same temperature?

A. Not at all.

2150 224 X Q. Is your answer applicable to all forms of cross-section, and if not to what shapes of cross-section do you consider it applies?

A. It applies to all the usual shapes of cross-section employed in commercial lamps, and would be least applicable to a carbon of the form of a very thin ribbon.

225 X Q. Would your answer apply to Exhibit Lamp No. 1, if you doubled the area of your carbon by doubling its width?

A. Only in a slight degree. The current would in that case be more nearly proportional to the cross-section. The reverse would be the case, if the thickness were doubled, in which case the increase in current required to bring the lamp to incandescence would be much less than double the amount previously required.

226 X Q. In the carbon shown in figures 3 and 4 of this patent if we double the sectional area, keeping the sections similar, how much do you think the current would have to be increased to raise it to the same temperature?

A. I don't know.

227 X Q. Would it not have to be more than double?

A. I cannot see that it would. I should say, certainly, less than double.

228 X Q. Assuming the carbon to be clamped as shown in the figures of the patent, the clamp always embracing the same length of the carbon, does not the surface of contact in the carbons at the clamp increase directly as the side dimension of the carbon?

A. Yes, that would be the case, if I understand the question.

229 X Q. Does not the resistance of the contact vary inversely as the surface of contact, that is to say, inversely as the side dimension of the carbon, all other conditions remaining the same?

A. Yes.

2151 230 X Q. Does not the current passing over this resistance vary more rapidly than the surface contact, assuming carbons of similar cross-section, and the same temperature in clamps like the drawing of the patent?

A. Not necessarily, but I think that in most cases that would be so.

231 X Q. In two such lamps would not the heat produced at the clamp contact be greater in the carbon of large section than in the other?

A. It very likely would, but I must add in connection with this and my previous answers that I consider all these limitations as to contacts of the same length and clamps of the same size and form purely hypothetical, and such conditions as would never be contended with in the actual production of a lamp. It is a matter involving only ordinary common sense, to make the contact large enough and good enough for each size of carbon, and I would call attention to the fact also, that a strong thick carbon can be squeezed up very tight in the clamps, thus securing a good contact, while with a small, fragile carbon, great care is required in mounting, and the contact is apt to be loose. This whole question, and the answers I have given to the questions on the same subject preceding, is purely a matter of experience, and the mounting of carbons of any size, even from that indicated in figures 4 and 5, as some Patent Office draughtsman's idea of how large a carbon ought to be, down to the smallest filament used in the highest resistance lamp of modern manufacture, presents no difficulty whatever.

232 X Q. Will not the heating of the clamps by conduction, also be greater in the carbon of large section?

A. Yes. I have in previous answers fully explained this matter as I understand it.

233 X Q. Similarly, will not the heating of the clamps by radiation from the carbon of the shape shown in the letters patent be greater than in a longer carbon than there shown?

A. Yes, most certainly this will be the case.

234 X Q. Will not the insertion of the platinum foil as shown, increase the heat produced at the clamps by the current?

2152 A. No, it reduces the amount of heat for several reasons. In the first place a contact at the same pressure between the platinum and carbon offers less resistance than a contact between two pieces of carbon. In the second place, the pressure can be made greater by the use of platinum, owing to its softness. It is unnecessary to state any others I believe.

Adjourned to meet at 2 p. m.

Resumed at 2 p. m.

235 X Q. At what candle power did you test lamp No. 1?

A. At ten candle power.

236 X Q. At what candle power was it run?

A. I meant by my previous answer that it was run at ten candle power. It was tested at seven and at eleven also.

237 X Q. At what candle power did you test and run lamp No. 7?

A. At one and five-tenths candle power, except one day, when it was run very much higher than this. I suppose at more than 20 candle power.

238 X Q. At what candle power did you test and run lamp No. 8?

A. It was run at 20 candle power.

239 X Q. What were the volts, amperes and watts of lamp No. 1?

A. 14.5 volts, 7.3 amperes, 105.8 watts; 10.58 watts per candle power.

240 X Q. You state that your experiments with treating blotting paper showed a very large reduction of resistance due to the process of treating. Was this not due to the porosity of the blotting paper.

A. Yes, in a large measure.

2153 241 X Q. If it were not for that treatment, would not blotting paper, in your opinion, be eminently disqualified for use in an incandescent lamp?

A. Without treating or something to take its place, I do not think it would be useful; but it makes a remarkably good carbon for lamps of low resistance when properly treated.

242 X Q. But if used untreated and carbonized without treatment, its life would probably be very short, would it not?

A. That would be a mere guess on my part, as I never tried it in that way.

243 X Q. All your electrical knowledge and experience as to incandescent carbons would lead you to assume that such would be the case, would they not?

A. I should think that probable.

244 X Q. Have you had any experience in treating carbons in hydrocarbon oils or liquids, or such substances as melted beeswax, olive oil, etc.?

A. No, I have had no personal experience in treating carbons by direct immersion in a hydrocarbon of liquid form. All such treating with which I have had anything to do has been from the vapor arising from hydrocarbon liquids.

245 X Q. Do you, or do you not know, that when carbon is treated in hydrocarbon liquid by immersion, nearly all deposit is an external shell, the cooling effect of the liquid causing an almost instantaneous deposit upon the external surface of the carbon, so preventing any further internal deposit?

A. That might be the case, I should think, but I do not feel prepared to say that it would under all cond-ti*i*ons.

246 X Q. The more porous the carbon, the greater the variation that can be produced by treatment according to your methods, is that not so?

A. I have previously answered that question about as follows:

> The more porous and the greater the suscept*a*bility to the
> 2154 tempering process and consequent consolidation of the fibres,
> the greater will be the reduction in resistance.

The reduction of resistance is produced, generally, I think, by this consolidation and internal deposition of carbon.

247 X Q. I believe you stated that in the vacuum lamps among your exhibits, you brought the carbons to incandescence *in vacuo* for the purpose of removing the occluded gases. Are you, or are you not, aware that that process is described in and covered by the specification and claims of letters patent of the United States to Thomas A. Edison, dated October 10, 1882, and No. 265,777?

A. I believe after its invention by Sawyer and Man that process was patented by Mr. Edison.

248 X Q. I referred to the process of removing occluded gases *in vacuo*. Do you understand that that process of removing occluded gases *in vacuo* was so patented to Mr. Edison?

A. I have been told that a patent was issued to him. I am not familiar with the patent. The process of driving out occluded gases is described in the patent in suit, whether *in vacuo* or nitrogen I believe to be immaterial.

249 X Q. You stated that it is, or was, known that without the treating process the availability of carbon as a material for conductors in incandescent lamps is certainly very limited. How many materials do you know from your personal experience to be available for that purpose without treatment?

A. I think all substances of a fibrous nature are more or less improved by treating, and it is simply a question of degree and the amount of perfection aimed at in the production of the lamp, and the consideration of cost of production, that would set apart any definite number of substances as belonging to the class considered suitable without treatment. I believe a number of substances could be so used with considerable success, as, for instance, paper, bamboo, several of the grasses, like Mexican grass, and perhaps a few others. I have had personal experience with these materials in an untreated state, and examined their behavior when submitted to an electric current.

2155 250 X Q. When Prof. Stillman was at the Pittsburgh factory what was the reason that he only filled one lamp?

A. He was delayed by the accidental breaking of the sodium retort.

251 X Q. Was the sodium retort all right the day before he came?

A. It was all right on the same day that he came, and had been in use the day before.

252 X Q. You had no reason to think it was going to break, just as he wanted to fill the lamp, had you?

A. No.

253 X Q. In the various fibres used in your commercial lamp globes presented by you during your testimony by what method were the carbons treated?

A. They were treated in the same way as I have already described in connection with the preparation of carbon for the six Sawyer-Man lamps I have produced.

254 X Q. Exclusive of these experiments, have you had any experiment with lamps of the Sawyer-Man construction?

A. None whatever, if you refer to the old type such as the exhibits.

255 X Q. How long were you working on the silk-carbon lamps before they were made a practical success?

A. They were used commercially from about the time I became associated with the switch and signal company. It has always been the aim of Mr. Westinghouse, however, to improve everything about the concern as much as possible, no matter how good it might be at any given time.

256 X Q. How soon after the lamps were filled was the incandescence begun?

A. As soon as the appearance of the sodium indicated that the atmosphere in the lamps was pure. This time would vary according to the speed with which the operation was carried on. Sometimes we did it very slowly and interruptedly, and sometimes they were finished up within a short time, say, two or three hours.

2156 257 X Q. About how long would you allow the nitrogen to flow through the lamp, before sealing off?

A. For perhaps an hour or two.

258 X Q. And how long would the lamps be treated to remove occluded gas, before being sealed off?

A. That was what I meant to say in the last answer. I meant after the current was passed through the carbon.

259 X Q. How long did it take to charge the lamp with nitrogen gas by the Stillman apparatus?

A. As we had it arranged I should say that the amount of time continuously employed in charging a lamp would be about three hours, and after that an hour or two, possibly, for driving off occluded gases: so that about half a day would be required to complete the operation thoroughly. This time might be very much shortened, I suppose.

260 X Q. All your estimates of cost and commercial expense of operation as to the Sawyer-Man lamps are based upon these experiments, as to which you have testified, at Pittsburgh, are they not?

A. Yes.

261 X Q. How continuously were the lamps at Pittsburgh kept incandescent?

A. Almost continuously after they were once started. The current was interrupted, I suppose, on an average of two or three times a day. The lamps ran all night. Those tests were carried on night and day at the Pittsburgh factory.

262 X Q. Was this in the same room as the one in which the lamps were filled?

A. No.

263 X Q. In bringing the lamps to New York how many of them were broken in transit?

A. Two.

264 X Q. Out of how many?

A. Out of twelve. I will here state that the two lamps broken were in a separate package, and were probably broken from some unusual and severe shock.

2157 265 X Q. It has been stated that the Sawyer-Man Company used bamboo carbons for the filaments in their lamps. What portion of the bamboo did they use?

A. I am not personally and practically familiar with the manufacture of lamp carbons from bamboo; but I have learned incidentally that the outer and denser portion of the splint next to the outer shell is preferable where the size of the carbon will admit of its being limited to this part, and I believe that is the part used at the Sawyer-Man factory.

266 X Q. The lamps made by the Sawyer-Man Company are all slender, or filament carbon lamps, are they not?

A. Not all, but nearly all.

Redirect examination by Mr. KERR:

267 R. D. Q. Cone valves, such as were used in the lamps made by you at Pittsburgh, were well known and common at the time of the first experiments of Sawyer and Man in 1878, were they not?

A. Yes; I believe they were.

268 R. D. Q. Have the lamps described by you, and not offered in evidence, platinum interposed between the clamps and the carbons?

A. These lamps did not have platinum clamps or platinum introduced at the contacts.

The broken lamp referred to in answer to question 136 by the witness Shallenberger is now offered in evidence as Exhibit Sawyer-Man Lamp Stop-cock.

269 R. D. Q. Please give the efficiency of any of the other Pittsburgh Sawyer-Man lamps introduced in evidence by you other than No. 1.

A. Lamp No. 2 had an efficiency of 6.6 watts per candle power;
lamp No. 4, had an efficiency of 4.57 watts per candle power as run;
lamp No. 3 had 11 watts per candle power; lamp No. 5 had
2158 7 watts per candle power; lamp No. 6 had 7.5 watts per candle power; each of which compare favorably with many lamps commercially used at the present time.

260 R. D. Q. What do you mean by your remark in reference to the efficiency of commercial lamps which closes your last answer?

A. I mean by the last remark that these lamps if operated on commercial circuits, would give the same average return of light per horse-power expended as many of the lamps now in use commercially, and supplied by some of the largest companies doing business to-day.

2159 NEW YORK, *April* 22, 1889—10.30 a. m.

FRANK STUART SMITH, a witness on part of complainant, being duly sworn, testifies as follows in answer to interrogatories by Mr. KERR:

1 Q. State your name, age, residence and occupation.

A. Frank Stuart Smith, twenty-six, am at present in charge of the experimental work in the lamp department of the Westinghouse Electric Company at Pittsburgh, Pa. My residence is also at Pittsburgh.

2 Q. What experience, if any, have you had in the manufacture of incandescent electric lamps, and in this connection please state first what training you have had in the science of electricity and practical application of the same?

A. I first began the study of electricity in the year 1885 in one of the technical schools of the Lehigh university gaining such knowledge of the theory of the science together with its practical application as is possible in a thorough college course. During the following two years I was often called upon to utilize the information thus gained in connection with its application to exact chemical analysis; thereby gaining a working knowledge, such as can be only acquired from actual experiments. In June, 1887, I took the position of assistant superintendent of the lamp factory of the Westinghouse Electric Company, of Pittsburgh, Pa., giving my entire time for the year following to the manufacture of incandescent lamps in detail, but with particular attention to the preparation and treatment of the carbon conductors for the same. On or about June 1st, 1888, I gave up this work to devote my entire attention to experimental work on carbon filaments under the personal direction of Mr. Alexandre de Lodyguine, of St. Petersburgh, Russia, gaining from him much valuable and useful information. Since that time I have been engaged exclusively in such experimental work.

3 Q. Have you recently made or assisted in making any experimental lamps constructed mechanically in accordance with the patent in suit?

2160 A. I have.

4 Q. Please state when and where these experiments were made and give a detailed account of the same and the result?

A. These experiments were begun about the 10th of March, 1889, at Pittsburgh, Pa., and were carried on until the 17th of April, at which time work was discontinued in order to present evidence in connection with the patent in suit. The object of the work was to determine whether a practical lamp could be made after the specifications of the patent. In our work we adhered as closely as possible in mechanical details to Sawyer-Man patent No. 317,676. Experiments were made to determine whether lamps made after this pattern could retain a perfect vacuum for any considerable length of time. Various forms of carbon were employed, some being burned *in vacuo* and some in nitrogen gas. In the lamps made to contain carbons burning *in vacuo* we have experienced no trouble whatever, the joints in the lamps being easily made perfectly air tight, as tests made at the expiration of several hundred hours prove conclusively. Lamps containing nitrogen gas were also made very successfully, many having burned for nearly two hundred hours without any appreciable deterioration. In preparing nitrogen for these lamps we have employed the reagents as specified in Stillman patent, No. 235,730.

Reference is made to the following lamps which have been entered by complainant as exhibits as the best means of setting forth the results of our work. I have been present during the preparation of all of these lamps, having devoted a large part of my time during the past four weeks to them.

Pittsburgh lamp, No. 1, contains a paper carbon formed after being carbonized in coke dust by Mr. O. B. Shallenberger. It contains nitrogen gas at low pressure, and has been burned 132
2161 hours and 50 minutes. At the end of this time no marked deterioration had taken place, the lamp being removed from circuit in order to take to New York and present as evidence.

Pittsburgh lamp, No. 2, contains paper carbon fastened to platinum electrodes. The carbon has been burned *in vacuo* for 131 hours 20 minutes. At the end of this time the lamp shows perfect vacuum and was removed from test for purpose of placing in evidence.

Pittsburg lamp, No. 3, contains willow carbon, formed by Mr. Shallenberger, carbonized in coke dust, tempered and treated in very low pressure of hydrocarbon gas. It contains nitrogen at low pressure, and has been run 156 hours and 3 minutes, at the end of which time there is evidence of no deterioration whatever, the carbon being perfectly bright, and the glass globe perfectly clear. This lamp at the end of test shows no depreciation so far as condition and quantity of gas contained in globe is concerned, and has been removed at the end of this time to place in evidence.

Pittsburg lamp, No. 4, contains a silk-thread carbon which has been burned for 200 hours *in vacuo*; tests show vacuum to be perfect at the end of this time.

Pittsburgh lamp, No. 5, also contains a silk filament which has run at proper incandescence for 138 hours in an atmosphere of nitrogen, with no appreciable deterioration.

Pittsburgh lamp, No. 6, differs from the others in that the air-tight joint at base of lamp is made in the form of a ground-glass bottle stopper. This lamp was exhausted to very high vacuum and has been run 24 hours and 20 minutes at about 20 candles. At the end of this time the vacuum was still perfect.

Besides these lamps, several other lamps were made and which have not been offered in evidence.

Pittsburgh lamp, No. 7, contains paper carbon, nitrogen atmosphere. Life 43 hours, 52 minutes. This carbon broke at the clamp from imperfect contact, is still bright and clear, globe not blackened.

2162 Pittsburgh lamp No. 8, contains paper carbon, nitrogen at low pressure, burned for 38 hours 45 minutes, carbon bright, globe not blackened, cause of breaking due to fact that carbon was twisted when inserted in clamps, thus being subjected to very severe mechanical strain while being burned.

Pittsburgh lamp No. 9, contains paper carbon, nitrogen gas at low pressure, has burned 47 hours and 14 minutes, defect due to imperfect spot in carbon which was noticed before lamp was put on test.

Pittsburgh lamp No. 10, paper carbon, carbon electrodes, exhausted to highest attainable vacuum. Carbon burned at very high incandescence; accidentally forced to about 100 candle power before placing on test. Life 42 hours and 30 minutes. Cause of short life probably due to this fact. Lamp exhausted April 2d; vacuum good, April 17th.

Besides these lamps a number were made up in the modern form, but with carbons of many different materials, the idea being to determine positively some of the other forms of fibrous carbon that might be employed successfully as conductors for incandescent lamps.

5 Q. You have referred to making a number of lamps of modern form with carbons of different materials. Please state what materials you used, how many such lamps you made, and how they operated?

A. We have made successfully at the first attempt incandescent lamps in which the carbon conductors were made from the following materials:

1. Broom-corn; 2. Ash; 3. Hickory; 4. Rattan; 5. Piazava; 6. Linen thread; 7. Fibre from a manilla rope; 8. Hemp cord; 9. Linwood; 10. Palmetto; 11. Ixtl, or white Mexican grass; 12. Bamboo paper.

The number of lamps made was necessarily limited to the amount of material that could be readily obtained. We chose different materials suitable for making lamps of high and low electromotive force.

2163 Of broom-corn, we made three lamps. The material used was formed upon a carbon block, carbonized in coke dust, then tempered and treated at a very high temperature in a highly attenuated atmosphere of hydrocarbon gas. In preparing these filaments we were enabled to lower the resistance after tempering and treating to about one-half of the original resistance without any appreciable increase in diameter. Two of these lamps ran for 78 hours and 50 minutes, at the end of which time there was no deterioration in candle power, the carbons were bright, bulb was not blackened, the lamp apparently perfect in every respect. One of the lamps constitutes "Complainant's Exhibit Broom-corn Lamp."

Of ash, there were six lamps made. These were planed down to the requisite size, formed upon carbon blocks, and carbonized as usual. They were all tempered and treated in a highly attenuated hydrocarbon gas and mounted in lamps. After running for 78 hours the five which had been put in circuit were removed to make place for other lamps. At the expiration of this test the lamps bore every evidence of being as good as new.

The carbons for the lamps made from hickory wood were prepared in the same manner as the ash; 3 lamps were made. After running on test for 78 hours and 15 minutes, the lamps give no evidence of being at all defective.

From rattan, we made 2 lamps. These were prepared in the manner described for the ash lamps. When put on test these run for 21 hours and 35 minutes, with no apparent deterioration in candle power. These lamps were removed from test at the expiration of this time for the reason that they had to be packed immediately and forwarded to New York.

From piazava 4 lamps were made. The carbons were prepared by simply winding around carbon blocks the fibre without any preliminary preparation; placed on test, ran without deterioration 23 hours and 15 minutes.

From linen thread 10 lamps were made. The carbons 2164 were prepared by winding the thread directly upon a block of carbon and carbonizing in coke dust. They were afterwards tempered and treated at a very high temperature in highly attenuated hydrocarbon gas. By this means we were enabled to reduce the resistance of the carbon in many instances to less than one-third of the original resistance. This material forms a very good example of what may be done in the way of making a lamp of high resistance and high electro-motive force; the latter, in one of the lamps, being as high as 109 volts, for 16-candle power, most of the remainder being from 95 to 101 volts for the same candle power. Seven of these lamps were placed on test, and at the end of 24 hours and 15 minutes two were broken, one from short circuiting in the base, the other, from being run about 8 per cent. too high. The 109-volt lamp is produced as an exhibit.

From manilla fibre we made 8 lamps; the material was obtained by taking a piece of ordinary manilla rope, untwisting and separating the fibres, winding over the carbon form, and carbonizing as above described. This material forms one of the best examples of a material suitable for high electro-motive force incandescent lamps. Three of these lamps were placed on test, and ran for 16 hours and 23 minutes, when they were removed for the purpose of placing in evidence.

Carbons from hemp cord were prepared by taking the ordinary cord, winding upon carbon blocks and carbonizing in coke dust. They were tempered and treated as usual, the resistance being lowered in most cases by such treatment to one-third the original resistance without any perceptible change in cross-section. 5 lamps were made. They were placed on test, and run a proper incandescence for 23 hours and 15 minutes, showing at the end of test no defects.

3 lamps were made from linwood, and tested for candle power.

2165 No test other than this test for candle power was made, for the reason that the lamps were finished just prior to the time when they had to be shipped to New York.

From palmetto 2 lamps were made, and run 23 hours and ten minutes, with no diminution of candle power. The fibre is hard, compact and uniform, apparently well suited for use in incandescent lamps.

5 lamps were made from Ixtl or white Mexican grass; carbons were prepared by taking the fibre, simply wiping free from dirt with a damp cloth, winding upon carbon blocks and carbonizing as usual. By varying the resistance we were enabled to obtain lamps varying in electro-motive force from 43 to 83 volts. There is no change in cross-section whatever due to lowering the resistance, to the extent of 50 per cent.

From bamboo paper 2 lamps were made. The paper was cut in narrow strips, formed and carbonized as specified above, tempered and treated at a high temperature in a highly attenuated hydrocarbon gas. These lamps were successfully made and tested for candle power.

6 Q. What was the nature of the treatment you bestowed upon these carbons?

A. In every instance the carbon under treatment was heated to a very high incandescence in a highly attenuated hydrocarbon gas. The object aimed at being to expel occluded gases, temper the carbon and fill in the pores. A great many measurements were taken with a micrometer gauge of the cross-section of the carbons before and after this treatment. These measurements demonstrated conclusively that but a very minute amount of artificial carbon was deposited upon the surface of the filament, as there was no appreciable increase in cross-section. The effect of the treatment was to make a dense hard carbon of uniform resistance throughout its length and capable of standing considerable mechanical strain.

7 Q. Please state why you did not give the various lamps referred to in your foregoing answers longer tests?

2166 A. On account of the limited time we had at our disposal to make these tests.

8 Q. Please state how the amount of difficulty and trouble you experienced in making these lamps compared with that occurring in connection with other work of the same character?

A. I would say that the construction of the Sawyer-Man lamp, as specified in the patent in suit, was an entirely new character of work for us, as was also the preparation of the different varieties of fibrous carbons which are contained in the twelve exhibits which are made up in the form of a modern type of lamp. Our success was unusual for work of that character which was so entirely new to all engaged in it. In the preparation of the carbons which are mounted in the modern type of lamp, no attempt was made to prepare a filament which did not result in complete success. In making a selection of materials for these lamps, it is simply necessary to be guided by common sense, selecting that material whose well-known properties are apparently well adapted to this purpose.

9 Q. Please state how the Sawyer-Man lamps made and used at Pittsburgh, operated?

A. From the first we had little or no trouble at all from the mechanical details of the lamps. As given in my answer to question 4, we were able to make the joints in the lamps perfectly tight with the exercise of a little care in assembling the parts. This fact being once settled it was a comparatively easy matter to make a good practical lamp. The tests of all these lamps were carried on in the same manner that tests are usually made for the life of modern incandescent lamps. The lamps were all burned at a reasonably high temperature, some of them being at times forced considerably above normal. The lamps were inspected by me during the proces of the tests anywhere from ten to fifteen times per day, and at no time was the temperature of the filament and the consequent candle power too low to make what could be considered a fair test. This test was run alongside with other tests of the same nature,
2167 and I was enabled to judge as to the relative conditions of
the two tests very accurately. The fact that some of these lamps, namely, the last four referred to in my answer to question 4, gave out inside of fifty hours is not unusual. It is a well-known fact that a lamp can be forced to almost any candle power. It is also known that by this means the life of a lamp is shortened in a much greater ratio. It was noted that when these four lamps were put on test that they were burning at a very high incandescence, they were, however, allowed to burn in order to be able to determine roughly in a very short time about what they were capable of doing.

New York, *April 23d*, 1889—10.30 a. m.

Met pursuant to adjournment.

Present: Thomas B. Kerr, of counsel for complainant, and Walter K. Griffin, of counsel for defendant.

10 Q. Please state whether there is any difficulty in making

practical and operative electric lamps in accordance with the specifications of the Sawyer and Man patent in suit.

A. Judging from the absence of any trouble on our part in making the lamps I would say none whatever. It is simply necessary to exert the same amount of care that is ordinarily employed in the construction of an incandescent lamp.

11 Q. Please state whether or not a lamp constructed in accordance with the mechanical construction described in the patent in suit is, in your opinion, a practical and useful thing.

A. It is.

Adjourned to meet April 24, 1889.

2168 NEW YORK, *April 24th*, 1889.

Cross-examination by Mr. GRIFFIN:

12 X Q. What experience have you had in the art of electric lighting by incandescence prior to 1885?

A. None whatever.

13 X Q. What practical experience of any kind have you had in the art of electric incandescence prior to your going to the Westinghouse Company in June, 1887?

A. None.

14 X Q. Since that date you have been assistant superintendent of the lamp factory of that company?

A. Yes, until I gave up my time after June 1st, 1888, to experimental work.

15 X Q. As I understand, since June 1st, 1888, you have been engaged substantially, exclusively in experimental work preeminently on carbon filaments?

A. Yes, sir.

16 X Q. How many men have been under your charge in the ordinary course of these experiments?

A. Seven men are constantly employed, and at various times the number runs up as high as twelve or fifteen.

17 X Q. The object of this experimental work generally has been the improvement or betterment of the carbon filament used, or intended, or hoped to be used by the Westinghouse Company?

A. Principally.

18 X Q. And the ascertainment of the conditions of preparation, manufacture and mechanical surroundings best adapted for these filaments.

A. Yes, together with the best preparatory processes before being made up into lamps.

19 X Q. In the Sawyer-Man experiments, did you have any parts sent on to you understood to be old original Sawyer-Man parts?

A. There were a few bulbs together with the glass discs for the bottom of the lamp received at Pittsburgh, which, I understand, were from New York.

2169 20 X Q. Did the Sawyer-Man Company send on to you a sample lamp?

A. I believe they did.

21 X Q. You stated that Mr. Lodyguine gave you much useful information as to carbon filaments. What was the general nature of this information?

A. Principally in the direction of the best general preparation and handling of our carbons preliminary to mounting them in the modern form of lamp.

22 X Q. Have you had any experience in treating carbons in a hydrocarbon liquid by immersion, and rendering the carbon then incandescent?

A. I have made a very few lamps by such process.

23 X Q. Did you ever examine the lamp carbon within those lamps to see how far within the interior of the carbon the deposit had extended?

A. I did not.

24 X Q. And you have no personal knowledge how far under such treatment a deposit of carbon would extend.

A. No knowledge derived from actual experiment.

25 X Q. You have testified as to certain lamps made and used in the commercial globe of your company. The carbons in these lamps were all treated, were they not, and treated in a highly attenuated atmosphere of hydrocarbon gas?

A. The carbons for these lamps were all prepared by heating the carbon to a high temperature in highly attenuated natural gas.

26 X Q. Do you know anything of the temperature at which these carbons were carbonized?

A. I can only say that I should judge it was from three to four thousand degrees Fahrenheit.

27 X Q. Are you aware of any commercial lamp on the market having fibrous or vegetable carbon with the exception of such lamps as have bamboo carbons?

2170 A. Yes, sir. The lamp manufactured by our company contains a silk fibre, and there are also commercial lamps, I believe, made from paper or cotton thread.

28 X Q. Are there any lamps having carbons made from cotton thread on the market in this country?

A. I am under the impression that the Swan Company make their lamps from cotton thread.

29 X Q. You mean the Swan English Company?

A. Yes, sir.

30 X Q. Do you know to what treatment the cotton threads are subjected prior to carbonization?

A. I have no personal knowledge.

31 X Q. Do you not understand that they are soaked in various acids and chemicals?

A. I have no knowledge whatever, of that.

32 X Q. The paper carbons you referred to are the paper carbons which are, or have been, manufactured by the United States Company, are they not?

A. Yes, sir.

33 X Q. And these paper carbons are treated, are they not?

A. I don't know.

34 X Q. Do you know that they are made of paper?

A. Only from what I have been told.

35 X Q. And from what you have been told, do you not understand that they are treated?

A. I am under the impression they are; but have no positive knowledge.

36 X Q. Have you any personal experience of any practical use of any vegetable fibrous carbon for use in incandescent lamps which has not been treated?

A. I have made some few lamps from silk fibre which had not been treated.

37 X Q. But none from vegetable fibre?

A. I consider silk fibre a vegetable fibre.

38 X Q. Why do you consider silk fibre a vegetable fibre?

2171 A. For the reason that the production of silk fibre through the agency of the silk worm is derived directly from vegetable material.

39 X Q. On the same principle I suppose you consider the wool of a sheep a vegetable fibre?

A. I believe, in general, silk fibre is called a vegetable material, and wool, animal material. The distinction is, perhaps, somewhat arbitrary.

40 X Q. Then you are inclined to the theory that "all flesh is grass"?

A. Yes.

Redirect examination by Mr. KERR:

41 R. D Q. Please look at the lamp which is marked "Stillman lamp," and state what you know about it.

A. This is the lamp which was filled by Dr. Stillman on April 15th at the Pittsburgh factory, with nitrogen, put on the circuit and tested.

42 R. D. Q. In whose custody has the lamp been since that time?

A. In my own until I produced it here in evidence.

The lamp is offered in evidence as Complainant's Exhibit Stillman lamp, W. T. F., S. E.

And now, to wit, April 24th, 1883, it is stipulated that Edward R. Knowles, if recalled, would testify that Henry E. Vineing was first employed by the complainant on November 23rd, 1883, and that he continued in such employ until June 1, 1884.

It is further stipulated that the signatures of the witnesses Shallenberger and Smith are waived by consent.

2172 *Thomas B. Stillman.*

THOMAS B. STILLMAN, being recalled on the part of the complainant, testifies as follows in answer to interrogatories by Mr. KERR:

165 Q. Please state whether you, at any time or times recently, visited the Sawyer-Man Electric Company's factory in New York;

and if so, whether you there saw apparatus for producing and filling incandescent electric lamps with nitrogen gas?

A. I have. I was there two or three times recently, saw lamps being filled by the apparatus similar to the one I used ten years ago for filling the lamps with nitrogen gas. I don't think that I saw any apparatus for making the gas during these visits. The nitrogen gas was already in the bags made when I was up there. The method of making the gas was the same as I used, however, namely, by chloride of ammonium and nitrate of potash.

166 Q. Please state how long ago these visits were made?

A. One was made about three weeks ago, the other last week, or the week before last.

167 Q. What was the object of your last visit?

A. To fill some lamps with nitrogen gas personally by the same process I used ten years ago.

168 Q. Did you do so, and if not, why not?

A. I could not do so as a portion of the apparatus was broken.

169 Q. Did you see any of the lamps burning during either of these visits, and if so, state whether they differed, so far as you could see, from the lamps you filled in 1879?

A. I saw some of the lamps running that were filled with nitrogen, and I could see no difference in their construction and those I filled in 1879, of the same character.

170 Q. How did they appear to burn?

A. All right.

2173 171 Q. State whether or not you have recently been at the works of the Westinghouse Electric Company, at Pittsburg, and if so, for what purpose?

A. Yes, sir, I was there on Monday of this week, to examine the apparatus used there for filling the lamps with nitrogen gas, to see the lamps that were running filled with gas, and also to see a lamp put together and filled by myself in the same manner as I used before and to see the lamp tested and run after it was filled.

172 Q. What did you do on that visit with reference to making nitrogen gas, filling and testing the lamps?

A. I made the nitrogen gas, purified it, charged the lamp in the same manner as before, and left the lamp running in perfect condition when I left Pittsburgh.

173 Q. How did the apparatus for making nitrogen gas, purifying it, and filling the lamps which they had in Pittsburgh, and which you used on Monday last in the filling of the lamp, compare with the apparatus used by you for similar purposes for Sawyer and Man in 1879?

A. There was no material difference.

174 Q. Please look at the lamp now shown you, marked Complainant's Exhibit Stillman Lamp, and state whether or not that is the same or similar to the lamp you filled last Monday?

A. The lamp is similar to the lamp filled last Monday. I have not seen the lamp since Monday, but I believe it to be the same.

175 Q. You spoke of seeing this lamp put on a circuit and burned. How did it operate?

A. Very successfully.

176 Q. How did its operation compare with those which you filled for Sawyer and Man in 1879?

A. The lamp burned successfully. I can't compare it with the other lamps. The lamp at present is in perfect condition, and a comparison could not be made unless the life of the lamp was given also, that is to say, this lamp may burn six weeks, or two months, as some of the Sawyer-Man lamps did, and this requires a comparison, as I stated before, of the life of the lamps.

2174 177 Q. My question was intended to relate only to the appearance of the lamp while you saw it burning; and I would like to know whether it burned during that period in any way different from the lamps which you tested successfully for Sawyer and Man after filling them in 1879, your test, as I understand, lasting from thirty minutes to an hour at that time?

A. The lamps which I tested in 1879, after filling and during the filling, for a half hour or more in each instance, were brought up to a state of low redness. This, however, stood the test for the same period of time, giving out a much brighter light.

178 Q. How did its appearance while burning compare with the similar lamps you saw burning at Sawyer and Man's factory?

A. I have no means of deciding that point definitely, but I judge its appearance was about the same.

179 Q. Did you see any other lamps of this construction burning at the Westinghouse factory last Monday?

A. I did.

180 Q. How did they appear to burn?

A. All right.

181 Q. Please state why the lamps you tested in 1879 were brought up to a state of low redness?

A. To drive out any occluded gases, and also as a means of testing whether the globe was properly charged, since by keeping the carbon incandescent the nitrogen gas containing oxygen for a half an hour or more, combustion would ensue, which would show itself by the destruction slowly of the carbon. If much oxygen was present, the destruction was very rapid.

Cross-examination by Mr. Griffin:

182 X Q. When you went to the New York Sawyer-Man factory and when you went to the Pittsburgh factory, I understand that the apparatus employed for making the gas and filling the 2175 lamps, was the apparatus and process invented by you and patented to you in two several patents taken out in 1880 in this country. Is that so?

A. No, sir.

183 X Q. What difference was there between the apparatus patented to you and the apparatus you saw?

A. There was no patent for the manufacture of nitrogen gas.

184 X Q. Did you not take out one patent for the purification of nitrogen, and one patent for the process of filling the lamps with nitrogen?

A. Yes, I did.

185 X Q. And one of those patents was numbered 227,530, for your method of manufacturing the gas, dated March 23d, 1880, and the other was numbered 227,454, dated May 11th, 1880, for apparatus for charging the lamps?

A. I believe so.

186 X Q. As far as any difficulty in filling lamps with nitrogen by your process is concerned, do you know any reason requiring your presence and assistance at either factory in order to insure the proper filling of the lamps?

A. No, sir, not after looking over the specifications of the patents.

187 X Q. What would be the effect with your apparatus upon the glass tube holding the sodium, if it was started up and heated, after, by any means, a leakage of air had entered into the apparatus?

A. The sodium would be changed to oxide of sodium and the efficiency of the sodium would be deteriorated if enough air should be allowed to enter the apparatus to combine with all the sodium present. This, however, is a contingency which should not arise.

188 X Q. The special object of your use of melted sodium was to insure the absolute consumption of all air or oxidizable matter before the gas was passed on to fill the lamps?

A. It was.

2176 189 X Q. When you say you saw lamps in New York at the Sawyer-Man factory which were filled with nitrogen, you mean simply that from the surroundings and the apparatus you saw, and what was told you, you saw no reason to doubt the gas was nitrogen?

A. Yes, sir.

190 X Q. Please look at Complainant's Exhibit Sawyer-Man Broadnax Lamp No. 2, already in evidence in this suit, and say whether that resembles any of the lamps you filled in 1878 and 1879.

A. It resembles the lamps; yes, sir.

191 X Q. I also ask you to look at Complainant's Exhibit Sawyer-Man Treating Apparatus, and to state whether that apparatus, so far as regards the radiators, the upper disc, and the arrangements of the clamps, resembles any of the lamps filled by you for Sawyer and Man in 1878 and 1879.

A. My impression is that I filled lamps similar to this in construction.

192 X Q. Are you able to say whether there is any difference in the upper part of that Sawyer-Man treating apparatus, and the lamps which you remember filling?

A. As I stated before, lamps were already set up and in proper condition to be filled with nitrogen gas by me. Otherwise than that I cannot state in regard to this lamp.

193 X Q. You stated that lamps having arch-shaped carbons were filled by you. Can you point out any difference in the radiators, the discs, the uprights, or any of the upper portion of that

exhibit which to your recollection or knowledge differs from the lamps having arch-shaped carbons which you filled?

A. As I stated before, various forms of carbons and lamps were sent down to be filled some containing the *the* soapstone upper base and others containing a metallic base insulated by means of mica. If my recollection is correct, I have filled some of these lamps like the sample; but my impression is that after January, 1879, I saw but few in which the bolt and nut went through the clamps.

2177 194 X Q. Otherwise do you notice any difference between the arrangement in any way, either as to the size or as to the relation of the parts between the upper part of the exhibit just now shown you, and the upper parts of the lamps that you recollect as having arch-shaped carbons?

A. There were a number of small changes made in the lamps from time to time which I do not recollect; but, which if brought to me, I might remember.

195 X Q. When you say that the lamps which you saw at Pittsburgh and New York resembled the lamps which you filled in 1879, you do not mean to assert an identical construction, but in general appearance, they resembled the lamps which you filled in 1879?

A. The lamps which I filled in 1879 consisted of various forms of carbon, and the lamps which I saw running at the New York factory and the Pittsburgh factory were identical in form and construction with some which I saw in 1879.

196 X Q. Do you mean that the lamps were identical in their construction?

A. So far as I could remember I should say that they were identical in construction?

197 X Q. Similarly is the upper part of the exhibit just shown you identical with the lamps which you filled in 1878 and 1879?

A. The lamps which I saw running in the factories in New York and Pittsburgh were identical with some of the lamps which I filled in 1879, but I do not recollect seeing this particular form running in the Westinghouse factory, though they may have been so.

198 X Q. What I want to know is this; whether to the best of your recollection these two lamps, the Broadnax lamp No. 2, presented during Mr. Broadnax's examination by complainant*s*, and the Exhibit Sawyer-Man Treating Apparatus, are more or
2178 less identical with the lamps which you filled in 1878 and 1879, than were the lamps you saw at Pittsburgh?

A. My attention while in the factory in Pittsburgh was drawn more especially to the conditions of the carbons and their rate of burning, than to the exact construction of the upper portion of the lamp, though there is a general resemblance to the lamps filled by me in that regard, consisting of a piece of carbon, arch shaped, or otherwise, as an illuminant, connected between two large anodes or terminals. For this reason there may have been lamps of the description mentioned by you in circuit without my being able to say positively that they were there.

199 X Q. What, again, I want to understand distinctly from you, is this: is your knowledge as to the identity of the Pittsburgh lamps, as to their upper portion, with the lamps which you filled in 1878 and 1879 any more or less accurate than your recollection about a similar identity of the two exhibits that have just been shown you?

A. In regard to the two exhibits I can swear positively to filling lamps of that form, and I saw nothing in the lamps running at Pittsburgh which drew my attention to peculiarity of construction from the lamps which I had filled for Sawyer and Man.

200 X Q. Was there anything in the lamps which you saw at Pittsburgh as to the construction of the upper part, which, to your recollection, differed from the construction of the upper part of the exhibit treating apparatus?

A. As I stated before, lamps of this construction might have been on exhibition there, but the lamp which I filled with nitrogen gas while there, or others similar to it, represented the bulk of the lamps running at Pittsburgh.

201 X Q. What difference do you recollect as to the upper part of the lamps running at Pittsburgh and the upper part of the exhibit treating apparatus?

2179 A. As stated before, some of these lamps may have been in circuit; but the difference between this exhibit and the majority of the lamps running there of similar pattern consisted in the upper base not being of soapstone and no brass clamps through the upper carbons.

202 X Q. What were used at Pittsburg through the upper carbon clamps?

A. The arch was placed down in the carbon holders and contact made by means of platinum.

203 X Q. And what held the clamps together in the lamps at Pittsburgh?

A. To my recollection there were no clamps.

204 X Q. Didn't you see any lamps there with carbon clamps?

A. I do not recollect them.

205 X Q. I ask you to look at the Stillman lamp. Are the clamps there not of carbon?

A. They are.

206 X Q. Then the only difference that you recollect between the Stillman lamp exhibit and the Sawyer treating exhibit is in the change of the material of the upper disc from soapstone to metal with mica insulation?

A. Yes, sir.

207 X Q. And outside of that difference, both exhibits, to your recollection, are equally identical, so far as you can now remember with the lamps you filled in 1878 and 1879 of this type?

A. Yes, sir.

208 X Q. When you filled the lamps in 1878 and 1879, how long did you keep them on the bag, and flow the nitrogen through them before taking them off?

A. It depended upon the number of lamps in circuit, varying from one hour to four, depending upon the number of lamps in circuit.

209 X Q. What was the usual length for the lamps you had on circuit?

A. It would vary. Some days I would have one or two lamps and some days ten lamps.

2180 210 X Q. During the time you were with Sawyer and Man, which type of lamp did they consider in their conversation with you to be their most successful lamp? Was it not the straight-pencil lamp?

A. That was a matter of considerable discussion at all times; but I don't think that that was definitely settled.

211 X Q. Haven't you frequently expressed yourself as saying that Sawyer and Man had considerable more trouble with their horseshoe carbons than with the other types of lamps—the straight pencils?

A. I don't recollect that statement. I know that Mr. Man claimed that if the horseshoe carbon burned so successfully in the old shop for several months, there was no reason why others should not do the same. This old lamp, I know nothing of personally.

212 X Q. To your knowledge, didn't they have more trouble with these horseshoe carbons than with the others?

A. I think not; but I could not state positively on that point for the reason that I never kept a record of the life of the lamps, and as I stated before, I don't think they did at the factory; that is, what we call a time book.

213 X Q. You never knew of their keeping a record at all, did you?

A. I think they would keep a record of a lamp which burned an extraordinary time; but if a lamp broke it would be set up and sent down to be filled.

214 X Q. In other words, when a lamp burned out or broke down for any reason, they would fix it up again and send it down to you to be refilled?

A. Yes, sir.

215 X Q. And you cannot positively state how many times this was done with regard to any particular lamp?

A. No, sir; I can only distinguish between a lamp that had been filled once and a new lamp.

THOMAS B. STILLMAN.

2181 NEW YORK, *April 16th*, 1889.

Met pursuant to adjournment.

Present: Thomas B. Kerr, of counsel for complainant, and Walter K. Griffin, of counsel for defendant.

Testimony of James W. Packard.

JAMES W. PACKARD, a witness on part of the complainant, being duly sworn, testifies as follows in answer to interrogatories by Mr. KERR:

1 Q. State your name, age, residence and occupation.

A. James W. Packard, age 26, residence New York, I am assistant superintendent of the Sawyer-Man Co.'s lamp factory.

2 Q. Were you ever in the employ of the Consolidated Electric Light Co., and if so, when did you go into its employ and how long did you continue?

A. I was in the employ of the Consolidated Electric Light Co., from the 1st of August, 1884, until the 1st of October, 1888, since which date I have occupied the same position in the same factory, the latter being now carried on by the Sawyer-Man Electric Co.

3 Q. Have you recently made some Sawyer-Man lamps of the pattern shown in the complainant's patent in suit, No. 317,676, dated May 12th, 1885, and if so, state what sources you obtained your information from by which you made such lamps.

A. I have recently made several such lamps, receiving my information entirely from the patent and other patents belonging to the consolidated company issued to Thomas B. Stillman and from personal instruction and various parts of old lamps furnished me as samples by Mr. Man. My information received from the Stillman patent was in regard to the manufacture of nitrogen gas and the process of filling the lamps therewith. In the manufacture of the nitrogen and its introduction into the lamps I have been guided entirely by the information received from the Stillman patents.
The Stillman patent for the manufacture of the gas is No.
2182 225,730, dated March 23, 1880, and the one for apparatus for
charging the lamps is No. 227,454, dated May 11, 1880.

4 Q. Did you make any tests of the lamps made by you, and if so, please make a statement of the same.

A. I completed seven of these lamps containing various forms of carbons, and tested them all. The following is the result of the test:

Lamp No. 1: Carbon made of bamboo; candle power 22, volts 23, current in amperes 12; burned for 240 hours, the carbon was then broken on account of the defective joint between the carbon and the electrode which resulted in an arc at this point, rupturing the carbon. The carbon is yet in good condition.

Lamp No. 2: Carbon paper; candle power 64, volts 29, current in amperes 8; burned 107 hours; the carbon is yet in fair condition, not being broken.

Lamp No. 3: Carbon willow; candle power 70, volts 35, current in amperes 11.6, burned 77 hours. The carbon seems yet to be perfect.

Lamp No. 4: Carbon bamboo; lamp not measured for candle power, burned 190 hours, carbon in fair condition.

Lamp No. 5: Carbon willow; burned 77 hours, carbon in fair condition. This lamp was burned at about 40 candle power, taking a current of about 27 volts and 8 amperes.

Lamp No. 6: Carbon paper, burned 49 hours, carbon in good condition. There was no test of candle power or current with this lamp.

Lamp No. 7: Bamboo carbon; candle power 28, volts 22, current about 8 amperes, burned 30 hours, when the carbon broke apparently from a defect in the carbon itself.

I produce the three first-mentioned lamps showing samples of the three kinds of carbon mentioned, namely, bamboo, paper and willow.

The three lamps referred to in the last paragraph of the foregoing answer are offered in evidence as follows:

2183 Complainant's Exhibit Packard Sawyer-Man lamp No. 1, with bamboo carbon, W. T. F., special examiner, April 16, 1889.

Complainant's Exhibit Packard Sawyer-Man Lamp No. 2, with paper carbon, W. T. F., special examiner, April 16, 1889.

Complainant's Exhibit Packard Sawyer-Man Lamp No. 3, with willow carbon, W. T. F., special examiner, April 16, 1889.

5 Q. Please state what the efficiency of these Sawyer-Man lamps made by you is relatively to the ordinary incandescent lamps at present manufactured?

A. The efficiency at which they burned during test was fair, being approximately 4 watts per candle. The average efficiency of the commercial lamps on the market is about three and one-half watts.

6 Q. Why did you not subject these lamps to longer life tests?

A. These lamps which are not burned out were not subjected to a longer life test on account of a lack of time in which to do so. Two out of the seven were burned out, the others were all burned until the morning of April 15th, when I took them off the circuit to bring them to this office.

7 Q. State whether you have tried the use of nitrogen in an ordinary bulb lamp?

A. I have tried the effect of nitrogen in our ordinary lamps with bamboo carbon, and now produce a 32-candle 50-volt lamp containing a residual atmosphere of nitrogen; it has been burning 126 hours and appears to be in perfect condition.

Lamp offered in evidence as Complainant's Exhibit Packard Bulb Lamp Containing Nitrogen. W. T. F., special examiner, April 16, 1889.

8 Q. State whether the seven lamps of which the Exhibits Packard Sawyer-Man Lamps 1, 2 and 3 are examples, were all filled with nitrogen gas.

A. Yes.

2184 9 Q. Please describe the construction of the lower end of the seven lamps made by you.

A. The bottom of the bulb or tube had formed upon it a heavy flange, and carefully ground to this flange was a glass plate, of the same diameter as the flange, with two holes in it through which the hollow brass electrodes passed. On the inside of the bulb there was screwed to these electrodes the nut to which the conductors inside the lamp were fixed. The electrodes were prolonged on the outside of the glass bottom plate, these prolongations being provided with stop-cocks, which stop-cocks were afterwards covered with a brass cap screwing over them. The flange of the bulb and the bottom plate were clamped together by means of brass rings fitting over them, with paper washers next to the glass, these brass rings being held together by screws. In making the joint between the bottom flange and the glass plate, Canada balsam is used as a cement.

10 Q. Did you make any attempt to follow any particular pattern in the construction of these lamps, and if so what?

A. In making these lamps I was guided entirely by the Sawyer-Man patent and samples of old lamps and parts furnished me by Mr. Man. The lamps I made were exactly like that described in the patent with the exception of two in which I used a rubber washer over the opening in the electrodes, instead of the brass plug for a stop-cock; all the others were provided with the brass plugs. Lamp No. 1 is one of those with the rubber washer. The reason I used the rubber in these two lamps was on account of poor workmanship in the brass stop-cocks I had then on hand.

11 Q. State whether you used any of the old parts supplied by Mr. Man in the construction of these seven lamps.

A. The corrugated conductors used in these lamps were, with the exception of about two sets, supplied me by Mr. Man, as were
2185 also three or four of the glass bulbs and bottom plates. The others were made new, being a precise copy of those obtained from Mr. Man.

Adjourned to meet April 18th, at 2 p. m.

New York, *April 18th*, 1889.

Met pursuant to adjournment.

Present: Thomas B. Kerr, of counsel for complainant, and Walter K. Griffin, of counsel for defendant.

12 Q. Please examine the Stillman drawings, 1, 2 and 3, and state whether the apparatus used by you in making the gas and filling the lamps differed from that shown in the Stillman drawings?

A. The apparatus used by me differed from that shown only in the form of some of the apparatus, and the progressive arrangement of some of the re-agents. It was practically the same.

Cross-examination by Mr. Griffin:

13 X Q. What has been the nature of your duties as assistant superintendent at the factory mentioned in your second answer?

A. I have taken charge of all the details of lamp manufacture and the general management of the employés.

14 X Q. Who has been and is the superintendent?

A. Since occupying my present position, John M. Robertson has been superintendent.

15 X Q. How many lamps have been manufactured a day under your supervision?

A. It has varied between one hundred per day and three thousand per day.

2186 16 X Q. And you had to superintend the various processes of the manufacture of these lamps?

A. I had.

17 X Q. How many hands are employed at the factory as a rule?

A. Between 50 and about 250.

18 X Q. What kind of carbons have been used in the lamps you have mentioned?

A. Bamboo, silk and tamadine.

19 X Q. What proportion of the lamps have been bamboo?

A. Probably eighty per cent.

20 X Q. How recently were the silk filaments introduced?

A. About fourteen months ago.

21 X Q. How many of the silk filaments used by you have been manufactured at your factory?

A. None of the preparation and carbonization of the silk has been done there. The treatment and preparation of the carbon has all been done there.

22 X Q. What do you mean as to the difference between the preparation of the silk and the treatment of the carbon?

A. By carbonization I mean the mere baking of the filament, by treatment, the hydrocarbon flashing process.

23 X Q. Do I understand then, that the silk filaments were carbonized elsewhere and sent to your factory, and then at your factory treated by the deposition of carbon from hydrocarbon vapor upon the filament?

A. That was the case.

24 X Q. And the tamadine filaments were made by and sent to you from the United States Company, were they not?

A. They were sent from our Newark factory, which was operated by the United States Electric Company.

25 X Q. That was the factory of the United States Company, was it not?

2187 A. As I understand the matter, since we have received these carbons this factory has been owned by the Sawyer-Man Electric Co.

26 X Q. Was it not formerly the factory of the United States Company?

A. It was.

27 X Q. When did you begin to make the lamps mentioned by you in your third answer?

A. It was about two months ago that I started making these lamps. I had previously obtained some of the apparatus necessary.

28 X Q. Which of the apparatus had you previously obtained?

A. The gas-holders, some of the re-agent bottles and a few sample parts.

29 X Q. In making these lamps what study did you give to the Sawyer and Man patent in suit?

A. I did not study the matter especially, merely following the details of the patent and the drawing as closely as possible.

30 X Q. When you made the lamps who gave you the patent?

A. H. R. Garden.

31 X Q. President of the Consolidated Company, is he not?

A. I believe so.

32 X Q. For what purpose did he inform you that he gave you the patent?

A. At that time he merely stated that he wished me to make a lamp according to that patent.

33 X Q. When was this that he gave you the patent?

A. I think in August, 1888.

34 X Q. And when did you begin to make lamps?

A. About the middle of February, 1889.

35 X Q. Who gave you the Stillman patent you have mentioned?

2188 A. It was given to me with the Sawyer-Man patent by H. R. Garden.

36 X Q. For what purpose was it explained to you that the Stillman patents were given to you?

A. I understood that it was desired to show in some lawsuit of the Edison Company, that lamps could be made according to these methods.

37 X Q. Didn't you know in which suit it was desired to show these things?

A. I did not until later.

37 X Q. When did you first learn which suit it was?

A. About the first part of February.

39 X Q. And it was after this time in February that you made the seven lamps you have mentioned?

A. It was.

40 X Q. From whom else, besides Mr. Garden, did you receive instructions as to the purpose of your making these seven lamps?

A. I received no instructions in regard to the purpose of making these lamps, but believe I was informed of it by Messrs. Kerr, Curtis and Shallenberger, and Robertson.

41 X Q. When did Mr. Man first send any of the parts of the lamps to the factory?

A. I obtained these parts from Mr. Man in the middle of August, 1888.

42 — Q. Did you go to him, or he come to you?

A. When Mr. Garden spoke to me of making these lamps, I suggested to him that I should go to Mr. Man, and did so with Mr. Garden's consent.

43 X Q. How many parts did Mr. Man give you?

A. Incomplete parts for eight or nine lamps.

44 X Q. How many globes?

A. About twelve at that time.

45 X Q. And how many later on?

A. About twenty later, part of which only I have retained.

2189 46 X Q. How many globes did you have made for you?

A. I had about 150 made, but found in this lot only about eight good ones, the rest were defective and were returned to the makers. I also received ten globes from Pittsburgh, which were fair, but would not fit our parts of lamps and only two of them were used.

47 X Q. When you returned the 140 globes as defective, how many were sent to you in return?

A. I received two lots of 100 each, and none others after these.

48 X Q. Is this in addition to the first lot of 150 of which you returned 140?

A. No, sir, the 200 was all that we received. The maker acknowledged their defects, agreeing to take them back.

49 X Q. What was the defect in these lamps?

A. The bottom flanges were *on* properly put *out* allowing a leakage between the flange and the bulb, and they were irregular in size.

50 X Q. How did you ascertain that these globes allowed leakage between the flanges?

A. Generally an examination by eye would show seams and holes. Some few were mounted into lamps, and showed leakage when tested with the air pump and vacuum *guage*.

51 X Q. Just where would these defects exist?

A. These globes were not blown in a mold as they should have been; but were made by blowing the plain globe and afterwards attaching to it by hand a flange of glass, the globe being cold would not adhere perfectly to the flange which was in a molten state when applied.

52 X Q. Who manufactured these 200 globes?

A. F. Thills, Sons & Co., of Brooklyn.

53 X Q. Who recommended you to that firm?

A. I knew them personally, having dealt with them before.

2190 54 X Q. Besides this, who suggested to you to go to that firm?

A. I first suggested it myself.

55 X Q. Did you talk about this with Mr. Man?

A. Yes, sir; and he informed me that this firm had made the bulbs for him.

56 X Q. When did he say the firm had made the bulbs for him?

A. He did not state any date; but I understood that it was when he was manufacturing lamps.

57 X Q. You mean when he was manufacturing Sawyer-Man lamps such as shown in the patent?

A Yes, sir.

58 X Q. How many of the globes Mr. Man had given you did you send over to Thills, Sons & Co. as samples?

A. Two.

59 X Q. When the globes came from Thills & Co. were the flanges ground down?

A. They were rough ground.

60 X Q. All of them?

A. All that I saw.

61 X Q. How many base plates did Mr. Man give you?

A. I think about 18 or 20.

62 X Q. In all, or the first time?

A. In all.

63 X Q. Did you have any of *of* these made at Thills'?

A. No, sir.

64 X Q. Where did you have them made?

A. Some were made by John Walter, of, I think, 81 Worcester street, and some were sent to me by Mr. Shallenberger.

65 X Q. How many dozens did Mr. Walter make for you?

A. He made one hundred bottoms.

2191 66 X Q. How many samples did you send him out of the originals which Mr. Man gave you?

A. One.

67 X Q. When were these made?

A. I think it was about the middle of February.

68 X Q. How long after this was it Mr. Shallenberger sent you the bottoms?

A. It was three weeks or a month after that.

69 X Q. Sent them to you from Pittsburg, did he not?

A. Yes, sir.

70 X Q. Thills, Sons & Co. of Brooklyn are large manufacturers of electric-lamp globes are they not?

A. They are.

71 X Q. Globes for incandescent lamps?

A. Yes, sir.

72 X Q. Walker, what does he manufacture?

A. He is a workman who cuts and drills glass in special forms.

73 X Q. That is his specialty in trade, is it not?

A. He is employed, I believe, as a packer, by a plate-glass house during the day, and does odd jobs evenings at home.

74 X Q. How did you come to go to Walker?

A. I was directed to him by James Cavenagh, a glass-etcher on South Fifth avenue.

75 X Q. In what condition were these glass bottoms sent to you by Walker?

A. They were comparatively rough, being cut out of plate glass.

76 X Q. Who ground these glass bottoms smooth at your factory?

A. Our principal glass-blower, a man named Schramm.

77 X Q. The foreman of your glass-blowers?

A. No, sir, our pump-maker.

78 X Q. How long had Schramm been in your employ?

A. About two years.

79 X Q. And you considered him your principal man in glass-blowing?

2192 A. Yes, sir.

80 X Q. Who ground down the glass globes?

A. Mr. Schramm.

81 X Q. How many years' experience do you understand Mr. Schramm to have had?

A. I should say at least ten years.

82 X Q. Did you ever watch him personally grind down these base plates from beginning to end?

A. Yes, sir.

83 X Q. How long did it take him?

A. I should say from about ten to twenty minutes to complete one.

84 X Q. How many did you see him personally grind down?

A. About six or eight.

85 X Q. When did you see him grind the first one?

A. I think it was in August.

86 X Q. When did you last see him grind one?

A. About the first of April.

87 X Q. Where did you go to see him grind them?

A. In what we call our laboratory.

88 X Q. Why did you go to see him?

A. I did not go to see him, but happened to be present while he was doing it.

89 X Q. What do you mean by the laboratory?

A. The first floor of our rear building at 326 West 23d street, which is used for special and experimental work.

90 X Q. Work which you do not wish the ordinary workmen to see?

A. No, sir. Work which requires to be done immediately, and which might interfere with our regular work in the factory.

91 X Q. When was your first experience or knowledge as to the manufacture or construction of incandescent electric lamps?

A. In the spring of 1885, when I went to work in the Brooklyn factory of the Consolidated Company.

2193 92 X Q. And since then you have overseen the manufacture of from 100 to a thousand lamps a day.

A. Yes, sir.

93 X Q. Since 1885 have you not had large experience in the carbonization and treatment of filaments for incandescent lamps?

A. I have had experience with only one kind of filament.

94 X Q. What kind is that?

A. The bamboo filament as used by Sawyer-Man Electric Co.

95 X Q. Are any of the seven lamps which you made, made from the actual parts given you by Mr. Man?

A. Not complete. Some of the parts are used in them.

96 X Q. Take the lamps numbered from 1 to 7 respectively, and state just what parts of each lamp are original parts given you by Mr. Man.

A. I cannot identify them, they having become mixed in with the other parts.

97 X Q. Can you swear of your knowledge that there is any one part of those seven lamps which is one of the original parts given you by Mr. Man?

A. I cannot positively identify any such part, but I am certain that such parts are there used.

98 X Q. How many dozen radiators did you have made at Newark?

A. None.

99 X Q. Where were they made?

A. They were sent to me from the Pittsburg factory.

100 X Q Did you have any radiators or conductors made elsewhere?

A. No, sir.

101 X Q. When did you first put together a lamp and burn it?

A. I think it was about the first of March or the latter part of February.

102 X Q. Was that the first you can remember?

2194 A. Yes, sir.

103 X Q. What did you have the glass plates ground for in 1888?

A. For making these lamps.

104 X Q. Weren't some of the lamps then made?

A. Not that I recollect.

105 X Q. Don't you know that there were?

A. I believe that two were put together and burned a short time.

106 X Q. Don't you know that there were more than two?

A. I can recollect but two.

107 X Q. What do you mean by saying they burned a short time?

A. To my knowledge at least one of them burned two or three hours.

108 X Q. Didn't they all give out within two or three hours?

A. I am quite positive that they did not.

109 X Q. What makes you positive that they did not?

A. I recollect seeing the current put on one of them several days after we had abandoned working on them.

110 X Q. When did you abandon working on them?

A. I think it was in the latter part of September, 1888.

111 X Q. Is that the best of your recollection as to the date?

A. That is the best of my recollection.

112 X Q. Who put together those lamps?

A. It was done by one of our workmen, I believe, a Mr. Mayo.

113 X Q. Where is he now?

A. I do not know.

114 X Q. When did he leave your employ?

A. I believe during the first week in April.

115 X Q. Why did he leave your employ?

2195 A. He demanded higher wages, which I refused to give him, and he accordingly left.

116 X Q. What work was he employed on at the time he demanded higher wages?

A. At that time he was employed on repairs to some of our apparatus.

117 X Q. Wasn't he employed in putting together Sawyer-Man lamps for you?

A. Occasionally.

118 X Q. Wasn't he the man who put them together for you?

A. He put together most of them, not all.

119 X Q. Up to the time of his leaving, who else put up Sawyer-Man lamps?

A. Another workman of ours, named Kammer.

120 X Q. How many lamps did he put together?

A. About five or six.

121 X Q. Going back to 1888: were not Sawyer-Man lamps put together and tried in your factory, after September and before the close of the year?

A. I do not remember any just now.

122 X Q. Weren't lamps put together and burned in December of that year?

A. I don't remember it.

123 X Q. Would you swear there were not?

A. No, sir.

124 X Q. How many lamps have you yourself put together?

A. None.

125 X Q. How many of the parts of lamps have you yourself made?

A. Some of the carbons is all.

126 X Q. How many carbons did you make?

A. I cut about ten fibres and saw them baked, and treated these myself, and also treated some others.

127 X Q. How many others did you treat?

A. I treated none others for these lamps.

128 X Q. Who baked these fibres that you cut?

2196 A. Some of them were baked by John Kane, and some by Mr. Kammer.

129 X Q. How many did Kane *back?*

A. I cannot state the number, even approximately.

130 X Q. And how many did Kammer bake?

A. About six or eight, I believe.

131 X Q. Did Kammer cut any carbons?

A. No, sir, not to my knowledge.

132 X Q. That is you don't know whether he did or not?

A. I know that he had no facilities for so doing.

133 X Q. Did Kane cut any carbons?

A. No, sir.

134 X Q. Who sent you carbons for the Sawyer-Man lamps from outside?

A. Mr. Vandegrift of the Newark factory.

135 X Q. How many dozen did he send you?

A. About four dozen.

136 X Q. Do you know how many he carbonized before he sent you these four dozen?

A. I do not know.

137 X Q. Were these carbons that he sent you treated?

A. They were.

138 X Q. How many did you treat personally?

A. None of these.

139 X Q. Who did the treatment?

A. I do not know. They were all treated when I received them.

140 X Q. After Mr. Mayo left, who put the Sawyer-Man lamps together?

A. Mr. Kammer.

141 X Q. What part of the factory was this done in?

A. In the before-mentioned laboratory.

142 X Q. What part of the laboratory?

A. At the work-bench against the north wall.

143 X Q. Who is Mr. Kammer, and what was his employment by your company?

2197 A. He was engaged part of the time in repairing apparatus, the remainder of the time in working upon these lamps, being a machinist by profession.

144 X Q. Were you ever present from beginning to end while either Mr. Mayo and Mr. Kammer assembled or put together a Sawyer-Man lamp?

A. I do not recollect ever seeing this done in one continuous operation.

145 X Q. How much of the operation have you seen done?

A. I have seen every operation of making these lamps but cannot say that it was the same lamp.

146 X Q. Will you swear that you ever watched them assembling a lamp for more than an hour at a time?

A. Yes, sir.

147 X Q. What is the longest time that you have been present watching either of these men assembling a lamp?

A. I think about two or three hours.

148 X Q. What part of assembling a lamp were they doing when you first began to watch them?

A. Connecting the electrodes with the glass bottom.

149 X Q. And what was the last stage at which you saw them working?

A. I don't recollect.

150 X Q. I refer in my last question to the time you watched either of these men two or three hours, as you testify in your 147th answer. Did you so understand my last question?

A. I did.

151 X Q. How long did it take these men to connect the electrodes to the glass bottom?

A. I should say anywhere between fifteen minutes and an hour.

152 X Q. How long did it take them to assemble the lamp altogether.

A. I do not believe one ever was assembled in one continuous operation.

2198 153 X Q. Put all the operations together that you have seen separately and state what, to the best of your recollection, was the gross time occupied in assembling the parts of the lamp.

A. Provided no accidents were met with, I should say two to four hours.

154 X Q. That is your estimate of the time it would take to put together one of these lamps?

A. It is my estimate of the time required to put together one of the lamps.

155 X Q. When a carbon burnt out in one of these lamps, what had to be done to it before the lamp could be re-burned?

A. The globe required to be taken off by taking out the screws clamping the brass flanges at the bottom, the globe removed from this bottom plate, the globe and all parts cleaned, the burned-out carbon replaced with a new one, and the lamp assembled in the reverse manner.

156 X Q. All the wax and cement had to be removed, had it not?

A. That is what I meant by stating that the parts had to be cleaned.

157 X Q. And this business took two or three hours, did it not?

A. No, I should say, on an average, not more than one hour.

158 X Q. Will you swear that you ever saw it done in less than two hours and a half?

A. I do not recollect seeing it done.

159 X Q. Then you are not speaking of this from your own knowledge.

A. I am.

160 X Q. Did you ever see a lamp taken apart and put together again from end to end?

A. I do not recollect seeing this done in one continuous operation, but have seen them taken apart in less than ten minutes, and put together in less than forty minutes.

2199 170 X Q. After this the lamps were filled with nitrogen gas, were they not?

A. They were.

171 X Q. How many lamps have you personally taken apart and put together?

A. None.

172 X Q. How many lamps have you personally filled with nitrogen gas?

A. If by personally filled you mean doing all the operations unaided: none.

173 X Q. How many of the operations have you yourself performed?

A. I believe I have done each one of them at various times.

174 X Q. How many times have you taken part in the operation?

A. I do not remember.

175 X Q. Why can't you remember?

A. Because I was very busy all the time at other work, and made no special point of remembering this.

176 X Q. What else had you to do?

A. Overseeing the general manufacture of lamps, and fitting up our factory for an increase of output.

177 X Q. Who did the filling of the lamps?

A. The men before mentioned, Mayo, Kammer and Schramm, and a man named Cavenagh.

178 X Q. How many lamps did Cavenagh fill that you saw?

A. I do not recollect seeing him fill any. By filling I mean going through the entire operation.

179 X Q. How many lamps did you see him assist to fill?

A. I do not recollect.

180 X Q. How many lamps did you see Schramm fill or assist to fill?

A. I do not remember.

2200 181 X Q. How many lamps did you see Mayo fill or assist to fill?

A. I do not remember.

182 X Q. And how many lamps did you see Kammer fill or assist to fill?

A. I do not remember.

183 X Q. How long is it since you have read either of the Stillman patents?

A. About one week.

184 X Q. How came you to read it then?

A. I had no special object in reading it then, merely reading it to refresh my memory.

185 X Q. When before that had you read either of these Stillman patents?

A. I don't remember.

186 X Q. Had you ever read them since the time Mr. Garden gave them to you, until last week?

A. Yes, sir; several times.

187 X Q. Who put up your nitrogen apparatus?

A. Kammer and Schramm, with perhaps one or two helpers.

187½ X Q. How much of the work in putting up the nitrogen apparatus did you personally do?

A. In putting up one apparatus, I did perhaps three-quarters of the work.

188 X Q. Which apparatus was that?

A. It was one that we put up, I think, in August, 1888.

189 X Q. Describe that apparatus.

A. It *is* consisted of an ordinary chemical flask for generating the nitrogen, connected by means of rubber tubes with a number of Wolff or washing bottles filled with various re-agents for purifying the gas, and a rubber bag for collecting the gas at the end of the apparatus.

190 X Q. What re-agents did you use for purifying the gas?

A. As I remember the arrangement, the first bottle con-
2201 tained sulphuric acid, the next, caustic potash, then pyrogal-
late acid in solution, phosphoric anhydride, then a bottle
containing melted sodium, and finally phosphoric anhydride.

191 X Q. Who gave you directions as to putting up this apparatus?

A. Mr. Albon Man.

192 X Q. Did he come personally to see the apparatus?

A. I am not positive, but think not.

193 X Q. Didn't he give you a written description to go by?

A. I received a few notes by no means a description, which, I believe, came from Mr. Man.

194 X Q. Don't you know they came from Mr. Man?

A. This description was given me by Mr. Lewars, the treasurer of the Sawyer-Man Company, just after Mr. Man had been there. Whether it was written by Mr. Man or by Lewars at Man's dictation, I do not know.

195 X Q. But directly, or indirectly, Mr. Man had been requested to give instruction as to the apparatus, had he not?

A. I had myself asked him for some instructions.

196 X Q. And you also asked him for instruction as to putting the lamps together and the use of them, did you not?

A. Yes, sir.

197 X Q. And this was in August or September, 1888?

A. To the best of my recollection it was in August. I also received instructions from him after that date.

198 X Q. What date did you receive further instructions from Mr. Man?

A. I cannot remember the date.

199 X Q. What instructions did he give you?

A. They were mainly in regard to the necessity of exercising great care in the preparation of the parts, as to small details and the methods of working: for example, to use the proper kind of screws to use in clamping, and so forth.

2202 200 X Q. What was the trouble with the screws that they weren't quite right?

A. He cautioned me that iron screws would be preferable on account of its coefficient of expansion, and platinum could also be used with success.

201 X Q. And you tried both kinds, did you not?

A. I tried only iron and brass, finding the iron preferable.

202 X Q. What further instructions did Mr. Man give you that you can now remember?

A. The only further instructions that I can recall was as to how to proceed to grind the bottoms.

203 X Q. What did he tell you about that?

A. He told me that the proper method was to grind both the bottom plate and the bottom flange of the globe flat on a cast-iron surface plate, using fine emery and oil to grind them in this manner until the surfaces were as highly polished and smooth as it was possible to get them, and then to grind the plate and flange against each other slightly so as to insure a perfect fit.

204 X Q. I notice in the lamps you have presented in evidence, that the upper brass flange is thinner than the lower one. How did you come to use the upper flanges thinner than the lower ones?

A. I believe Mr. Man instructed me to do this, but I would have done so anyway, as the upper surface of the flange on the globe is apt to be irregular and would be easily cracked by any unequal pressure brought upon it. The giving of a thin brass plate will allow for slight inequalities in the surface.

205 X Q. As a matter of fact didn't you break quite a number of those glass flanges in the beginning because the metal plates used by you were too thick?

A. We broke quite a number of these flanges, but I do not attribute the breaking necessarily to the thickness of the brass flange, but rather to the inexperience of the workman, and the lack of sufficient packing on the top of the flange.

2203 206 X Q. As a matter of fact were the brass flanges first used by you thicker than the subsequent flanges adopted after Mr. Man's suggestions? I refer, of course to the upper flange.

A. The first ones used were thicker.

Adjourned to meet April 19th, at 10.30 a. m.

NEW YORK, *April 19th*, 1889.

Met pursuant to adjournment.

Present: Thomas B. Kerr, Esq., of counsel for complainant, and Walter K. Griffin, Esq., of counsel for defendant.

207 X Q. How many of the lamps made at the factory were finished with the metal cup and filling material shown in the patent in suit?

A. One.

208 X Q. What became of this one?

A. It burned, I think, for about three hours, and was then dismantled.

209 X Q. Why was it dismantled?

A. In order to get the parts for use in other lamps.

210 X Q. Hadn't it burned out?

A. Yes, sir.

211 X Q. Then it was taken apart because it had burned out, was it not?

A. For this reason and because we wanted the parts to use in other lamps.

212 X Q. Did you use the cup in other lamps?

A. No, sir.

213 X Q. Why didn't you use the cup in other lamps?

A. I had no instructions to do so.

214 X Q. You described a nitrogen apparatus used by you in 1888 as being one apparatus you used for nitrogen. When did you use a second apparatus?

2204 A. I think the second apparatus was set up in the first part of February, 1889.

215 X Q. Who set up that apparatus?

A. Mr. Kammer.

216 X Q. Was this the apparatus you described as being the Stillman apparatus.

A. Yes, sir.

217 X Q. And this apparatus, I understand, continued to be used until the end of your experiments?

A. It was modified slightly, and the modified apparatus was used.

218 X Q. When was this modification made?

A. I think about a week after this second apparatus was set up.

219 X Q. You spoke yesterday of lamps being tried on the air pumps and found to leak. To what experiments did you refer?

A. We exhausted these lamps on the air pump in connection with a vacuum g*ua*ge, shut off the air pump, and observed whether or not the vacuum g*ua*ge fell.

220 X Q. As I understand it these lamps were filled with gas and all ready to be burned, were they not?

A. They were.

221 X Q. And you tested them, and when you found them unsatisfactory, took them apart, did you not?

A. Yes, sir.

222 X Q. Turning to the seven lamps mentioned by you in your 4th answer, did you make any one of those seven lamps?

A. Not with my own hands. They were all made under my personal direction.

223 X Q. You mean by that, that you as superintendent gave directions to have lamps made and they were made?

A. Yes, sir.

224 X Q. Who made those lamps?

A. The various workmen under me. Some of the work was done by outside parties.

2205 225 X Q. You stated that radiators or conductors were sent from Pittsburgh to you. How many dozen were sent to you from Pittsburgh?

A. I think it was two dozen.

226 X Q. Wasn't it a great many more than that?

A. No, sir.

227 X Q. Would you swear that there were not five dozen sent?

A. No, I can't.

228 X Q. In other words you are not certain of the number?

A. I am not certain.

229 X Q. How many sets of parts for the lamps were sent to you from Newark?

A. I think it was 24.

230 X Q. You state in your 4th answer that lamp No. 1 with a bamboo carbon, burned for 240 hours at 22 candle power. Is that correct?

A. To the best of my knowledge and belief it is.

231 X Q. Where does your belief come in on this matter?

A. I believe that the workmen spoke truly when they so informed me.

232 X Q. Did you ever see that lamp burning yourself?

A. Yes, sir.

233 X Q. Did you ever test its candle power yourself?

A. No, sir.

234 X Q. Was its candle power ever tested or any electrical measurements taken before the lamp was first burned regularly?

A. Not until after it had been burned some time.

235 X Q. And as I understand you, you did not ascertain before that lamp was burned the electrical conditions as to voltage and current under which it was to be burned?

A. No, sir.

236 X Q. Did you do that with any single lamp at any time before regularly burning it?

2206 A. It may possibly have been done. I did not do it.

237 X Q. And you don't know and you never heard of anybody else doing it, do you?

A. No, sir.

238 X Q. In other words you put up the lamps at random without any knowledge of the electrical conditions under which they were to be burned to give a standard candle power?

A. They were not put at random. They were put in circuit, and sufficient current sent through them to bring the carbon to what we judged to be a proper degree of incandescence.

239 X Q. But this current you did not measure?

A. No, sir.

240 X Q. In making lamps for the market, do you not send out lamps with standard *guages* as to the strength of current required to bring them to incandescence for the use of your customers?

A. We do.

241 X Q. And each lamp is tested and marked as to its electrical conditions before it is sent out, is it not?

A. Not as to all its electrical conditions.

242 X Q. Do you not test them so as to find the electrical current or amount of pressure necessary to give the candle power which they are intended to be used at?

A. We run them up to the standard candle power, ascertain the voltage, and mark this and the candle power on the lamp.

243 X Q. You say your factory sometimes turned out 3,000 lamps a day. What are the different electrical pressures required by these lamps when working at normal incandescence? Between what limits will they run?

A. The manufactured lamps between the limits of about four volts up to 128 volts.

244 X Q. What would be the effect of sending out lamps to the public without making these tests, and indicating upon the lamps the conditions of use?

2207 A. Disastrous.

245 X Q. Simply ruin the business, would it not?

A. Not necessarily.

246 X Q. And these Sawyer-Man lamps were not so tested by you?

A. Not before being run.

247 X Q. How many tests of the candle power of these lamps did you personally make?

A. None.

248 X Q. How many did you see made?

A. None.

249 X Q. What date do you understand any tests were made?

A. As nearly as I can remember, about the 1st of April.

250 X Q. How long had you been informed that lamp No. 1 had then burned?

A. I do not remember.

251 X Q. How long after the test was this lamp burned?

A. I can't state positively, but believe about 100 hours.

252 X Q. Will you swear that lamp No. 1 burned one hour after the test?

A. Yes, sir.

253 X Q. Will you swear that it burned two hours after the test?

A. Yes, sir.

254 X Q. What day did lamp No. 1 fracture its carbon?

A. I will require to look at the lamp; it is marked on the lamp. The record is March 20th.

255 X Q. Do you mean that the lamp burned out March 20th?

A. Yes, sir.

256 X Q. What does the date March 5th mean which is marked above March 20th.

A. That is the date of its being started on the test.

2208 207 X Q. Then I understand you that the lamp broke down March 20th, and was tested April 5th, as you understand the record written on this lamp?

A. No, sir. It was first burned April 5th.

258 X Q. That is when it started to burn, and it burned out or broke down March 20th?

A. Yes, as I understand it.

259 X Q. Was April 5th the day the tests were made as to candle power?

A. I believe it was tested latter than that.

260 X Q. Will you swear that you ever made or that any one ever made any tests of the Sawyer-Man lamps as to their candle power, except on April 5th?

A. No, sir.

261 X Q. Wasn't that the day that the only test was made that was ever made of these lamps?

A. I don't know.

262 X Q. Which month comes first in the year: March or April?

A. March.

263 X Q. How do you explain then that the lamp, according to

your testimony just now, was first burned April 5th, and burned out, or had its carbon broken March 20th.

A. I should have stated the dates April 5th, and March 20th, in the reverse order from what I did.

264 X Q. From what memoranda did you get the statement of candle power which you made in your direct testimony?

A. Memoranda furnished me by the workmen and from the marking on the lamp.

265 X Q. What is the date of the memoranda furnished you by the workmen?

A. April 11th.

266 X Q. And what date was the test, was it not April 5th?

A. I do not know.

2209 267 X Q. And this memoranda which was given you was dated six days after the lamp broke, according to your testimony?

A. Yes, sir.

268 X Q. Now again I ask you whether you will swear as a matter of fact, that lamp No. 1, burned more than a single hour after the test was made of its candle power?

A. I will.

269 X Q. How do you know that it burned more than a single hour?

A. From the fact that I saw it burning after the marking was on the lamp and after the report had been made by me that the lamps were tested.

270 X Q. You stated you were not present at the tests, have you not?

A. I have.

271 X Q. Therefore of your own knowledge you know nothing of the candle power arrived at by the means of that test, or of the electrical conditions of that test, is that not so?

A. That is true.

272 X Q. And you don't know the time of that test?

A. No, sir.

273 X Q. Nor anything about it, except what somebody has told you?

A. That is all.

274 X Q. When were lamps Nos. 2 and 3 and Nos. 5 and 7 tested, as reported to you? Was it not at the same time as lamp No 1?

A. I believe it was.

275 X Q. How long does it take to make a test of the candle power of a lamp? I mean how long is the lamp subjected to the current for the purposes of the test?

A. Generally only long enough to read the instruments.

276 X Q. How long does that take; half a minute, or a minute, or how long?

2210 A. From a quarter of a minute to three minutes.

277 X Q. And these electrical measurements as to voltage and as to the number of amperes in the current and the candle power on such of these seven lamps as were tested were derived

from such a test, as far as you know, lasting possibly from a quarter of a minute to a minute.

A. They were derived from such a test; but the test in this case must have taken at least two minutes.

278 X Q. Were you there to see the test made?

A. No, sir.

279 X Q. Who did you understand carried out the test?

A. F. E. Cavenagh.

280 X Q. Who else, if anybody?

A. I believe Mr. Kammer was present when the test was made.

281 X Q. Was Mr. Cavenagh the man who burned the lamps regularly?

A. Yes, sir; Cavenagh and Kammer conjointly.

282 X Q. Wasn't Mr. Cavenagh the man employed in the test-room regularly?

A. Not regularly.

283 X Q. You stated in your 5th answer the efficiency of the Sawyer-Man lamp. Was not that efficiency calculated from this test, lasting not more than two minutes, of the lamps just referred to by you?

A. No, sir; I only estimated their efficiency.

284 X Q. When did you estimate their efficiency?

A. At various times, judging by the degree of incandescence of the carbon, and the amount of current flowing through them.

285 X Q. How did you measure the amount of current flowing through them? Did you ever do it?

A. I never measured it.

2211 286 X Q. Going back to lamp No. 1, you testified that in addition to yourself and Mr. Robertson, Messrs. Curtis and Kerr, the attorneys for the consolidated company, and Mr. Shallenberger, of the Pittsburgh factory, had been up to your factory either to see or to talk about the lamps. Am I right?

A. Yes, sir.

287 X Q. When did Mr. Shalleberger first call at the factory?

A. I don't remember.

288 X Q. Did you or your men have any lamps to show him?

A. We had the parts. Whether we had any completed lamps or not, I don't remember.

289 X Q. Did he ever see any of your lamps burning?

A. Yes, sir.

290 X Q. When?

A. I can't state the date.

291 X Q. How many did he see?

A. We had at least three burning.

292 X Q. Are those three any of the seven you have presented in your testimony?

A. No. 1 was certainly burning, and I think, two others that are presented.

293 X Q. What candle power were they burning at?

A. Certainly over 16 candle power. The exact candle power I do not know.

294 X Q. Will you swear they were over three or four candle power?

A. Yes, sir.

295 X Q. Don't you know that Mr. Shallenberger told you to increase the candle power because what he saw was no test?

A. He directed me to increase the candle power; but I do not remember his stating that reason.

296 X Q. What other reason did he give you, or do you understand was given.

A. I don't remember any.

2212 297 X Q. Wasn't the only reason because the candle power at which you had those lamps burning was not a fair test?

A. I do not know his reasons.

298 X Q. Don't you know the candle power was not a fair test?

A. No, sir, I do not.

299 X Q. What possible reason then had you for raising the candle power of the lamps?

A. The reason was that we might give them a more severe test.

300 X Q. And did you give them that more severe test?

A. For about one day.

301 X Q. And how many of the lamps broke down under that more severe test in that one day?

A. I believe one broke.

302 X Q. Will you swear there were not three broke?

A. Yes, sir.

303 X Q. Didn't one break through the cracking of the glass globe?

A. I did not know of it, if it did.

304 X Q. And you can't say whether it did or not?

A. No, sir.

305 X Q. And didn't another burn out within nine hours after the more severe test had begun to be applied to it?

A. I believe so.

306 X Q. And didn't a third lamp burn out within six or nine hours afterwards, under that more severe test?

A. I know nothing of the burning out of any except the one lamp.

307 X Q. And you don't know whether more burned out or not?

A. I know that one more may have burned out.

308 X Q. You recollect that now?

A. No, sir.

309 X Q. What is your recollection about that other lamp that may have burned out?

2213 A. I remember seeing four or five lamps burning during this test, and that next day after the test discontinued there were certainly not three of the lamps missing.

310 X Q. And you gave up this more severe test within a day after beginning it, did you not?

A. The lamps were not run after this quite as high as Mr. Shallenberger had left them.

311 X Q. And what was your reason for putting down the degree of incandescence again?

A. I considered it an unfair test, the lamps being at an abnormal brilliancy.

312 X Q. Didn't you find out that the lamps would not stand that test?

A. No, sir.

313 X Q. Weren't you told that the lamps would not stand that test, and didn't you order them to be put down again?

A. I was so told, and gave such orders.

314 X Q. Who told you so?

A. Mr. Kammer, and I think Mr. Robertson.

315 X Q. What did Mr. Kammer say to you and what did Mr. Robertson say to you?

A. Kammer simply told me the lamps gave a very brilliant light and probably would not stand it long. I don't remember what Mr. Robertson said.

316 X Q. Didn't you understand at the beginning of your experiments that your object was to be to get these lamps to burn as long as possible?

A. No, sir.

317 X Q. You didn't understand that?

A. No, sir.

318 X Q. Wasn't that your effort?

A. My effort was to make them burn as long as possible with a fair degree of economy.

319 X Q. And you never measured the amount of current that was consumed or employed?

A. Only during the test I mentioned before.

2214 320 X Q. And as to the circumstances of that you personally know nothing?

A. That is true.

321 X Q. In your seventh answer you state that you have tried the use of nitrogen in an ordinary bulb lamp. When did you try this?

A. I think I first tried it about the first of 1887, and later, during last March.

322 X Q. What experiments did you try in March?

A. Tried it on two separate sets of lamps, one of which lamps is offered in evidence.

323 X Q. How many lamps were in the first set?

A. I think three.

324 X Q. Were there not four?

A. I don't remember.

325 X Q. What percentage of nitrogen did you put in this first set of lamps?

A. Varying from, I should say, 60 per cent. to about 2 per cent.

326 X Q. Was that on the first set?

A. Yes, sir.

327 X Q. How long did those lamps burn?

A. My recollection of it is that one was broken in finishing, and the two others were burned out at about the end of 60 hours by too high an electro-motive force.

328 X Q. These were ordinary commercial lamps with the exception of the use of nitrogen gas, were they not?

A. Yes, sir.

329 X Q. That is to say, they did not differ in any respects from the ordinary incandescent lamps sold by your company to the public except for the presence of nitrogen instead of an air vacuum.

A. That was the case.

330 X Q. How many lamps did you fill with nitrogen in the second set?

A. Three.

331 X Q. Wasn't it four?

2215 A. No, sir.

332 X Q. How do you know it wasn't four?

A. Because it was done but a short time ago. I was personally present, marked every lamp and kept a record of it.

333 X Q. Where is your record?

A. I have it with me.

334 X Q. What was the percentage of nitrogen in those lamps?

A. In lamp No. 1 estimated it about $\frac{3}{16}$th inch pressure. In lamp No. 2, estimated $\frac{1}{2}$ inch pressure. In lamp No. 3, estimated 20 inches pressure.

335 X Q. What was the life of these lamps Nos. 1, 2 and 3 respectively?

A. Lamp No. 1 ran 126 hours, when it was taken down to be filed as evidence; it was then apparently perfect. Lamp No. 2, the bulb was broken in finishing. Lamp No. 3 burned out at the end of 80 hours' run.

336 X Q. So that the lamp that had least nitrogen burned longest?

A. Of the two tested in this case it did.

337 X Q. And those tested in the previous tests lasted about 60 hours, according to your recollection?

A. Yes, sir.

Adjourned to meet at 2 p. m.

Resumed at 2 p. m.

338 X Q. At the same time that you filled these three lamps with varying quantities of nitrogen, didn't you pump out a fourth lamp to the ordinary commercial air vacuum?

A. I did.

339 X Q. Did you have these four lamps tested as to their electrical condition?

A. I did.

340 X Q. Were they tested before they were burned regularly?

A. Yes, sir.

2216 341 X Q. Give the results of that test in the voltage and amperes for four lamps at the candle power at which you tested them?

A. I have not the record of that test.

342 X Q. Didn't you have a copy of that record?

A. I had a copy and mislaid it. I can from memory give the result of two of these tests. Lamp No. 0 commercial vacuum, 32 candles, 50½ volts, 2 amperes. Lamp No. 3, 20 inches nitrogen, 32 candles, 57 volts, and about 2.3 amperes. Lamp No. 1 about 52 volts, 32 candles, 1.15 amperes.

343 X Q. Whom were these tests made by. Were they not made by Mr. Cavenagh?

A. They were.

344 X Q. Are not the aggregate figures for those four lamps as follows: commercial vacuum lamp, volts 50.5, amperes 1.98. Lamp No. 1, volts 55, amperes 2.11. Lamp No. 2, volts 55.5; amperes 2.24. Lamp No. 3, volts 57.5; amperes 2.32? All tested March 30th at 32 candle power.

A. As I remember it, this is correct, with the exception of the commercial vacuum lamp, which certainly did not take less than 1.9 amperes. I misunderstood the question as read to me, and will omit the exception made.

345 X Q. Upon these figures what was the difference in the resistance of the lamps between the commercial lamp and lamp No. 3, with the nitrogen admitted at a pressure of about 20 inches as tested at your factory?

A. The resistance of these lamps, to my knowledge was not measured.

346 X Q. Being given the volts and the amperes can you not calculate the resistance?

A. I can.

347 X Q. Will you please do so for these two lamps?

A. The resistance of the commercial vacuum lamp I make 15½ ohms hot; lamp No. 3, 24.6 ohms.

348 X Q. Similarly will you please calculate the watts for the two lamps?

A. I make the watts, taken by these two lamps respectively, 99.9 and 133.4.

2217 349 X Q. And this 133.4 for the lamp filled with nitrogen was for a vacuum of about two-thirds, or more precisely $\frac{20}{32}$nds? Is that not so?

A. No, sir. It was for a vacuum of about one-third.

350 X Q. Have you made any test of lamps filled with nitrogen at the normal pressure?

A. No, sir.

351 X Q. What was the life of the commercial lamp No. 0 in the second series?

A. It has been burned for 126 hours, and is still apparently perfect.

352 X Q. Burned alongside No. 1 in the same circuit?

A. There was a small resistance introduced into the circuit of

No. 0, in order to get the same apparent candle power from the two lamps.

353 X Q. It was a 50-volt current was it not?

A. About a 54-volt current.

354 X Q. Did you measure the current?

A. I measured the current of that circuit frequently.

355 X Q. How did you measure it?

A. By means of a Cardew volt-meter.

356 X Q. Did you burn the other lamps of the same series on the same circuit continuously?

A. The other one of the series, No. 3, was burned on the same circuit.

357 X Q. And did you similarly introduce resistances for that lamp?

A. No, sir.

358 X Q. Why not?

A. Because it did not require it.

359 X Q. In other words you kept up the current at about the voltage required to keep that lamp at a standard 32-candle-power incandescence?

A. About that.

360 X Q. As I understand, you took pains then to subject these three lamps to a careful test, the lamps being preserved at normal incandescence of 32 candles?

2218 A. That was my intention.

361 X Q. And you tested the four lamps of this series before burning for this purpose, did you not?

A. Yes, sir.

362 X Q. And kept them under the requisite conditions as to standard incandescence until the end of the experiment?

A. As near the standard as we could.

363 X Q. You stated that Mr. Kammer worked on the nitrogen apparatus. When was he first employed by you on the nitrogen apparatus?

A. I think it was about the latter part of August.

364 X Q. Did he not enter the service of your company in August?

A. I don't remember; but my impression is that he came to us before that.

365 X Q. Who assisted you in putting up your first nitrogen apparatus?

A. Mr. Cavenagh and Schramm.

366 X Q. This was in August, 1888, was it not?

A. As I remember it, yes.

377 X Q. Didn't you ask Mr. Kammer in December, 1888, what he knew about nitrogen, and give him the Stillman patents, directing him to rig up a nitrogen apparatus?

A. As to the date, I don't remember. I did give Kammer these patents, and told him to go ahead on them using the apparatus which we then had.

388 X Q. And didn't he then fill some lamps; and weren't they burned and shown to you and Mr. Robertson?

A. That is the case.

389 X Q. And did they not last about 2, 3 or 4 hours?

A. My recollection of it is that some of them burned out in two or three hours; but that at least one was preserved for several days.

390 X Q. Don't you remember now that this was in December, 1888?

A. I am inclined to think you are right about that.

2219 391 X Q. And this one lamp that was preserved, was it not burned for about an hour and a half before Mr. Kammer was directed to stop burning it and preserve it?

A. I have no recollection of that.

392 X Q. You stated in your direct testimony that you made the lamps according to the directions in the patent in suit. Is there any substantial difference between the size of any of the globes you used and the size of the globe in figure 4 and figure 3 of the drawing?

A. To my eye there is very little difference in the size.

393 X Q. I see you have a *guage*, kindly measure and say what is the exact difference between the outside measurement of the globe shown in figures 3 and 4 of the patent in suit and the globes actually used by you in your experiments.

A. At the top of the globe they are practically the same size; the bottom of the globe I have measured is about $\frac{3}{16}$ larger than that shown in the patent.

394 X Q. Is there any difference in the number of corrugations in the radiators or conductors in the lamps as used by you, as compared with the radiator or conductor shown in figure 2 of the patent?

A. The number of corrugations in the radiators used by us varied somewhat; but they are approximately the same in number as those shown in the patent.

395 X Q. Of the four before you three have the same number of corrugations as the one shown in the patent; to wit, 21 corrugations?

A. As closely as I can count them they have.

396 X Q. Is there any material difference in the operation of the lamps whether the globes are a little larger or smaller than those shown in figures 3 and 4 of the patent in suit, or whether the corrugations are more or less than there shown?

A. I have noticed no such difference.

397 X Q. And in manufacturing these lamps you would not consider the size of the globe or the exact number of corrugations as material, would you?

2220 A. Provided the various parts were adapted to each other, no.

398 X Q. Where did the upper brass circular discs with their insulating strips of mica come from?

A. A few were made by us, most of them coming from the United States factory in Newark.

399 X Q. When did you first adopt the mica insulation?

A. We have used it from the start.

400 X Q. Why in making these lamps did you, or the workmen of your company, reverse the position of the radiators or conductors as compared with the position shown in the patent?

A. I never noticed the difference.

401 X Q. What is the effect of so reversing those radiators or conductors upon the distance between the standards or clamps between which the incandescent carbon is fastened, as compared with what the similar distance would be with globes of the same diameter were the radiators fastened as shown in the patent?

A. It would apparently bring the clamps closer together.

402 X Q. You mean that the method shown in the patent would do this, do you not?

A. I do.

403 X Q. What is then the resultant difference in the length of the incandescent carbon because of the method adopted by you in comparison with the method shown in the patent? Is it not to increase the length of the conductor or incandescent carbon?

A. It would increase the length slightly.

404 X Q. Is not the distance between the points of attachment of the carbons in your lamp in globes of the same size more than twice that shown in figures 3 and four of the patent?

A. I should say, not quite twice as much.

405 X Q. You mean judging by measur-ments through the glass, do you not?

2221 A. I do.

406 X Q. Assuming the semicircular carbon as shown in the patent, and the paper carbon lamp No. 2, produced by you in your direct testimony, is not the effect of the arrang-ment of the corrugated radiators to give an incandescent carbon of twice the length substantially of the carbon shown in the patent for a globe of the same size?

A. Taking the exact arrangement of the radiators as in the lamps I have produced, it is; but this is not necessarily due to a reversal of the position of the radiators.

407 X Q. It is due to the fact that the holders or clamps for the carbon are twice as far apart in the lamps you produced as in the lamps with the same sized globes shown in the patent. Is that not so?

A. It is.

408 X Q. Assuming carbons of the same cross-section, what is the variation in the resistance of the two carbons by reason of this increased distance between the clamps?

A. The resistance of the carbon used in our lamps would be considerably greater.

409 X Q. How much greater, assuming the carbons to be twice the length?

A. Assuming the carbon used in our lamps to be twice the length of the other, its resistance would be twice as great.

410 X Q. And the carbons in your lamps as presented by you in your direct testimony, are at least twice the length, are they not?

A. Some of them are at least twice the length; but some, I think are not quite twice the length.

411 X Q. Take the bamboo carbon lamp, No. 1, isn't that substantially three times the length?

A. Yes, sir.

412 X Q. And how does the cross-section of the bamboo filament in your lamp No. 1 compare with the cross-section of the carbon arch shown in figures 3 and 4, having the same size globe in the patent?

2222 A. The carbon in our lamp is considerably the smaller in cross-section.

413 X Q. Does not that give a carbon arch in your lamp a much higher resistance?

A. Certainly.

414 X Q. The resistance varies inversely as the square of the diameter, does it not, for the same material?

A. Provided the carbons have been similarly treated it does substantially.

415 X Q. Is not the bamboo filament in your bamboo lamp No. 1 at least four or five times less in cross-section than the carbon arch shown in figures 3 and 4 of the patent for globes of the same size?

A. No, sir. I think not.

416 X Q. Looking through the glass, what is your present approximation as to the difference?

A. I would estimate the carbon shown in the patent to be about two and one-half times the size of the carbon in lamp No. 1.

417 X Q. So that the bamboo filament in your lamp No. 1 would by reason of its length have three times the resistance and by reason of its diminished cross-section six and a quarter times the resistance or altogether 18 and ¾ times the resistance of an identical carbon if made of the size shown in figures 3 and 4 of the patent for a globe of the same size, assuming your measurements to be substantially accurate?

A. That is my calculation.

418 X Q. So that if you have made and used a lamp exactly as shown in the patent in suit for a globe of the same size as used by you, you would have had a resistance 18¾ times less than that actually arrived at in your lamp No. 1. Is that not so?

A. Apparently, yes, sir.

419 X Q. From your electrical experience that is so, is it not?

A. Substantially, yes.

2223 420 X Q. Turning to the figures given by you to this lamp in your 4th answer, namely, volts 23, amperes 12, does not that give very close on 2 ohms for the resistance of that lamp No. 1 under the conditions, whatever they may have been of the test?

A. Yes, sir.

421 X Q. And if the carbon had been made of the same material and of the size shown in figures 3 and 4 of the patent for a globe of the same size, the resistance would have been approximately one-ninth of an ohm, would it not?

A. Yes, sir.

422 X Q. What would be the difference between the heat developed at the clamps, between the filament used in your lamp and that shown in the patent in suit, other circumstances being equal?

A. The heat would be greater with the carbon of the size shown in the patent.

423 X Q. And if the resistance of the clamps was the same there would be 18¾ times as much heat developed at the clamps in the patent in suit as in the bamboo filament actually used by you?

A. I do not know.

424 X Q. What is the reason of your doubt?

A. Any statement as to what should occur in the case stated would be a mere guess on my part.

425 X Q. If you have two carbon clamps of the same resistance, and in one lamp the filament has 18¾ times the resistance of the filament in the other, what is the difference in the heat developed at the clamps by the same candle power?

A. I positively don't know.

426 X Q. Doesn't the heat at the clamps vary as the square of the current, the resistance of the clamps being assumed the same?

A. I don't know.

427 X Q. But your knowledge tells you that the heating
2224 at the clamps would be much greater with a bamboo carbon
of the size shown in the patent in suit figures 3 and 4, than
is the case with your bamboo filament No. 1, contained in a globe
of the same size?

A. Yes, sir.

428 X Q. And lamp No. 1 failed because the carbon burned out at the clamps, did it not?

A. The failure of the lamp was caused by imperfect contact between the carbon and the clamp.

429 X Q. And that developed extra heat at the clamp, did it not?

A. Yes, sir.

430 X Q. And this extra heat caused, as you imagine by imperfect contact burned out the carbon at the clamp, did it not?

A. Yes, sir.

431 X Q. And if a similar defect of imperfect contact had existed with a carbon of the size shown in figures 3 and 4 of the patent in suit there would have been a much greater tendency for that carbon to have burned out at the clamps, than existed with your lamp No. 1? Is that not so?

A. I think not.

432 X Q. Why not?

A. Because I think that with a carbon of the size shown in the patent, the heating of it up by the passage of the current would swell the size of the carbon and improve the contact, also in this carbon it has a much larger surface of contact with the clamp.

433 X Q. Isn't that all humbug?

A. It is not humbug, I have seen instances of this.

434 X Q. Does not your answer imply much greater current?

A. I don't understand the question.

435 X Q. Which is the easier to make: a half-ampere lamp, or a 20-ampere lamp of the same candle power?

A. I think there is no more difficulty in making one than in making the other.

436 X Q. In which lamp is there the greatest tendency to heating at the clamps?

2225 A. In the 20-ampere lamp.

437 X Q. Isn't the tendency to heating at the clamps, the resistance of the clamps being the same, or in other words, the clamps being identical, 1,600 times as much in a 20-ampere lamp as in a half-ampere lamp?

A. I don't know.

438 X Q. In other words you don't know the law or rule governing the production of heat of a given current through a given resistance? Is that so?

A. That is true.

439 X Q. And you don't know that it varies with the square of the current?

A. I did not know it.

440 X Q. How did you calculate the watts in your 5th answer on direct in giving the voltage and amperes of current?

A. By taking the product of the volts and amperes.

441 X Q. Going back to the lamps that Mr. Kammer made in 1888 for you, you saw them burning, did you not?

A. I saw the Sawyer-Man lamps made in 1888 burning.

442 X Q. I mean the lamps that burned 2, 3 or 4 hours. You saw those?

A. Yes, sir.

443 X Q. Mr. Kammer told you how long they were burning?

A. I believe so.

444 X Q. Didn't you tell him the Sawyer Company ought to give you and him a thousand dollars for making those lamps burn as long as that?

A. I think not. I have no recollection of saying it.

445 X Q. Please look at the paper-carbon lamp No. 6 referred to by you in your direct testimony, and at the paper-carbon arch. What does the condition of that carbon in that lamp indicate to you as to the uniformity of incandescence throughout that carbon when burning?

2226 A. It was probably of greater incandescence at its outside circumference.

446 X Q. Is it not just the opposite?

A. I think its condition would indicate what I have stated.

447 X Q. What in its condition indicates to you that the current chose the longer instead of the shorter path in that paper carbon?

A. The carbon appears to be in better condition on the inner circumference.

448 X Q. You mean by that there are more signs of treatment, of artificial treatment, of carbon on the inside diameter than on the outside, do you not?

A. I meant that there were more signs of disintegration on the outside?

449 X Q. Where do you find most signs of deposited carbon, on the inside or outside diameter?

A. On the inside diameter.

450 X Q. Could not that be accounted for by the fact that there was a greater incandescence during the period of deposition on the inside diameter than on the outside?

A. Yes, sir.

451 X Q. And if the paper were originally uniform in resistance, you would expect the current to produce greater incandescence on the inside than on the outside diameter.

A. I would expect the current to produce greater incandescence on the inside circumference.

451 X Q. And this increased incandescence on the inner circumference would cause greater deposition of artificial carbon during treatment on the inner than on the outer circumference, would it not?

A. Yes, sir.

452 X Q. And the increased deposition of carbon on the inner circumference would lower the resistance of the inner circumference as compared with the outer circumference, would it not?

A. Yes, sir.

2227 453 X Q. And this reduction in resistance would again tend in actual burning of the lamp to cause increased incandescence on the inner circumference as compared with the outer, would it not?

A. Yes, sir.

454 X Q. And the difference between the lengths of the paths for the current would be proportionately greater in an arc of small circumference as shown in figures 3 and 4 of the patent in suit as compared with the arc or arch employed by you in your lamps. Is that not so?

A. Yes.

Adjourned to meet April 20th, at 10 a. m.

NEW YORK, *April 20th*, 1889.

Met pursuant to adjournment.

Present: Thomas B. Kerr, Esq., of counsel for complainant, and Walter K. Griffin, Esq., of counsel for defendant.

455 X Q. How long did it take to fill the lamps with nitrogen?

A. The entire process of washing and filling the lamps with nitrogen, occupied, I believe, about six hours.

456 X Q. And during this six hours nitrogen was allowed to flow through the lamps while the carbon was kept more or less incandescent and before you ventured to seal up the lamps. Is that not so?

A. Yes, sir.

457 X Q. Did you ever try any lamps without letting the nitrogen pass through for five, six or seven hours?

A. I do not know of any such being tried.

458 X Q. And this process of passing through nitrogen six hours was to insure the cleansing of the interior of the lamp from atmospheric air, was it not?

A. For that and also for the purpose of purifying the nitrogen.

2228 459 X Q. The lamps were so burned on the gas bags containing the supply of nitrogen, were they not?

A. Yes, sir.

460 X Q. Can you swear that after beginning your experiments in February or March, that you have not had at least as many as 80 lamps finished and burned apart from the lamps tested on the air pumps?

A. I cannot swear as to the number; but am quite positive that no such number was ever made by us.

461 X Q. I don't mean separate lamps; but lamps refilled and retested?

A. I so understood the question.

462 X Q. How many lamps were reported to you to have been tested in the tests made early in April as to the candle power? Was it not five lamps?

A. I believe that was the number.

463 X Q. Do you of your own personal knowledge know of any of the conditions under which any of the lamps were burned, except during such time as you happened to be present in the room where they were burned?

A. Of my own personal knowledge, no.

Redirect examination by Mr. KERR:

464 R. D. Q. Please state whether Kammer is still working for you, and if not, state the circumstances of his leaving you, when it occurred, and the causes, so far as you know.

A. Kammer is not working for us now. I believe it was the 13th of April that he left. I had told him on the afternoon of the day before, that Dr. Stillman would be up the next morning for the purpose of examining our nitrogen apparatus, and of using it in filling some of the Sawyer-Man lamps, and directed Kammer to have the apparatus in complete working order. He was apparently greatly displeased at this information, leaving me instantly without saying a word. The next morning I told him that I would send Cavenagh up to examine the lamps he then had burning and inspect their condition. He was again greatly displeased at this, muttering to himself complaints which I did not understand, and again went off apparently about some work. Cavenagh came to me shortly after saying that Kammer was wild about something and that I had better go and see him. Cavenagh also stated that he had been into the laboratory, in accordance with my instructions; that Kammer had ordered him out; that he remonstrated with Kammer, saying that Mr. Packard had instructed him to go there. Kammer muttered with several oaths 2229 that he would not be interfered with, and immediately commenced to pack up his belongings. As soon as I heard this I went back to the laboratory and found Mr. Robertson and Kammer there, Mr. Robertson was apparently questioning Kammer as to his reasons for leaving in this manner. All that I could catch of Kammer's answers were his mutterings about not being interfered with. He was greatly excited, his face was flushed, he could hardly utter an articulate word, his voice trembling with anger. He immediately left, taking with him a couple of bundles. I found immediately after he had gone that part of the nitrogen apparatus, the sodium bottle, which I had seen working perfectly the evening before, was broken and could not be used. This same bottle had been in use for about a week, working perfectly all the time, and should not have required any further adjustment or arrangement for the experiment we had then in view, and if not interfered with I do not believe it could have been broken.

465 R. D. Q. Please state whether Dr. Stillman came, and whether he was able to use the nitrogen apparatus.

A. Dr. Stillman came at about 11 o'clock that morning, but was unable to use the apparatus in its dismantled condition.

466 R. D. Q. Please state how closely you watched the construction, filling and testing of the Sawyer-Man lamps which you testified to in your present examination.

A. I watched all these operations as closely as my regular duties would allow, observing each operation minutely, 2230 being in and out of the laboratory several times a day, and constantly receiving reports from there from all of the workmen there employed, and from Mr. Robertson.

467 R. D. Q. Was there any difference in the way you conducted these tests from that in which your ordinary tests as to your regular commercial manufacture of lamps is carried on?

A. It was done in precisely the same manner, I being unable by press of work to personally do the work on these lamps, or attend to their testing.

468 R. D. Q. Was there any difference in the way in which you conducted these tests and this manufacture from the way in which you conduct the manufacture of ordinary commercial lamps, and the tests and measurements upon which you settle the questions of cost, selling price, labor, and other things which enter into the estimates upon which your commercial business is conducted?

A. My relation to these tests in this manufacture was precisely the same as my relation to the ordinary commercial manufacture, as stated in the question. This work was regarded as experimental, the lamps not being intended for commercial use, and the tests were accordingly not conducted in the regular manner, that is, the regular series of tests which our commercial lamps go through.

469 R. D. Q. In your ordinary commercial tests upon which you base your estimates, do you conduct them personally or do you assign the various things to be tested to others, and receive their reports of the same, adopting them as your own?

A. In our commercial work, I, of necessity, leave all this testing to be done by others, and, of course, adopt their reports as my own, as often as possible checking the tests personally when I have any reason to think that they are not properly made.

2231 470 R. D. Q. Did you do any differently from that in connection with the construction, filling and testing of the lamps to which you have testified?

A. I acted in precisely the same manner, assuring myself that the instruments and apparatus were in proper order.

471 R. D. Q. Have you any reason to doubt that the reports which you received and to which you have testified, were exactly correct?

A. I have no reason to doubt.

472 R. D. Q. From your daily inspection of the tests of these lamps do you, or not, believe that those reports were exactly true?

A. I believe they were perfectly true.

473 R. D. Q. State whether or not you believe the construction, filling and tests of the lamps to which you have testified were full, fair and trustworthy.

A. I do so believe.

474 R. D. Q. Was it your custom to have such conversations with Kammer as that one which you were asked about relating to a thousand dollars?

A. It was not my custom.

Recross-examination by Mr. GRIFFIN:

475 R. X Q. Were not these lamps burned in a separate room and not in the general laboratory?

A. They were.

476 R. X Q. Who was employed in that room?

A. Kammer, Cavenagh, Schramm, and various workmen as we occasionally had work for them. I do not mean to say that all the parties mentioned were employed there regularly.

477 R. X Q. While these experiments were going on was not Mr. Kammer employed there regularly?

A. No, sir; what machine work he had to do was not done in this room.

478 R. X Q. Wasn't that his regular room or laboratory?

2232 A. For the purpose of this lamp work only.

479 R. X Q. What did you pay Mr. Kammer a week?

A. $23 a week was his salary.

480 R. X Q. And with overtime or extras did not his pay run from $30 to $36 a week, during the period of these experiments?

A. No, sir, it was only during the last two or three weeks, possibly four weeks, that he received overtime.

481 R. X Q. How many hours since the beginning of these experiments has he devoted to other work than these experiments?

A. I believe on an average about two or three hours a day.

482 R. X Q. And this work was done in the room where the lamps were burned, was it not?

A. Yes, sir.

483 R. X Q. Outside of the written memoranda of the test of the five lamps early in April, was any memorandum of these tests given ou?

A. No, sir.

484 R. X Q. Was it reported to you that when lamp No. 1 was raised to the degree of incandescence at which it was usually burned and Mr. Cavenagh made the tests upon the photometer, that the result was four candles?

(The question is objected to as a mere rehash of the cross-examination, and is immaterial, and attention is called to the course of the defendant's counsel in asking numerous unnecessary questions in the cross-examination of this witness, and unnecessarily prolonging the cross-examination through several days as an evidence of deliberate intent on the part of the defendant's counsel to prevent the complainant from closing its testimony within the time assigned by the court.)

A. I have no recollection of having this fact mentioned
2233 to me, nor do I believe it was mentioned to me.

485 R. X Q. Was it reported to you how many attempts were made to flash up lamp No. 1, before the 22-candle test was made?

A. I have no recollection of such a report, and do not believe that it was reported.

(Signed) JAMES W. PACKARD.

Testimony of Walter K. Griffin.

Counsel for complainant states that he would like to ask Mr. Griffin, counsel for defendant present, who has been sworn a witness in this case, some questions in behalf of complainant.

1 Q. Will you please state whether or not you cross-examined the witness Packard in part or in whole on information supplied you either directly or indirectly by the workman Kammer?

A. In part I did, using such information as a guide to me in the course of my questions.

Direct examination closed.

The witness, WALTER K. GRIFFIN, states as follows:

I never saw or heard of Mr. Kammer until the Saturday before the examination of Mr. Packard. Mr. Kammer then came to the office where I was, and was after a short conversation taken by me to the office of Mr. Lowrey, counsel for defendant, and in the presence of each of us for the first time made a statement as to certain experiments at the factory of the Sawyer-Man company. Prior to this neither Mr. Lowrey, myself, nor so far as I know, any one connected with defendant or the Edison Electric Light Co. had any knowledge of or connection with Mr. Kammer, and the statement by him then made was the first information as to the alleged experiments received by us. This was after Mr. Kammer had left the Sawyer-Man company. * * *

WALTER K. GRIFFIN.

2234 NEW YORK, *April* 22, 1889.

Testimony of Franklin L. Pope, a Witness on the Part of Complainant, Taken Before Caroline E. Davidson, Special Examiner.

Present: Thomas B. Kerr, Esq., of counsel for complainant, and Walter K. Griffin, Esq., of counsel for defendant.

FRANKLIN L. POPE, being duly sworn, deposes as follows in answer to questions by counsel for complainant:

192 Q. Are you the same Franklin L. Pope who testified on behalf of the complainant in this case on May 8th, 1888?

A. I am.

193 Q. I call your attention to the testimony of Thomas A. Edison, on behalf of the defendant, and particularly to question and answer 485; what is your understanding of Mr. Edison's historical position with regard to electric lighting?

A. While I agree in many respects with the statement of Mr. Edison as to the condition of the art of electric lighting when he commenced his experiments, which as I am informed and believe was in the month of September, 1878, yet I judge from his testimony that he could not have been fully informed in respect to the work which had been done by others; and hence I find myself obliged in some particulars, to differ with him in my opinion as to the precise relation of his own work, not only to that of other workers in the same field, but to the general problem of commercial incandescent lighting. It is quite true that at the date of the commencement of Mr. Edison's experiments the problem of commercial incandescent lighting had not been solved, although much had been done in the direction of its solution. Other investigators had been industriously at work upon the problem for some time before Mr. Edison turned his attention to it, especially William Edward Sawyer and Albon Man in this country, and St. George Lane Fox in England.

2235 I do not altogether agree with Mr. Edison in his definition of the problem of incandescent lighting as it awaited solution in 1878. It was not, as I conceive, limited merely to the problem of superceding gas as a house-to-house illuminant to be distributed from a central station, although this was a very important, and strictly speaking, perhaps the most important, field of application for incandescent lighting. My own view of the matter is that there were at least three distinct and well-defined applications possible to the incandescent electric light, in either one of which it might have been applied, as it has been, with great commercial advantage, even if its application had failed to be successful in the others. These three applications are:

1st. General, domestic or house-to-house lighting, now generally termed "central-station lighting."

2nd. The lighting of detached buildings or groups of buildings, such as manufactories, hotels, apartment houses, railway stations and ships, usually known as "isolated lighting."

3d. The lighting of streets and squares, railway stations and yards, and the like, usually termed "municipal lighting."

Each of these three adaptations presents certain special features different from the others. In central-station lighting, the two most important points are, that the lamps shall be individually controllable, at the pleasure of the consumer, that is to say, that any lamp in the system may be extinguished or relighted without affecting any of the others; and that the amount of copper required for the conductors shall be reduced to a minimum, for the reason that the average distance to which the electric current has to be transmitted from the generator to the consumers is necessarily very considerable. In isolated lighting the independent control of the lamps is in most instances quite as important as in central station lighting, but the question of the economy of the copper in the conductors is relatively of very much less importance, as the distance to be traversed, lying within the boundaries of a single
2236 building, is comparatively small. In municipal lighting, the
independent control of the lamps is a matter of little importance, as the service permits that large numbers of lamps or groups of lamps may be lighted and extinguished simultaneously. It is scarcely necessary to add that a constant and uniform electric pressure, producing an equally constant and uniform current in all the lamps is necessary in either system.

I have thus carefully defined what I conceive to be the principal application of incandescent lighting, in the endeavor to clear up the confusion which appears to exist in reference to the application of lamps of the same type, having different structural details, in order to adapt them to different classes of service.

In my opinion, it will not be far out of the way to fix upon the year 1877 as the date when the attention of inventors and experimenters was first strongly directed towards the production of a system of supplying incandescent electric lighting for domestic purposes by means of the dynamo-electric generator.

At this date the dynamo-electric machine as a source of almost unlimited electric energy had already been brought to a good degree of perfection. It had become a standard article of manufacture and sale, both in Europe and in the United States. Mr. C. W. Siemens of the firm of Siemens Brothers, London and Berlin, testified before a select committee of the British House of Commons on April 29, 1878, that his firm had sold, during the year- 1877 and 1879, 475 dynamo-electric machines for which they had received £57,000, nearly all of which had been used for electric lighting. In reference to the performance of these machines he said: "So complete is the transformation of mechanical into electrical energy that the most recent careful experiments which have been made by Mr. Louis Schwendler for the Indian Government, and by Dr. Hopkinson, show that the loss in effecting this transfer does not exceed

12 per cent." Machines of the same character were being
2237 sold in 1877, in this country by Wallace, Weston, Hochhausen and Brush, some of which were probably quite as efficient as the Siemens machine just referred to. I think, therefore, that it may fairly be considered, that by the end of 1877 the problem of the economic production of electricity in any required quantity by steam or water power was practically solved. The remaining portion of the problem, at least so far at it relates to the present subject, incandescent electric lighting, was three-fold, namely, first, distribution, second, utilization, third measurement.

These three matters are so related to each other that it is necessary to consider them to a certain extent, as Mr. Edison has done in his answer to question 485, with reference to their mutual relations. I quite agree with Mr. Edison in his opinion that—

"It was not only necessary that the lamps should give light and the dynamos generate current, but the lamps must be adapted to the current, of the current of the dynamos, and the dynamos must be constructed to give the character of current required by the lamps, and likewise all parts of the system must be constructed with reference to all other parts, since, in one sense, all the parts form one machine, the connections between the parts being electrical instead of mechanical. Like any other machine the failure of one part to co-operate properly with the other part disorganizes the whole and renders it inoperative for the purpose intended."

Nevertheless I am of the opinion that the invention set forth in the patent in suit, relates solely to the portion of the problem which has to do with the utilization of the current and has no connection, as an invention, with the question of distribution, or the question of measurement. It is an improvement in the construction of an incandescent lamp and stands by itself. It might have equally well happened, as in fact it did happen, that methods of distribution and methods of measurement of the electric current had been in-
2238 vented before, or on the other hand, that the lamp had been invented first and methods of distribution and measurement afterward invented and applied to it.

I will first consider some of the statements of Mr. Edison, with which I am unable to agree. He says:

"The subdivision of the electric light into small units comparable with that of the ordinary gas jet, was what I thought was required. The general scientific opinion was that this could not be done. Even after it had been announced in the public press in 1879, that it had been accomplished by me the statement was discredited and was pronounced by many eminent scientific men, both in this country and abroad to be an impossibility. A committee was appointed by the English Parliament to examine into the general subject, and they called before them as witnesses nearly all of the prominent scientific men in England, all of whom, with the single exception of Mr. Tyndall, testified that, in their opinion, the subdivision of the electric light was an impossibility. Mr. Tyndall said he would hardly go as far as to say it was impossible, but he would not like to undertake the solution of the problem."

I think Mr. Edison is in error in respect to the tendency of general scientific opinion; there is in all scientific countries a contingent of what may be called semi-scientific persons, who make up in pretension what they lack in accurate information and knowledge. Such persons are always very prominent in the newspapers and in the so-called scientific journals of the more popular class, and create an amount of noise out of all proportion to their real importance; and it seems to me as if Mr. Edison had in the present instance mistaken the opinions of such persons for those of the scientific world. I have here the report of the select committee of the British Parliament on electric lighting, referred to by Mr. Edison, from which I will read the extracts which 2239 will serve to show what were the opinions actually held by the most eminent scientific men at this time. The testimony from which I shall quote, was given between April 17, and May 23, 1879. The only witnesses examined who may fairly be called scientific men skilled in electricity, were Conrad W. Cooke, civil engineer, William H. Preece, electrician to the British post office; Charles W. Siemens, of Siemens Bros., electrical engineers; Prof. John Tyndall, successor of Faraday in the Royal institution; Dr. John Hopkinson, civil and electrical engineer, and Sir William Thomson of the University of Glasgow. There were other witnesses of equal standing, who made no pretensions to any specific knowledge of electrical matters, and to whom I need not refer. Newspaper accounts of Mr. Edison's work had already reached England, and most of the witnesses were put upon inquiry as to their opinion of the claims made in his behalf. Mr. Cooke's testimony was as follows:

"388 Q. Have you given attention to the question of obtaining light by means of incandescence, necessitating a closed circuit?—I cannot speak with any practical experience of that. My view of it is that you would have a far greater loss; it could not be done so economically, but it would probably be applicable in cases where economy was not so much an object, and where there was some special reason for dividing it.

"425 Q. Dr. Siemens, in referring to Mr. Edison, who is credited with having recently invented a machine for subdividing the light, expressed some doubt on the subject, and stated that he thought that it was not as promising as the reports indicated; do you know anything about that?—We really know very little about it. A few newspaper paragraphs have appeared on the subject, and I have been very much interested, as everybody has. His nephew told me, himself, that he has seen, I think, over 200 lights on one circuit. I must say I should like to see it myself, and that is all that I can say."

2240 The views of Mr. Preece will appear from the following extracts:

"515 Q. Then, according to your view, the electric light is really very economical when it is used for giving central lights, but not when it is used in a subdivided form?—It is only economical when one machine is used to produce a single light.

"516 Q. And any departure from that means waste, economically speaking?—Certainly."

Mr. Siemens testified as follows:

"258 Q. Then, as to its application to dwellings, it would, I suppose, be a work requiring some further experiment and a work of some difficulty, before you could hazard an opinion as to its being used in dwellings generally instead of gas? For instance, the expense of keeping the carbons and all the machinery in order would almost prohibit its being used generally in dwellings, would it not?—There would not be much machinery if central pumping or power stations were adopted. The consumer would only have his electric candle or his electric lamp to keep in order, and that would not involve any very serious difficulty. But if you subdivided the electric light, I think it perhaps would become an expensive light.

"259 Q. Has your attention been called to some of the more recent experiments of Mr. Edison, and to the success which he is stated to have achieved in subdividing the light, and making it applicable for rooms and dwellings, and so on, with great ease and cheapness?—I have, and I think Mr. Edison can, no doubt produce by his means a very steady and possibly an agreeable light.

"260 Q. And a cheap light, he claims, I believe?—Dynamically speaking, I think he has to prove his case as yet. Our experience, as far as I can judge from my own, leads me to an opposite conclusion.

2241 "261 Q. That is, to a conclusion opposite to that which is said to have been the result of Mr. Edison's recent experiments?—Yes. The dynamo machine which Mr. Edison proposes, I think is not promising."

It should be stated that the dynamo machine here referred to is the earliest form proposed by Mr. Edison known as the "tuning-fork dynamo" and not the one which he subsequently adopted for practical use.

The remark attributed to Professor Tyndall by Mr. Edison was not a part of his testimony before the committee, but is in substance what he is reported as having said a few weeks earlier, in the course of a public lecture on the subject of electric lighting. His testimony, as printed, on this point is as follows:

"78 Q. Have you, from a scientific point of view, paid attention to the experiments reported to us as having been made in America by Mr. Edison?—I have paid a good deal of attention to that subject. Mr. Edison is an uncommonly clever man, and although one sees very serious difficulties in his way, one would be hardly entitled to say that he will not overcome those difficulties; but I do not know that he has up to the present time overcome them."

In his answer to question 93, as to the practicability of using platinum or iridium for electric lighting, he said:

"I am afraid, as regards public illumination, incandescency will not do; the expenditure would be too great."

Further on he *he* made some additional statements in reference to incandescent lighting which I will quote:

"105 Q. You showed us the ignition of platinum wire by the pas-

sage of the electric current; have not experiments been made to use the ignition of such a wire and inferior conductors, or of alloys with
iridium, and so on, with a view of using that as the source of
2242 the electric light instead of the carbon points?—I do not
know that that has been proposed with regard to public illumination, but I remember with the greatest distinctness, more than 30 years ago, seeing a lamp formed upon that principle and exhibited in Manchester. The incandescence of platinum wire by the electric current was known before Davy made his experiments in 1810. Children raised platinum to incandescence by his battery; and at the time to which I refer, I saw a very pretty lamp on a table in Manchester ignited by a voltaic current; but I do not know that that has been produced for public illumination; I believe that the waste of electricity would be inordinate with a continuous conductor."

The following questions and answers will be sufficient to show the opinion of Dr. Hopkinson on the subject:

"622 Q. What is the reason that a large electric arc produced, say, as a central light by a single machine, gives you a considerably greater illuminating power than when it is divided into small electric arcs?—It is no doubt due to the higher temperature to which the substance of the carbon is raised.

"632 Q. From your scientific investigations of the subject, do you agree with some other witnesses who have stated that the electric current when divided into various electric lights will decrease according to the squares or the cubes?—I think not, certainly. I think those deductions are based upon assumptions which any one would not have the least difficulty in setting aside.

"623 Q. With regard to the electric light, the machinery now known for producing the energy is very much more advanced than the means of displaying that energy by carbons or lamps?—Undoubtedly that is so.

2243 "650 Q. As I understand it, the real expense of the iridium
light consists in this, that the iridium being a continuous conductor, there is great waste of power in the consequent flow of electricity from which you are getting no light?—The real loss in these incandescent lamps lies in this, that the temperature cannot be driven to so high a point as when the electric arc is used; but not even iridium, which has, perhaps, the highest fusing point of any metal, will stand the temperature of the electric arc without melting or being volatilized."

I close these extracts by making the following quotations from the evidence of Sir William Thomson:

"1753 Q. If then, the electric light is such an economical producer of the waves that we call luminous rays, do you consider that the electric light has a great future before it or not?—A great future. In the immediate future, I anticipate a great extension of the practical usefulness of the electric light. In a future somewhat less near, I anticipate the use of the electric light for every case of fixed lights, whether in large rooms or in small rooms, or in great public halls or in passages and staircases leading to them, and even in fixed lights in the lobbies and staircases of private houses.

"1754 Q. Then you think that the use of the electric light is not the dream of a savant, but a practical possibility in the future?—Certainly. The electric light has been in dreamland for 60 years, and it has now come into the world of realities.

"1755 Q. And it is now rapidly progressing?—It is now rapidly progressing, and in good hands. A great deal of good work is spent upon it at this time, and there is immense promise in the work that is now being carried on by practical men upon the electric light.

2244 "1756 Q. Your reason for supposing so is, that there is now a prodigiously greater economy in the transformation of mechanical force or energy into light than there formerly was?—That is my reason.

"1779 Q. Would you allow me to ask you about the division of the electric light into various small lights; scientifically, do you agree with calculations, the result of which have been put before us, that the effect of a division must be, in some cases, to decrease the light so divided, according to the squares, or according to the cubes of the distance?—We have no scientific law of the economy of the electric light in different degrees of division and concentration; but practice and theoretical guesses seem to agree in making the economy much less when we spend the same quantity of energy, for example, in ten feebler lights than when we spend it in one strong light; when we do this we do not get nearly one-tenth part of the whole light by any of the plans hitherto in use.

"1780 Q. But there is nothing in the mathematical discussion of the question that should render that reduction necessarily by the squares or cubes?—No; it is quite possible that a plan of using electric energy for light might be found and may yet be found in which ten feebler lights will give a sum of light equal to that obtainable by the same energy in one concentrated light.

"1848 Q. Supposing that we had a lamp in a dining-room, and that after dinner I did not want the lamp any more, how should I put it out?—If there are other lamps in series, you would do it by short-circuiting it. It may be short-circuited through a resistance, but then there will be a waste of light.

"1849 Q. Then there is the same cost for that lamp, as 2245 when it was burning, with the exception of the carbon?—Yes, but with proper regulators by inventions not yet made, the machine will have a governor according to which, when you short-circuit without resistance any one of the lights, the machine will not give more current than you want for the other light or lights, whether in the same circuit or in parallel circuits."

It will appear from the extracts which I have quoted, that the leading scientific men who testified before the parliamentary committee were very far from expressing the opinion that the "subdivision of the electric light was an impossibility." The testimony of Dr. Hopkinson, especially, who was really the best authority of any of the witnesses, was emphatically in favor of the possibility of doing it, and that of Sir William Thomson scarcely less so. Many of them expressed doubts as to the economy of the light when produced by an incandescent burner of platinum or iridium, which was the kind with which Mr. Edison had experimented up to that time, and the result showed that they were entirely right, for before the close of the same year, 1879, Mr. Edison himself was obliged to abandon the attempt to produce a commercial system of lighting by the incandescence of metals on account of its great cost.

A review of the testimony above quoted, shows clearly that in 1879 it was fully recognized that the future commercial success of incandescent lighting depended upon the utilization of some other substance than platinum or iridium for the incandescent lamp. In my opinion, the statement cannot be successfully controverted, that the solution of this problem was ultimately reached by the invention of a lamp having a burner made of organic carbon of an arch or horseshoe form, and placed in a transparent chamber free from carbon-consuming gas. No successful incandescent lamp has ever yet been made which did not involve this construction, and on the other hand this construction is found in every successful lamp which is in use to-day. The adaptation of this typical lamp to 2246 different circumstances and different conditions, such for instance, as making the carbon thin and of high resistance, when it is designed to be used in parallel with the generator, or thick and of low resistance when it is intended to be used in series with the generator, may, in my judgment be considered more properly as matters of electrical engineering, than of invention in the strict sense of the term. The lamp, in its essentials, had first to be invented, but when this had been done, the adaptation of it to *to* different conditions by the exercise of engineering skill or by the making of subsidiary inventions, followed as a matter of course, hand in hand with the gradual progress of the art.

Mr. Edison, in his testimony, considers the problem as if it related solely to the distribution of electricity over large areas in competition with gas as an illuminant, but as I have before said, I regard that as only one portion of the general problem. In support of this opinion I quote from the affidavit of Edward H. Johnson, president of the Edison Electric Light Company, made June 29th, 1888, in the motion papers for a preliminary injunction on behalf of that company against the Consolidated Electric Light Company, in the U. S. circuit court for the southern district of New York. Mr. Johnson says:

"I am president of the Edison Electric Light Company, complainant herein * * * I have been connected with the various Edison companies for some years past, and am entirely familiar with the business carried on by such companies * * * There are in the United States at the present time about 130 of such central stations representing in the aggregate about 400,000 lamps * * * There have been sold in the United States about 1,000 of such isolated plants and their aggregate lamp capacity at the present time is about 300,000."

2247 It appears from these figures that the extent of the isolated electric lighting of Mr. Edison's own company is three-fourths that of the central-station lighting, instead of being, as might be inferred from the statements of some of the witnesses, a comparatively unimportant portion of the business. Mr. Edison says:

"The problem that I undertook to solve was, stated generally, the production of the multifarious apparatus, methods and devices, each adapted for use with every other, and all forming a comprehensive system whereby electricity, properly controlled and directed, could be distributed over large areas through the streets of a city, and supplied to houses in which it would feed incandescent electric lamps of moderate candle power, which would be entirely under the control of the householder, the whole to be on the same scale as the present system of gas distribution, and affording the same character of convenience to the users."

On the 28th of January, 1880, Mr. Edison executed an application for a patent for a system of electrical distribution, which was filed in the Patent Office, on February 5th, 1880, but was not finally issued until August 30, 1887, as No. 369,280. This specification may, I think, be fairly assumed to represent the state of the art of electrical distribution at that date, as it had been developed by Mr. Edison. In order to facilitate a comparison between this specification and the specifications of others who had been at work upon the same problem, so as to show at a glance the relation of Mr. Edison's work to the general state of the art, I will make extracts from this specification placing them side by side with extracts from the patents and publications of others of prior date.

2248 *Extracts from Specification of Edison's Patent No. 369,280. August 30, 1887.*

Filed Feb. 5, 1880.

The object of this invention is to arrange a system for the generation, supply, and consumption, for either light or power, or both, of electricity, that all the operations connected therewith requiring special care, attention, or knowledge of the art, shall be performed for many consumers at central stations, leaving the consumers only the work of turning off or on the supply, as may be desired—in other words, to so contrive means and methods that electricity may be supplied for consumption in a manner analagous to the systems for the supply of gas and water, without requiring any greater care or technical knowledge on the part of the consumer than does the use of gas or water, in order that economy, reliability, and safety may be insured.

In carrying the invention into effect, a city, town, village, or locality may form one district, or, if the extent of territory makes it desirable, may be divided into several districts. In each district I provide a certain station, at which are grouped a suitable prime motor or several motors, dependent upon the amount to be supplied, generators or means for converting the prime motive force into electricity, and means for determining and regulating the amount of electricity generated and supplied, in order that a constant pressure of electricity (so to speak) may be kept up. The prime motors are any suitable engines, steam or water, and one or a series of two or more is provided, as may be necessary, each of which is provided with its own system of shafting and belting, driving a number of magneto-electric machines, the number actuated by one prime motor being hereinafter termed a "battery." . . . .

At the central station all the supply-generating coils or batteries thereof are connected to conductors on the multiple-arc system, and from these conductors at the station, main conductors (which for convenience may be called
2249 simply the "mains") connected thereto, also on the multiple-arc system, lead in any and all desired directions for conveying the energy to the points where work, either by translation into light or motive power, is to be done. All of such conductors from the generators at the station to the lamps are made in pairs—one for the outgoing current and the other for the returning

Extracts from the Specification of Sawyer's Patent No. 194,111. August 14, 1877.

Filed June 22, 1877.

The object of my invention is to supply the streets, blocks, or buildings of a town or city in a practicable manner with any desired quantity of electricity for the purpose of electric illumination, electroplating, electric heating, the running of electro-magnetic engines, &c. I place the generator or generators of electricity in any convenient portion of a locality, whence I carry the necessary conductors over or under ground to the streets, blocks or buildings in which the electric current is to be utilized.

The advantages of my invention are that it enables householders to obtain a supply of electricity for any purposes without the care and inconvenience attending the maintenance of local galvanic batteries; that it greatly reduces the cost of electricity to consumers; and, lastly that it renders practicable the lighting of buildings by electricity.

My generators may be in the form of the galvanic battery, or, what is preferable, magneto-electric machine driven by wind, steam, water or other power.

Extract from the Specification of Sawyer's Patent No. 196,834. Nov. 6, 1877.

Filed August 10, 1877.

For the proper performance of the work devolving upon an electric lighting system, the quantity of current required being so great, it is impracticable to employ the earth for the return circuit. It is therefore necessary, in running two such electric conduits, as the two railroads instanced, to run return conduits for each, and where many such are needed the expense is very considerable.

It is apparent, further, that to insure the requisite conductivity for the great volume of current required, the main conductors must be very large, and as a single conductor traversing a territory (letters patent No. 194,111) is forced to take many devious paths, passing into and out of houses, or into and out of rooms, to or from lamps or engines, in all of which deviations the large size of the conductor must be maintained, the expense of construction is very great. By placing my circuit-continuity preserving devices, however, in branch circuits, the branches alone pursuing the devious paths mentioned in running across from the two large mains or conductors, the branch conductors may be small, for if I wish to divide the current

current of electricity, the circuits throughout the system being complete or round metallic circuits, the conductors of which are well insulated from each other and from the earth. . . . .

To avoid any appreciable variations and insure uniformity, it is essential that any lessening of pressure be immediately indicated, in order that just sufficient energy be generated and sent out to keep up an equal flow through the circuit of each translating device—that is, that the pressure be kept up uniform, whether more or less translating devices be in circuit. This is attained by providing at the central station means for *for* constantly indicating the pressure and for regulating the production if appreciable variation be indicated. . . . . The translating devices in each house may be either for light or power, or both. For light, the electric light, consisting of an incandescing material hermetically sealed in glass (shown in other applications filed by me) is preferred. This lamp is made of a high resistance in comparison with that of any electric lamps which, to my knowledge, have been proposed.

In lights heretofore proposed the endeavor seems to have been to lessen the resistance of the carbon, none having been suggested of higher resistance than, say, ten ohms; but I have discovered that a very much higher resistance—say one hundred ohms—must be used, in order that a number may be economically and successfully used in a system. . .

As ordinarily proposed, each electric light requires its own regulator, which usually is either thermostatic or magnetic, breaking the circuit or bringing in resistance—in any case making a cumbrous lamp, requiring delicate management and constant attention. By
2250 regulating at the central station
entirely, I am enabled to use a small separate lamp, which may be used with the exercise of no more than ordinary care or attention. . . .

The means for measuring insure accurateness in furnishing a basis for equitable charges for the amount used by any particular consumer.

flowing in the two main conductors, and thence through the branches, among, say, fifty branches, the wire forming the branches need be only one-fiftieth the mass of that forming the two main conductors; hence, instead of running a single very large and expensive conductor into and from houses, to and from each lamp or engine, I have only to run two main conductors, and by small and inexpenive branches reach the lamps or engines. The current is evenly distributed throughout all of the branches, and my circuit-continuity preserving devices, whether those of my present invention or those of letters patent No. 194,111, or any others of like function, enable me to light or put out any one or more of the lamps, or start or stop any one or more of the engines operated by the current common to all, without decreasing or increasing the flow in the other branches.

Extracts from Specification of Sawyer & Man's Patent No. 205,305. June 25, 1878.

Filed May 25, 1878.

The objects of our invention are, first, to supply to an electrical circuit or circuits containing electric lamps an absolutely uniform volume of current, in order to obviate the unsteadiness which has characterized most attempts at distribution; second, to supply automatically, only so much current as may be necessary to meet the demand, thereby insuring the economical and satisfactory operation of a distributing system; and, third, when the demand for the current is lessened or increased by the removal of lamps from or their introduction into the circuit or circuits supplied by the generator, to cut off steam from, or add steam to, the engine driving the generator, in order that there may be no waste of power when the demand for the current calls for a limited application of it merely. . . .

The regulator of our invention so controls the steam or other power actuating the generator of electricity that this power is increased or diminished, as the demand for the current is increased or diminished; and while we have shown the result as accomplished in one way, we do not confine ourselves to the precise apparatus and the manner of its operation shown and described.

2251 The patents of Sawyer, and of Sawyer and Man, from which the foregoing extracts have been made, were issued and published a considerable time before the commencement of Edison's experiments in September, 1878, and were therefore a part of the state of the art. Patent No. 194,111, was dated August 14, 1877, and No. 196,834, November 6th, 1877, and No. 205,305, June 25, 1878.

In stating in detail the advance made by him in the art of incandescent electric lighting, in his answer to Q. 485, Mr. Edison enumerates seven different things which were necessary to be done, which may be summarily stated as follows: First, to adopt a fundamentally correct system of distributing the electric current and then to devise lamps which could be worked practically on such a system.

A fundamentally correct system of distribution is that of parallel or, as it is sometimes termed, multiple-arc distribution. This was adopted by Mr. Edison, but had been fully described in the prior patent of Sawyer 196,834, of November 6, 1877, in which, however, he disclaims it as not being a part of his invention, it being already well known in the art of electrical distribution, as may be seen by reference to the prior patent, of Woodward, Khotinsky and others, in evidence in this case. Given a system of distribution in parallel arc, the only thing remaining to be done calling for the exercise of invention, as distinguished from the work of the skillful electrical engineer, was to provide a device which should regulate the supply of electric current at its source in proportion to the consumption. This it appears had been accomplished to a certain extent as early as 1875 by Professor Moses G. Farmer of the United States torpedo station at Newport, Rhode Island. No description of this apparatus, however, was made public until 1880, and therefore it cannot properly be regarded as a part of the state of the art; but in the patent of Sawyer and Man 205,305 referred to, we find for the first time an apparatus for automatically regulating the production of electricity at its source in accordance with the requirements of the consumers;
2252 a plan which is now in universal use, and which I regard as lying at the very foundation of all the approved modern systems of electrical distribution—not only for electric lighting, but for all other purposes.

Second, to devise a suitable electric lamp for use in such a system. I am of the opinion that the lamp described in the patent in suit fulfills the condition of a suitable lamp; by which I mean a lamp comprising an incandescing carbon of organic material and of an arch or horseshoe form enclosed in a transparent glass chamber, from which oxygen or other carbon-consuming gases have been removed. I consider that the adaptation of this lamp to the special requirement of each case is properly a matter of engineering, or of additional subsidiary inventions, the lamp of the patent in suit being, in my opinion, one of a type which adapts itself readily to any required modification for such purposes.

Third, to devise means of measuring or determining the amount of light furnished to each consumer. This was first done, so far as my knowledge extends, by William E. Sawyer, whose electric meter is described in his patent No. *No.* 210,151, for which the application

was filed on October 17, 1878, and patented November 19, 1878, a description of which was published in the Scientific American of December 7, 1878, page 354. Mr. Sawyer's meter consists of a set of indicating dials similar to those of a gas meter, which when in operation are moved at a uniform rate by a chronometer. This device registers the number of hours each lamp is run, and inasmuch as each lamp when burning is necessarily traversed by a constant current, the indications of the dials may equally well register the quantity of electricity used. I consider this a perfectly accurate and efficient meter, and one which might perfectly well be used in the present state of the art, were it not that other meters more simple and less expensive in construction, and less inconvenient in maintenance have since been invented and applied. The
2253 earliest patent of Mr. Edison, relating to meters, which I have been able to find is No. 251,545 of December 27, 1881, the application for which was filed on March 20, 1880, a year and five months later than the filing of Sawyer's application.

Fourth. To devise a comprehensive system of conductors for general electrical distribution.

While there can be no doubt that such a system of conductors forms a most essential part of a general scheme of distribution, I nevertheless regard it as more properly a matter of engineering than of invention in the strict sense of that term. I mean by this, that when the general requirements of such a system had been formulated and set forth as they had been in the patents of Sawyer and Man, and subsequently in the patent of Edison, it was perfectly certain that the engineering skill could be found to devise and construct a proper system of conductors. I do not mean to be understood by this that it might not require much study, many experiments, and the making of a large number of subsidiary inventions, these inventions being, however, of a class which are absolutely certain to be made by somebody, as soon as the necessity for them becomes clearly apparent. The history of the art shows that the utmost credit is due to Mr. Edison and his assistants, for the thorough and complete manner in which they devised and carried out a scheme of electrical distribution in accordance with the general plan which he (Mr. Edison) had first fixed upon. But it is nevertheless true that other and wholly different schemes of distribution have since been devised, carried into effect, and are now in extensive use, and which under some conditions are even more economical and efficient than that employed by Mr. Edison.

Fifth. To devise means of producing a uniform pressure over an extended area of distribution, irrespective of the number of lights in use, and also to devise means for regulating at the point where the current is generated the equality of pressure throughout the lighting area. What I have said in reference to the fourth
2254 head, is equally applicable to this one. The required uniformity of pressure may be largely secured by the use of the automatic regulator of Sawyer and Man, which I have already referred to, which is described in their patent No. 204,305 of June 25th, 1878. The uniformity of supply in accordance with the con-

sumption having been provided for, it would only be necessary to apply proper engineering skill to so arrange, interconnect, and proportion the sectional area of the distributing conductors, to permit this supply to diffuse itself uniformly and properly over the entire area of distribution. This is of course a somewhat intricate and difficult matter in a large district, but in a small district, or in an isolated plant, it presents no difficulty which could not be overcome by the use of the ordinary knowledge which every skilled workman ought to possess.

Sixth. To devise economical dynamo machines and means for connecting, disconnecting and regulating the same. There was very little left for anybody to invent in respect to the essential features of dynamo machines at the date when Mr. Edison first turned his attention to them. The only improvements which have been made by him, or by anybody else, since 1878, have been in matters of detail and of proportion. In these latter respects a constant improvement has been going on at the hands of so many different persons that it would hardly be possible to enumerate them, ever since 1878, and the electrical output of the machine in proportion to the weight of metal used in its construction has been very greatly increased. Precisely the same course of improvement has been going on in the steam engine ever since the days of James Watt, but nevertheless the engine of Watt, like the dynamo machine of 1878, was a practicable and useful machine, and applicable in a large degree to the requirements of modern service. The arrangement of these dynamos in reference to the requirements of the service which they are designed to perform, is again a matter of engineering, requiring special adaptation and treatment in each particular case.

2255 Seventh. To devise means for preventing the current from becoming excessive upon the conductors so as to cause fire or other injury and to provide switches, lamp-holders and other subsidiary devices. The appliance which is in universal use for guarding against excessive currents is known as the safety fuse, which is a section of each conductor so arranged as to be fused and thereby interrupt the current before it becomes of sufficient strength to overheat the remaining portion of the conductor. This device was also an invention of Sawyer and Man and is described in their patent No. 205,303 of June 25th, 1878, page 2. I quote from the specification:

"In place of the safety switch, we may interpose in the circuit a section of a conductor more readily fused than the conductors constituting the rest of the circuit, so that when there is too much current this section shall be instantly melted and the continuity of the circuit destroyed."

This patent it will be seen was issued some three months before Mr. Edison commenced his work, and was therefore a part of the state of the art. The earliest mention I find of the safety fuse in his patents is in No. 227,226 of May 4, 1880. Switches, lamp-holders, electric chandeliers and means and methods for placing wires that were to convey the current to the chandeliers in buildings, are all described and illustrated in an article published in the Scientific

American, of December 7, 1878, describing the system and apparatus of Sawyer and Man, so far as it was at that date made public.

The extracts which I have given are, I think, sufficient to show beyond doubt, that the state of the art of electric distribution in the year 1879, was such that it only required the invention of a suitable incandescent lamp, having a capacity to be adapted to different conditions of service, to render the scheme of incandescent lighting a commercial and practicable one. Every one of the essential features of such a scheme, as enumerated by Mr. Edison in his 2256 answer to question 485, which was a subject of invention as distinguished from a subject for the exercise of the skill and knowledge of the engineer, had been invented and patented by Sawyer and Man, or was otherwise a part of the common knowledge of the public in respect to the state of the art before Mr. Edison took up actively the subject of electric lighting in 1878. It seems perfectly evident that Sawyer and Man were aware of the fact that a proper incandescent lamp was the only thing remaining to be invented to insure the commercial success of the scheme, to which Mr. Sawyer had devoted himself, as the evidence shows, since the beginning of 1877. That this was actually the fact is proven by the circumstance that within a few months after the announcement of the existence of a lamp possessing the essential characteristics of the lamp set forth and claimed as the invention of Sawyer and Man in the patent in suit, that incandescent electric lighting plants were in actual and successful public use for the first time, and that such have continued to be in uninterrupted and rapidly increasing use from that time until the present day.

Adjourned for lunch.

Met pursuant to adjournment.

Present: L. E. Curtis, Esq., for complainant; and R. N. Dyer, Esq., and H. D. Donnelly, Esq., for defendant, and the direct examination of Mr. Pope was continued as follows:—

194 Q. Have you read the depositions given in this case by Professor Cyrus F. Brackett, Professor George F. Barker, Professor William P. Wilson and Mr. Edison as experts on behalf of defendant?

A. I have.

2257 195 Q. Professors Barker and Brackett express the opinion in substance, that in order to make the incandescent lamp practically successful for any commercial purpose a radically new departure from the practice in vogue prior to 1880 was necessary, which consisted essentially in making the incandescent conductor of very high resistance so that the necessary electric energy required to give the light could be conveyed to the lamp in the form of a maximum of tension and a minimum of current, and that this radically new departure is first found in the New York Herald article, in evidence herein, and in Mr. Edison's patent No. 223,898, and No. 227,229. Do you agree with them in this opinion? Please give your reasons for any opinion you may express.

A. I find myself unable to agree with the witnesses Professors Barker and Brackett in the opinions which have been quoted in the

question. In the first place it cannot properly be considered that a high resistance in the incandescent conductor is an essential feature of the modern incandescent lamp. It would, in my opinion, be much more nearly the truth to say that the radically new departure which was necessary, consisted in the invention of a type of lamp which was capable of having its resistance modified at the will of the constructor, so that he might be enabled to produce a lamp which would give the best results under any one of the different conditions which are found to occur in actual service. It is quite true that in the particular scheme of long-distance distribution for central-station lightning, which was contemplated by Mr. Edison at the time the publication in the New York Herald was made, high resistance in the incandescent carbon was an extremely important desideratum, but it is equally true that in other and more recent schemes of distribution accomplishing precisely the same result, but by different instrumentalities, it has been found that a much smaller resistance in the lamps is preferable both on the score of economy and of efficiency. Again there are other methods of distribution such as that known
2258 by the name of the "municipal system" in which the lamps are placed in series, and in which it is found advantageous to make the resistance of the lamps comparatively small, as small as one-tenth and even less of the standard which would give the best results in a system of long-distance multiple-arc distribution. I consider therefore that the importance of the high-resistance incandescent conductor relates not to the incandescent lamp *per se*, but to the incandescent lamp when employed in connection with a particular one of several different schemes or plans of distribution, each of which possesses certain advantages over the others under certain conditions. If there were no other possible commercial application of the incandescent lamp except in connection with a direct-current multiple-arc system of distribution over a wide area, then the opinion expressed by Professors Barker and Brackett might be a more tenable one. But as I have already said, it seems to me that the new departure which marked a radical change from the practice which had before prevailed, consisted in making the incandescent conductor of such a material and of such a form that its resistance might be made as great as might be necessary under the particular conditions of its proposed use. In my opinion, the invention of an incandescent conductor made of organic material capable of being first formed and then carbonized, in the form of an arch or horseshoe, this being substantially the invention set forth and claimed in the patent in suit, rendered it possible for the first time to provide a lamp with a long, thin, flexible and sufficiently elastic conductor of high specific resistance and capable of withstanding a high temperature without disintegration. Given such a structure, and the adaptation of it to various methods of distribution and various conditions of use, would seem to fall more properly within the province of the skilled electrician than within that of the discoverer or inventor.

Even if we conceded the idea of making an incandescent lamp

of very high resistance to have really constituted a radically
2259 new departure and an important improvement in the art of
incandescent lighting, I do not consider that it was first disclosed in the New York Herald article in evidence herein, the date of which is December 21, 1879. In a paper read by Professors Elihu Thomson and Edwin J. Houston before the American Philosophical Society, on November 1st, 1878, which is printed in volume 7, page 25, of the Telegraphic Journal and Electrical Review, of London, the authors say:

"In respect to the relations that should exist between the external and internal work of dynamo-electric machines, it will be found that the greatest efficiency will, of course, exist where the external work is much greater than the internal work, and this will be proportionately greater as the external resistance is greater."

In this statement are clearly formulated the general conditions of maximum efficiency in an electric circuit supplied from a dynamo-electric machine. The application of it to any particular scheme of electrical distribution and utilization is a matter of engineering detail guided by and founded upon mathematical computation. Given the statement that the efficiency is proportionately greater as the external resistance exceeds the internal resistance, and it necessarily follows that the total resistance of the entire group of lamps supplied from the dynamo should be as great as possible, provided the resistance of each individual lamp does not become too great to permit a sufficient current to pass to maintain it in a condition of incandescence, under the eletrical pressure which the machine is capable of exerting.

The specific application of this general law to the case of a system of incandescent lamps supplied from a single dynamo is clearly set forth in the patent of St. George Lane Fox, in Great Britain, No. 3989 of 1878, of which the provisional specification was filed on the 9th of October, 1878, and the complete specification on the 9th
of April, 1879. The following quotations from the specifica-
2260 tion will show that the patentee thoroughly understood the
conditions which were required in an economical and efficient system of incandsecent lighting:

"The material or alloy employed should be capable of standing as high a degree of tempera*a*ture as possible without fusing, volatilizing or falling to pieces, it should also have a high specific resistance. The higher the temperature to which the material can be raised the more economical will be the light produced, that is the light will be greater in proportion to the force or energy expended, inasmuch as the radiant energy proceeding from the surface of the material will be more and more luminous as the temperature increases. In order to prevent the deterioration of the material when incandescent, I sometimes surround it with an atmosphere of nitrogen gas. The quantity of light will be proportional to the extent of the luminous surface. The resistance of the luminous material and its extent of surface should therefore depend on the amount of light it is required to give and the electro-motive force used. Speaking broadly it may be said that the resistance of the luminous conductor should be so adjusted or fixed that the electro-motive force of the mains to which it is attached is just sufficient to develop within it the strength of current necessary to raise it to the right degree of incandescence.

In order that the electric force may be conveyed at a high tension, that is, having high electro-motive force, so that there may not be very great loss from the resistance of the conducting mains or conductors, I make the lamps when I use an alloy of platinum and iridium of lengths of fine wires so that I may get a high 2261 resistance without having a large extent of luminous surface."

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"The electro-motive force of the electric conducting mains should be kept as nearly as possible constant at say 100 volts or British Association units of electro-motive force."

The electro-motive force here proposed is precisely that which has been adopted in practice by Mr. Edison and others who employ the direct system of distribution.

In this patent is also described the scheme of an interlacing network of conductors covering a large area of a city or town and supplied with current from a central station through a number of mains or feeders and having the lamps arranged thereon in parallel or multiple arc.

In view of these publications I cannot concur with Professors Barker and Brackett in the opinion that the idea of making the incandescent conductor of very high resistance was first made known in the New York Herald article and in Mr. Edison's patents, No. 223,898 and 227,229.

Adjourned to April 24th, 1889, 10 a. m.

NEW YORK, *April* 24, 1889.

Met pursuant to adjournment.

196 Q. Have you read and examined the various prior patents and publications put in evidence by the defendant herein, and read the testimony of defendant's experts in regard to the same?

A. I have.

197 Q. Do you agree with the opinion expressed by defendant's experts, Professor Bracket and Professor Barker, that in view of the prior state of the art as disclosed by the said prior patents 2262 and publications, there was no novelty in the inventions described in the patent in suit and referred to in the first, second and fourth claims thereof? Please give your reasons for any opinion you may express.

A. Professor Brackett in his answer to X Q. 38 expressly says that he does not find an incandescent conductor for an electric lamp in any one of the prior publications discussed by him in which both the carbonized fibrous material and the horseshoe shape are coexistent. In his answer to X Q. 40 he expresses the opinion that the combination of these two qualities in an incandescent conductor

does not disclose any invention, and the reason which he gives for his opinion is that whatever of advantage there may be in the form, if any, does not depend upon the material, and whatever advantage there may be in the material does not depend upon the form, and assuming as he does both the form and material separately considered to be old, concludes that their combination does not disclose any invention. In the first place, I do not agree with Professor Brackett in his assumption that the use of carbonized fibrous or textile material for the incandescent conductor of an electric lamp is old. When asked in X Q. 41 where such description is to be found, Professor Brackett can only cite two publications describing the carbonization of fibrous material without reference to its use in incandescent lamps, and an English patent which described an arc lamp (not an incandescent lamp) with electrodes of carbonized lignite. He says in his answer to X Q. 42 that he thinks these two publications and the English patent contain the best description he can find of an incandescent conductor for an electric lamp of carbonized fibrous or textile material. I can only say in reply to this, that the production of a carbonized fibrous material constitutes *per se* no part of the invention which forms the subject-matter of the patent in suit. The invention consists in the selection of this material for an incandescent conductor and applying it to use in such a way as to render its peculiar qualities available. And this, in my opinion, was done by making
2263 the conductor of an arch or horseshoe form, thus permitting its terminals to be mounted in rigid and unyielding supports, at the same time permitting the longitudinal expansion and contraction of the incandescent conductor under variations of temperature to be compensated by a slight variation in the degree of curvature of the arch distributed throughout its whole length in such a manner that the flexure at any one point is well within the limit of the elasticity of the material. Professor Brackett says in his answer to question 33, that an incandescent conductor of the particular dimensions shown in the drawing attached to the patent in suit, would be quite as likely to break in the form shown as it would be in the form of a straight rod, "as had been in the art before." While I do not admit, for reasons just stated, that such an incandescent conductor, even in the form of a straight rod, had been known in the art before, yet I do not agree with Professor Brackett that it would be as likely to break when made of arch form of the dimensions shown in the patent. In the first place I see no reason why the patentee should be confined to the precise thickness of carbon shown in the drawings of the patent, when every electrician skilled in the art in even the smallest degree, would know that the thickness and length of the carbon would have to be varied in accordance with the service which the lamp was expected to perform and the conditions under which it would perform it. It was just as much a matter of common knowledge to the skilled electrician, as it was for instance, to use electro-magnet coils of thick wire and a small number of turns for some applications, and a thin wire, and a large number of turns for other applications. A very moderate

amount of common sense would be sufficient to enable him to know that to develop a given amount of heat in the conductor it must be made short and thick for a strong current, and longer and thinner for a weaker current. If he had occasion to use a long thin carbon, the patent informed him that he could obtain it by the use of carbonized textile material which is one of the
2264 ways now commonly practiced. The fact that lamps now made, so far as I am aware, by many different makers, all of which, whether made with a short thick conductor or with a long thin one, are invariably in the arch or horseshoe form, would seem to be sufficient evidence that such a form possesses some peculiar advantages as applied to carbonizsd fibrous material. In fact, Professor Brackett himself admits in his answer to question 34, that the form does possess an advantage in connection with a long, thin conductor of carbonized fibrous material. Now it seems clear that whatever advantage may exist in this case, must exist, at least to some extent, in any conductor of the same form whatever its length or thickness, and I do not think there can be the slightest doubt that such advantage does actually exist in an arch-shaped conductor of the dimensions shown in the patent, or of any other dimensions.

Professor Barker in his answer to Q. 9, folio 2123, concurs with the opinion of Professor Brackett that there is no novelty in the subject-matter set forth in the patent, this opinion being based upon the same assumption, namely, that "carbonized fibrous material was used in the said incandescent lamps, or was described for such use either in the form of straight pencils, or in the form of arch or equivalent shapes." In answer to X Q. 53, 54 and 55, Professor Barker selects the English patents of Roberts and of Konn as equally complete and satisfactory anticipations of the first claim of the patent in suit. The patent of Roberts, speaks generally of a conductor made of charcoal, but as the term charcoal was commonly used in the art of electric lighting as it existed at that day, to denominate carbon of any sort, especially gas carbon, it does not seem to me that it would serve to direct attention to such a material as is clearly contemplated in the patent in suit. In his description of his invention, Roberts systematically uses the word "graphite," which may mean the mineral known as plumbago, or may mean gas carbon. It certainly does not mean carbonized fibrous material. As
2265 Professor Barker admits, the drawing shows the conductor in the form of a straight bar or strip, and he then makes the assumption, in which I entirely disagree with him, that "inasmuch as the advantages set forth in the patent in suit as belonging to the arch form of incandescent conductor, seem to me to be secured to the same extent by the form of said conductor shown in the Roberts patent," he thinks it is substantially equivalent for the conductor described in the first claim of the patent.

It does not seem to me to require any argument to show that a fragile material of a given thickness mounted between thick supports, would be much more likely to be broken by longitudinal expansion than if it were in the form of an arch or horseshoe, for the simple reason that in the first instance the breaking strain is concentrated at either end close to the supports, while in the latter it is uniformly distributed throughout the whole length.

The patent of Konn shows as incandescing conductor, preferably of graphite, in the form not of an arch, but of a V. It seems hardly necessary to point out that graphite is mineral carbon, that it is expressly distinguished in the patent in suit from the carbon of fibrous material, and that hence it cannot be considered an equivalent for it, nor *nor* can the V-shaped conductor be considered as an equivalent for the arch. It is true that it possesses some of the advantages of the arch in respect to the better distribution of light, greater convenience of construction, arising from the parallelism of the leading-in wires, etc., but on the other hand, it possesses but little if any advantage over the straight form in respect to the uniform distribution throughout its length of the strains caused by the longitudinal expansion and contraction under the variations of temperature. For this reason, I do not think it can be considered an equivalent for the arch in the patent in suit. Moreover in Konn's lamp the incandescent portion is confined to a short space at the angle of the V, which is a wholly different construction from
that contemplated in the patent in suit, and one which would
2266 utterly fail to realize many of the advantages which it was
the object of the patentees in the patent in suit to obtain.

I am unable to find the combination of the second claim in any of the patents and publications cited by Professor Brackett. He says in his answer to cross-question 42 that the English patents of Roberts and of Shepard, and the Lodyguine publication are the ones which he would select as better fulfilling the conditions, and of these he is inclined to regard Roberts as the best. As I have already said, Roberts only uses the word "charcoal" in the most general way, and it is by no means certain that he had carbonized fibrous material in mind at all. The lamp described by Shepard, is not, properly speaking, an incandescent lamp, at all, but is one in which the carbon is intended to be consumed, and the electrode gradually fed forward as required. Charcoal is mentioned as the material in the same general sense that it is in the Roberts patent. The same remark will apply to the description of the Lodyguine lamp. The article in evidence (which is a translation) in referring to the old method says, "The electric spark was passed between two points of charcoal, each attached to a copper wire connected with an electro-magnetic machine." At the date when this was written, 1873, charcoal in the form of carbonized wood had not been used for many years for electric lighting. No one ever thought of using anything but gas carbon or artificially prepared hard carbon, so that the word "charcoal" as there used, unquestionably refers to hard carbon, and it is fair to presume that it means hard carbon in the description of the incandescent lamp. It has always been understood among electricians that what Lodyguine actually used, was a thin pencil of artificially prepared hard carbon. It of course follows that unless carbonized fibrous material was actually intended to be described in these publications and patents they cannot constitute an anticipation of the second claim.

The anticipations of the second claim, cited by Professor Barker, are the same as those cited by Professor Brackett and I do
2267 not find that he gives any additional reasons for regarding
them as containing an incandescent conductor of carbonized fibrous material, such as is set forth as one of the elements of the combination in the second claim of the patent in suit.

In reference to the fourth claim of the patent, in which a carbon made from fibrous or textile material having the form of an arch or loop, is an essential element of the combination, it only seems necessary to say that if this element of the claim is new, the combination is necessarily new also. I do not find that either Professor Brackett or Professor Barker is willing to say that any of the patents and publications contains a description of the entire combination of the fourth claim, and in fact this is expressly admitted by Professor Barker in his answer to X Q. 59. This must necessarily be true, because the fourth claim consists essentially of the subject-matter of the first claim combined with certain additional elements.

197 Q. Defendant's experts express the opinion that the patent in suit does not contain a sufficient description of the character of the fibrous or textile material to be used for the burner, its preparation or carbonization and its carbonization, to enable others generally skilled in the art as it existed at the date of the application, to produce a practically operative incandescent conductor without experiment. Do you agree with them in this?

A. I do not agree with defendant's experts in their respective opinions on this point. The specification states that carbonized paper and wood carbon have been made use of in practicing the invention, and that the carbons are to be made from vegetable fibres or textile material as distinguished from mineral or gas carbon.

I think there can be no doubt that any person reasonably well skilled in the art, would without difficulty have been able, at the date of the patent, to select a suitable quality of paper or of textile material, and to carbonize the same by well-known methods. He would naturally have selected paper or thread of uniform
2268 thickness and of pure material, free from foreign substances,
either of which could be found in the market without the least difficulty. As to wood carbon, it does not appear to me that any description is needed other than the general directions which are given. It is well known at the present date that there are very many kinds of straight and close grained woods from which carbons of a very good quality may be made, and I think a persons skilled in the art would have hit upon some one of these without difficulty. There was no occasion for the patentees to describe, more than they have done, the process of carbonization, for it was just as well understood in 1880 as it is to-day. In my opinion, the patentees, in preparing their specification in accordance with the rules of the Patent Office, which direct that the description shall be devoid of unnecessary prolixity, were undoubtedly right in leaving out a description of the details of the process of carbonization and a catalogue of all the forms of fibrous material which might be more or

less suitable for the purpose. One material, namely, paper, is specifically mentioned, and that, as I understand it, is all that the statute requires. As I have already said, it does not seem to me that the selection of a suitable quality of paper would present any difficulty whatever, as there are many kinds of paper in the market which would infallibly suggest themselves as being well adapted to the purpose.

198 Q. Do you agree with the opinions expressed by defendant's experts in regard to the materiality or effect of the amendments made in the application for the patent in suit, while the same was pending in the Patent Office, and the differences between the application as originally filed and the patent as finally issued?

A. I do not agree with the opinions of defendant's experts as to the effect of the amendments referred to. I am unable to find any invention whatever which is described and claimed in the patent, which was not described in the application as originally filed. Defendant's experts appear to lay much stress on the omission in the final specification of the words "ordinary gas carbon." The omission 2269 of these words certainly does not extend the scope of the patent, but on the contrary restricts it. They also take the ground that the omission of the word "charcoal" which appears in the original specification, in some way alters the scope of the patent and tends to expand it. My opinion is substantially that of complainant's expert, Professor Cross, namely, that the word charcoal had been so loosely used in the art that it had wholly lost any definite meaning. It might have meant almost anything, including gas carbon and other substances expressly intended to be excluded from the scope of the invention. The cancellation of the word removed what I consider to have been a misleading and therefore objectionable ambiguity. The omission of the words "covered with powdered plumbago" used in connection with the carbonized paper has very much the same effect. It was not an essential part of the process of preparing the carbon and it was vague and obscure, inasmuch as it did not state clearly how the application was to be made. As to the matter which was inserted in the amendment in reference to the sealing of the electrodes and the advantages of the arch form of carbon, I am unable to see that the scope of the patent was in the least changed by their insertion. The first is merely a statement pointing out that certain processes may be used. These processes were old and any one had a right to use them so far as this patent is concerned, whether they were pointed out or not. As to the advantages of the arch form, they were inherent in the thing itself when constructed according to the original specification, and were afterwards neither more or less so because they were specifically pointed out. It is well understood that a patentee is entitled to the benefit of all the advantages necessarily arising from his invention, whether he knew them or not. Referring to the statement of Professor Barker in his answer to Q. 42, that in the original application the patentees expressed no preference for carbonized fibrous or textile material over other forms of carbon mentioned, I would

2270 say that in the fourth claim an incandescent conductor made of carbonized fibrous or textile material is claimed most specifically, and no other kind of carbon than fibrous or textile carbon is specifically referred to in any of the claims.

I wish to state here, lest the stat-ment I have just made may appear to be in contradiction to that made in my answer to X Q. 130, of my testimony in the *prima facia* case, that in making this last-mentioned answer I did so after examination of a printed copy of the original specification in which examination I overlooked the fourth claim, which was printed on the other side of the leaf, and hence my answer was made without reference to the fourth claim. Had I been aware of it my answer then would have been to the same effect as now.

My opinion is that the changes made in the specification were not only permissible, but were in accordance with good practice, and with the rules of the Patent Office, which expressly say that the specification shall be free from ambiguity and from unnecessary prolixity. The statement of the advantages of the arch form, while not required by the rules adds nothing whatever to the scope of the invention, but merely serves to indicate to the examiner and to any person reading the patent, some of the points wherein it differs from prior inventions of the same kind, all of which differences, however, as well as advantages, would be obvious to any person upon careful consideration of the invention.

The most essential and important part of the invention which is claimed by the patentees of the patent in suit as new, is the incandescent conductor of carbonized fibrous or textile material, and of an arch or horseshoe shape, and this is exactly the invention, neither more nor less, which was claimed in the fourth claim of the original specification in these words, to wit:

"An incandescing arc made of carbonized fibrous or textile material."

2271 The presence of this claim in the original specification is sufficient evidence that the inventors had the invention and that they intended to claim it as new. It seems to me, therefore, that the amendment of the specification in the direction of more fully and more distinctly describing and setting forth the invention claimed, was not only permissible, but was obligatory upon the patentees in order to comply with the statute and with the rules of the Patent Office, that the thing claimed shall be sufficiently described in the specification so that the meaning of the claim may be understood.

199 Q. Do you agree with the opinions expressed by defendant's experts, that the lamp structure shown and described in the patent in suit has such serious defects that it would be wholly unsuitable for practical use in electric illumination, and that it would not be superior to those described in the prior patents of Roberts, Shepard, Konn, Kosloff and others in evidence?

A. I think the defendant's experts are in error in this particular, an error perhaps arising largely from the fact that they lay down certain arbitrary standards of comparison with modern and improved lamps, which have been undergoing constant improvement for the last eight years; for example, Professor Brackett says in substance that a practically useful lamp should have a lifetime of 1,000 hours. I do not know of any manufacturer at the present time who will undertake to warrant lamps to last that length of time. It is only within two or three years that the manufacture has been so perfected that an average lifetime of four to six hundred hours could be depended upon. Mr. Edison lays down, as an essential requirement that it should be able to compete commercially with gas, but I know of no reason why such an arbitrary standard should be fixed upon. There are many applications which might be made of incandescent lamps in which a gas-light could not be used at all, or in which the first cost of the lamp or the length of its life would be of comparatively small importance, such for example as the lighting of mines filled with explosive gases; the lighting of powder magazines, of submarine caissons and other applications of like nature.

2272 In my answer to X Q. 26, in my testimony given in behalf of complainant in the *prima facia* case, I said that I considered it doubtful if so high a vacuum as that in defendant's lamp could be preserved with the structure of the enclosing glass chamber described in complainant's patent in suit and in their prior patent No. 205,144. Again in answer to X Q. 46, I said:

"I should regard it as quite doubtful whether a perfect vacuum could be maintained in a chamber having the construction described and shown in this patent, but I am not willing to go so far as to say that it is impossible."

This statement was made from an examination of the drawings of the patent and in the absence of any experimental knowledge as to the efficiency of the structure in maintaining a high vacuum. Since giving the testimony above quoted, I have examined a considerable number of lamps made in accordance with the drawings and specifications of complainant's patent, and in view of the results which have been obtained, I am even more strongly confirmed in my original opinion not only that an incandescent lamp may be made in accordance with the description of the patent which would have a sufficiently long life to be of value for many practical purposes, but that it would be a practically useful commercial incandescent lamp for ordinary purposes, and would be immeasurably superior to any of those which are described in the prior patents and publications referred to in the question.

Adjourned to 2.30 p. m., April 25th, 1889.

New York, *April 25th*, 1889—2.30 p. m.

Met pursuant to adjournment.
Present: Counsel as before.

200 Q. In your answer to Q. 197 you refer to the use of 2273 the term "charcoal" in the art of electric lighting, as it existed at the date of various prior patents and publications, put in evidence by defendant to denominate carbon of any sort.

Do you refer to the use of the term "charcoal" in the sense set forth by Professor Cross and Dr. Morton in their depositions in this case, and do you agree with them in the opinions they express on this point?

A. I entirely agree with the opinions of Professor Cross and Dr. Morton in respect to the meaning of the term "charcoal" in the art of electric lighting. The greatest confusion exists in all the literature relating to the subject as to the respective meaning of the terms "charcoal," "carbon" and "graphite." It is easy to see how this confusion has arisen. It is due to the fact that electrodes of wood charcoal were first used and for many years. Then it was discovered that gas carbon and graphite were preferable forms of carbon for producing the arc, but they still continued to go by the name of charcoal, just as the plumbago in the modern lead pencil continues to go by the name of lead. Since this point was raised I have examined a portion of the many works referring to the subject, and will quote a few extracts simply to illustrate the exceedingly loose and indefinite manner in which the term charcoal is used even in the standard literature of the subject which is always considered to be more accurate in the use of such terms than are the specifications of patents.

Elements of Chemistry, by W. A. Miller, New York, 1864, in describing the electric arc, refers to the electrodes repeatedly on page 414, as being of "charcoal." On pages 415 and 416 it speaks of "coke" and "gas coke." In the foot-note on page 415 is a description of the Duboscq lamp, in which the electrodes are called "charcoal points," although it is well known that charcoal was never used in this lamp, but on the contrary pencils of gas carbon either sawed out from solid blocks or moulded and baked.

2274 Prof. Faraday in his lectures on the Forces of Matter, published by Griffin & Company, London, 1860, page 165, in describing the electric light, says:

"I will first of all show you the image of the charcoal points on the screen and draw your attention to the spot where the light is produced. There are the coal points. The two carbons are brought within a certain distance; the electricity is being urged across by the voltaic battery, and the coal points are brought into an intense state of ignition."

Here we have the same electrodes spoken of as "charcoal, "coal" and "carbon" by Professor Faraday all in the same breath in an explanation of the construction of a light-house lamp, in which nothing but gas carbon ever has been or ever could be used.

Atkinson's translation of Ganot's Physics, Baillaire, publisher, London, 1863, page 61, describing the electric arc, repeatedly refers to the electrodes on pages 630 and 631 as having been produced with "charcoal," and with "light-wood charcoal." On page 632 it is said:

"At present the electrodes are made of gas graphite, a modification of charcoal, deposited in gas retorts; this is hard and compact, and only burns slowly in air."

On pages 633 and 634 the Duboscq lamp is again described and the carbon pencils are repeatedly referred to as "charcoals."

Here we have retort carbon described as a "modification of charcoal" and called "graphite;" this, too, in a standard text book of the very highest authority.

J. Muller, Principles of Physics, etc., Baillaire, publisher, London, 1847, page 376.

"If we fasten to each of the poles of a galvanic circuit pointed pieces of carbon (of the kind and size used in the carbon cylinders of Bunsen's battery), we shall, as soon as these points come into contact, perceive an uncommonly glittering light. This bright light can be seen by a Bunson battery of only four elements
2275 brightly, a small, luminous star appearing where the points of the charcoal come into contact with each other. By increasing the number of elements the splendor of the appearance considerably increases; and thus, in a circuit consisting of from thirty to fifty elements we may obtain a light far exceeding in brightness Drummond's hydro-oxygen light. By the application of this number of pairs of plates we may remove the points of the pieces of carbon tolerably far from each other, if only the current passes, and we may thus obtain a splendid bow of light formed by the glowing particles of the charcoal which pass from one pole to the other."

It is certain that this extract refers to hard or gas carbon, because no other kind is ever used in Bunsen's batteries, and yet we find it indiscriminately referred to as "charcoal" and "carbon" throughout the whole paragraph.

Pynchon's Chemical Physics, New York, 1872, page 344. In describing the electric light the author says:

"When pieces of well-burned charcoal are attached to the wires and become the poles of the battery, on bringing them near each other a most brilliant arc of flame, emitting the brightest artificial light known, flashes between them. The compact coke of gas retorts is better adapted to this purpose than any other form of charcoal. * * * * If the two carbon points are arranged in a horizontal position at right angles to the magnetic meridian," etc.

Here we have in another standard text book gas-retort "coke" called a "form of charcoal" and referred to as "carbons." In question 356, page 345 the inquiry is made:

"What change takes place in the length of the charcoal points during the passage of the current?" and the answer is "There is a considerable transport of the particles of carbon from the positive to the negative pole."

2276 Pepper's Science Simplified, London and New York. This work has no date, but I had a copy of it in my possession as early as 1874. On page 347 in a description of the Serrin regulator, in which no form of carbon is ever used other than moulded gas carbons, the electrodes are referred to almost in the same breath as "carbon points" and as "charcoal points."

It would probably not be difficult to find many other similar instances of the vague and ambiguous use of the word charcoal in the literature of electric lighting between 1847 and 1875, but those which I have cited are, I think, more than enough to show beyond question that the use of the term "charcoal" in the early specifications, as for example, that of Roberts, is much more likely to have meant gas carbon, coke or graphite, than wood carbon. It is at all events certain that its meaning could not have been confined to wood carbon, nor could it have excluded any other form of carbon of a mineral nature applicable to electric lighting. The extracts which I have cited also show, that the cancellation of the word charcoal in the original specification of the patent in suit, removed an exceedingly ambiguous term and was therefore in the direction of good practice, as I stated in my former answer.

201 Q. Have you read the testimony given in this suit on behalf of the complainant, by Professor Cross and Dr. Morton, and do you agree with them in the statements they make and the opinions they express?

A. I have read the testimony of Professor Cross and also that of Dr. Morton, and in my previous answers I have pointed out several important particulars wherein I concur with them and have given my reasons at length upon which such concurrence was founded. In answer to the question I can only say that in respect to matters not specifically referred to in my former answers I find no reason to dissent from the opinion which they have expressed, either separately or in concurrence, but on the contrary, fully agree with them in every essential particular.

2277 Complainant's counsel offers in evidence the title page and sections 677, 678 and 679, on pages 630 to 635 of Ganot's Physics, published at London in 1863, and the same is marked "Complainant's Exhibit Extract from Ganot's Physics;" also the title page and a part of page 376 of Muller's Physics and Meteorology, published at London in 1847, and the same is marked "Complainant's Exhibit Extract from Muller's Physics;"

Also the title page and parts of pages 413, 414 and 416 of Miller's Chemical Physics, published at New York in 1864, which is marked "Complainant's Exhibit Extract from Miller's Chemical Physics;"

Also parts of pages 335, 336, 345, 346 and 347 of Cyclopaedic Science Simplified, by J. H. Pepper, which is marked "Complainant's Exhibit Extract from Pepper's Cyclopaedic Science;"

Also an extract from Faraday's Lectures on the Physical Forces, published at London and Glasgow in 1860, part of pages 165 and 166, which is marked "Complainant's Exhibit Extract from Faraday's Lectures;"

Also section 355, on pages 344 and 345, of Pynchon's Introduction to Chemical Physics, published at New York, in 1877, which is marked "Complainant's Exhibit Extract from Pynchon's Chemical Physics;"

Defendant's counsel admits that the various books referred to were published and circulated at the dates mentioned on their title pages, and consents that copies of the parts offered in evidence may be used in place of the original books, subject to the correction of any errors that may be found therein.

Adjourned to April 26th, at 10.30.

The examination of Mr. POPE is continued on page —.

2278 NEW YORK, *April* 15, 1889—3 p. m.

Met pursuant to agreement.

Present: Thomas B. Kerr, of counsel of complainant, and Walter K. Griffin, of counsel for defendant.

Testimony of John M. Robertson.

JOHN M. ROBERTSON, a witness on the part of the complainant, being sworn, testifies as follows in reply to interrogatories by Mr. KERR:

1 Q. State your name, age, residence and occupation.

A. John M. Robertson, 40 years old. I am superintendent of the Sawyer-Man Electric Company and reside in New York.

2 Q. Were you ever in the employment of the Consolidated Electric Light Company, and if so, state when you first went into its employment and how long you continued?

A. I went into the employment of the Consolidated Company early in the spring of 1885 as superintendent of its factory, which was then located in Brooklyn at Adams and Front streets, and I continued until the first of October, 1888. Since then I have carried on the same factory, which is now being operated by the Sawyer-Man Electric Company.

3 Q. Do you know Henry E. Vineing, and if so, please state when and where you became acquainted with him?

A. Yes, I know a man by the name of Henry E. Vineing and became acquainted with him in the summer of '85, when he was employed by the then general manager of the Consolidated Electric Light Company to work under me at the Brooklyn factory.

4 Q. State what Vineing was employed to do and the circumstances under which his connection with the company terminated.

2279 A. Vineing was employed, as I understand, because it was supposed that he would make a good foreman in charge of the manufacturing of incandescent electric lamps, and he was put in charge of that department. The company at that time was manufacturing dynamos and other electric appliances. At that time the company was also increasing the capacity of the lamp department and Vineing was supposed to be a capable man for looking after additional apparatus, and so on, in this department. Also, at this time the company were having made, under direction of the legal department, experiments in baking and treating various materials for making carbons and Vineing had charge of this work. He looked after the baking of the carbons personally. He remained with us until the fall of the same year when we moved the factory to Park avenue and to more commodious quarters. I had found by this time that Vineing was entirely incapable of acting as foreman of the lamp manufacturing. While a capable man for any particular job that he was put upon, he was entirely unreliable in carrying out the whole work and in managing those under him. He was never willing to let well enough alone, but always was experimenting without asking permission or giving any notice to the superintendent that he was making such experiments and in this manner he frequently did very bad work which would show itself by bad lamps being produced. When we started to fix up the new factory he became very slack in his work, and we were on the eve of discharging him when he gave me a letter to Mr. Davis, who had employed him, stating that he had better offers from other companies and unless he was paid more money he would have to leave the services of the company. Mr. Davis said that the matter was entirely in my hands, so I told Vineing that he had better take the offers made him by the other parties, especially as he had not given satisfaction. He then left.

JNO. M. ROBERTSON.

2280 New York, *April 9th*, 1889.

Met pursuant to notice.

Present: Amos Broadnax, Esq., for complainant, and Grosvenor P. Lowrey, Esq., for defendant.

Complainant's counsel accepting the proffer of defendant's counsel; counsel stipulates that the testimony of Wm. H. Church taken in the interference between Sawyer & Man and Thomas A. Edison, as found in the certified copy of such testimony, said testimony to be copied into this record, and made a part hereof, substantially the same to all intents and purposes, as if the same had been taken in this case, said Church being called as a witness and subject to further examination and cross-examination, to all matters pertaining to the subject-matter of said testimony.

Testimony of William H. Church.

William H. Church, being called on behalf of complainant herein and duly sworn, testifies as follows:

1 Q. What is your name, age, residence and occupation?

A. William H. Church, about 57 years of age, I reside in the city of New York, I am in no regularly established business, I am taking care of my own property.

2 Q. Are you the same William H. Church that testified on the 15th of March, 1881, in the interference between Wm. E. Sawyer and Albon Man on the one side, and Thomas A. Edison on the other, and also on September 22 and the 11th of November, 1882?

A. I am.

3 Q. I place in your hands a certified copy of your testimony as taken in that interference. Please to look at it and state between what pages you find that testimony.

A. The first deposition is paged 25 to 43 inclusive, the seco[illegible]d is on pages 84 to 100 inclusive, and the third deposition is in the s[illegible]plemental record, pages 63 to 76 inclusive.

2281 4 Q. State, if you please, how recently you have read these depositions?

A. Within the last week.

5 Q. If the same questions contained in these depositions, were asked you now, would you make the same answers to them?

A. I would.

The examiner is requested at this point to copy into this record the depositions referred to as a part of the testimony of the witness in this case as provided in the foregoing stipulation.

COUNSEL'S NOTE.—The depositions of Wm. H. Church, taken in the interference case and referred to above are printed in vol. 3 of this record as follows:

First deposition, vol. 3, p. 125–143.
Second deposition, vol. 3, p. 187–204.
Third deposition, vol. 3, p. 601–613.

6 Q. State, if you know, who did the carbonizing for Sawyer & Man, at their shop, corner of Elm and Walker streets?

A. Edwin L. Myers.

7 Q. Did he do it all?

A. All that he did was under the direction of Sawyer & Man, and he attended to it personally, and he did most of it.

8 Q. State if you know what material he carbonized there for the incandescing conductors of the lamps.

A. There was paper and willow twigs, and bamboo—strips of bamboo and other woods that I don't know the names of. They were trying different things all the while.

9 Q. What was the form and the size of the bamboo and different kinds of wood that Mr. Myers carbonized there in addition to the paper, about which you have testified?

2282 A. I can't give the size. They were small strips of bamboo and of other woods.

10 Q. How did you know that Mr. Myers was making carbons from bamboo?

A. I saw the pieces on his bench.

11 Q. What was the form of the pieces?

A. They were small, straight pieces.

12 Q. Made from a bamboo fishing rod?

A. That is what I supposed, and Myers told me so.

13 Q. How often did you see them carbonizing bamboo and willow twigs?

A. I saw Mr. Myers working upon these things nearly every day for about two months, as I recollect it.

14 Q. State if you know whether any of these carbons were used in the lamps?

A. I don't know from having seen them put in the lamps, but

nd is
up-

Complainants Exhibit Rockwell-Kent letter.

John R Porter
Grosvenor P Lowrey
Geo Wales Soren
Chas Francis Stone
Geo S Hamlin

P. O. Box 1836

Porter, Lowrey, Soren & Stone,
Attorneys & Counsellors at Law
No 3 Broad St New York

March 26th 1879

Dear Sir:

Mr Lowrey directs me to say that he has not been able to make an engagement before Friday night. At that time if agreeable to you he will come with Mr. Wright and some other friends.

Very truly
Rockwell Kent

Wm. Church Esq
94 Walker St
City

Consolidated El. Co.
v.
McKeesport L. Co.
Complainants Exhibit Rockwell Kent Letter
April 9 1889
W.J.J.
S.E.

Friday night they
all came. They were
shown Sawyer man straight
pencil lamp; horseshoe
lamp & new Feeder lamp
which I was at work
on & told all about
carbonizing fibre re.
Got Edison Some
[illegible] on this.

No. 286.
C. E. Light Co.
v.
McK. Light Co.
p. 2283

was shown them after they were put in, and told by Mr. Myers that he had made them.

15 Q. How does it happen that when you testified in the interference case, you did not mention these bamboo and willow carbons?

A. I was only asked about paper, and as I understood then there was no question except as to the carbonization of paper.

16 Q. State if you recollect of an exhibition being given of the Sawyer-Man lamps in the Walker-street shop in the spring of 1879?

A. I do.

17 Q. At what time in the spring was it that that exhibition was given?

A. On the evening of March 28th, 1879.

18 Q. State, if you know, how that exhibition came to be given?

A. Mr. Sawyer wanted to sell a controlling interest in the Electro Dynamic Light Co. to the Edison Company, or to parties interested in that company, and in view of that he asked me to call
2284 upon Mr. G. P. Lowrey and see if I could bring about the
sale of the stock. I accordingly called on Mr. Lowrey, and made an appointment with him to come and see an exhibition of the lamp, and to bring his friends. He did not state to me who they would be. I think I called twice upon Mr. Lowrey. I think in one instance Mr. Sawyer was with me, but of this I cannot be certain. The result of our interviews with Mr. Lowrey was a letter from him to me, appointing a time when he would come and see the lamps. That letter is dated the 26th of March, 1879, and at the time appointed in the letter Mr. Lowrey and some of his friends came to witness an exhibition of the lamps.

19 Q. Can you produce that letter?

A. Yes, sir.

20 Q. Please do so.

A. Here it is.

(Witness produces a letter.)

21 Q. By whom does that letter purport to be written?

A. Rockwell Kent.

Letter offered in evidence and marked Complainant's Exhibit Rockwell Kent Letter, April 9th, 1889. Objected to as hearsay, as not competent evidence of the truth of the facts in said memorandum stated.

(Here follows lithograph marked p. 2283.)

22 Q. Was the exhibition of the lamps made at the time appointed in the letter?

A. It was.

23 Q. Do you find a memorandum in lead pencil written on the back of the letter?

A. I do.

24 Q. Please to read the letter and also the memorandum, so that the examiner may copy it into the record?

Witness reads as follows:

> "Friday night they all came. They were shown Sawyer-Man straight-pencil lamp, horseshoe lamp and a new feeder lamp 2285 which I was at work on and told all about carbonizing fibre, etc. Ask Edison some ? ? on this."

25 Q. In whose handwriting is that memorandum?

A. Wm. E. Sawyer's.

26 Q. Who was present at that exhibition?

A. Mr. G. P. Lowery, E. N. Dickerson, Mr. Wright, Mr. Goddard, Mr. Galloway, and myself. Mr. Sawyer was present.

27 Q. Is that all you recollect of being present?

A. Yes, I think so.

28 Q. Was Mr. Man present?

A. No.

29 Q. This letter which you have produced is addressed to you. Was it received by you personally, on or about the day of the date?

A. It was.

30 Q. Have you any memorandum made by you at the time of the proposition you made to Mr. Lowery for the purchase of a controlling interest in the Electro-Dynamic Light Company?

A. I have.

31 Q. Please to produce it.

A. I now do so.

32 Q. In what is that memorandum contained?

A. In a diary that I carried for the year 1879.

33 Q. Please to read the memorandum out of the diary produced by you, so that the examiner can copy it in the record.

A. Under date of Saturday, March 29, I read as follows:

"I called on Mr. Lowrey this morning. I made a proposition. His party to purchase"——

I am not certain whether the figures as written are $10,000 or $100,000.

"—of our stock and then to purchase enough of the treasury stock at 50 per cent. to control our company."

2286 34 Q. When you say "our company" in the memorandum, what do you mean?

A. The Electro-Dynamic Light Company.

Mr. Broadnax, counsel for complainant, here states upon the record, that the Exhibit Rockwell Kent Letter with the endorsement on the back in the handwriting of Mr. Sawyer, was given to him by Mr. Sawyer to be used in evidence in the interference between Edison and Sawyer and Man. Said letter was received by Mr. Broadnax almost immediately as he recollects it now, after the testimony was closed for Sawyer and Man and too late to be used by him in evidence; which said testimony was closed on or about the 23d day of September, 1881, that said letter and the endorsement in Sawyer's handwriting is exactly as it was when received by Mr. Broadnax and has been in his possession ever since.

Mr. Broadnax here agrees to have said letter and endorsement photo-lithographed to be used on the hearing of this case.

35 Q. State, if you please, whether the extract read by you to the examiner from your diary and by him copied into the record is an exact copy of the memorandum found in your diary.

A. It is.

36 Q. Was it made on the day of its date?

A. It was, which was Saturday, March 29th, 1879.

37 Q. These gentlemen that appeared to witness the exhibition in March, 1879, whom did you understand them to represent?

A. Parties interested in the Edison Company.

The examination of Mr. Church is adjourned till Monday, April 15th, 1889, at 11 a. m.

2287 NEW YORK, MONDAY, *April 15th*, 1889.

Met pursuant to adjournment.

Present: Counsel as before.

Direct examination of WM. H. CHURCH continued:

38 Q. You have stated that Mr. Man was not present at the exhibition in the Walker and Elm street shop on Friday evening, March 28th, 1879; state if you know why he was not present at that exhibition.

A. Because Mr. Man and Mr. Sawyer had disagreed in relation to the construction of their lamp. Mr. Sawyer claimed that what he called a feeder lamp would do better than the lamp they had been making, known as the Sawyer-Man lamp. Mr. Man had discontinued working with Mr. Sawyer altogether and would have nothing to do with the feeder lamp. Mr. Man had no knowledge of this exhibition at the time.

39 Q. Did you never measure the size and length of the bamboo and willow carbons you saw Mr. Myers making at the Walker and Elm street shop?

A. No, sir.

40 Q. Please to give the size and length of such carbons as nearly as you can judge and give also the form of them as nearly as you can recollect.

A. In size and length I should judge they were from one to six inches in length and were about the size of a broom-corn whisp; in form they were in straight pencil and in arch or loop form.

41 Q. At the time of the exhibit on the evening of March 28, 1879, how long did Mr. Lowrie and his friends remain there to witness the exhibition?

A. They arrived there about half past seven and remained there till about ten, as nearly as I can recollect.

42 Q. Were the lamps burning all the time?

A. Yes, sir, they were.

43 Q. How many lamps were there in circuit?

2288 A. Seven or eight.

44 Q. Who was Mr. Rockwell Kent, the person whose name is signed to the letter you have produced making the appoint-

ment for Mr. Lowrie and his friends to witness the exhibition on March 28th, 1879?

A. I don't know Mr. Rockwell Kent personally, but this letter was written in accordance with a promise made by Mr. Lowrie to myself, which promise was duly kept, and as this letter was written on one of their letter-heads I presume that Mr. Rockwell Kent was in some way connected with their office.

Cross-examination by W. K. GRIFFIN, Esq.:

42 X Q. In what other Sawyer-Man interferences have you testified other than the Sawyer and Man-Edison interference?

A. I do not recollect of any.

46 X Q. Did you not testify in the Sawyer and Man-Weston interference as to treating carbons?

A. Possibly.

47 X Q. Did you not testify in the Sawyer and Man-Maxim interferences?

A. I may have testified in those, I knew of them.

48 X Q. And you can't say whether you testif*y* in the Weston interference or not?

A. I cannot say positively.

49 X Q. When did you first become connected with the United States Electric Company?

A. About the time of its organization or soon after, about 1880 I should think.

50 X Q. How did you first become connected with the company?

A. I was employed to sell plants for electric lighting.

51 X Q. How did you come to go with them?

A. I was sent for by them.

2289 52 X Q. How long did you remain in their employment?

A. Quite a while, I can't remember exactly.

53 X Q. What is your best recollection?

A. Well I think I went into their employ in 1880, and left them in the winter of 1881, toward the spring. I am not quite sure.

54 X Q. Did you then know Mr. Curtis, the attorney for that company?

A. I did.

55 X Q. Did you not, in 1880, bring to Mr. Curtis' attention a certain agreement made between Mr. Sawyer and Mr. Flanagan, dated January 2, 1877, whereby Sawyer assigned three-fifths interest in certain patents and inventions to Mr. Flanagan?

Complainant's counsel objects to the question as not cross-examination and as not competent, pertinent and material in any aspect of the case and unless counsel shows upon the record that the question calls for something that is competent, material or relevant, complainant's counsel instructs the witness not to answer.

Defendant's counsel states that the materiality and relevancy of the question will fully appear as the cross-examination proceeds.

Complainant's counsel says in response that the question is not cross-examination, and that if he persists in examining witness upon matters not named in the examination-in-chief he makes the witness his own, and is responsible for what he testifies to, and complainant's counsel will claim the right to cross-examine him on such matters, and further that in the event that the relevancy, pertinency and competency of the questions does not appear by the examination he will move to strike out the whole of the so-called cross-examination.

2290 A. I don't think I did as early as 1880.

56 X Q. When did you do so?

Same objections and notice.

A. Some time after 1880 as I recollect.

— Q. Was it before or after you left the employment of the United States Electric Company?

Same objections and notice.

A. Oh, after.

58 X Q. Who represented the interest of Mr. Flanagan at that time?

Same objections and notice.

A. I think Mr. Schuyler always represented Mr. Flanagan's interest.

59 X Q. Why do you say you think; do you not know?

Same objections and notice.

A. I do not know positively.

60 X Q. Did you not act for Mr. Schuyler?

Same objections and notice.

A. Subsequently I did.

61 X Q. In trying to dispose of the Flanagan rights?

Same objections and notice.

A. I did, yes.

62 X Q. Were not certain drawings relating to those Flanagan rights in the possession of Mr. Schuyler?

Same objections and notice.

A. They were.

63 X Q. Mr. Schuyler's office at that time was in Nassau St., was it not?

Same objections and notice.

A. I think it was in Cedar, near Nassau, and then he moved round into Nassau street.

64 X Q. When did you first become acquainted with Mr. Richard N. Dyer, now one of the attorneys for the Edison Company and also of counsel for the defendant?

Same objections and notice.

A. I think it was in 1881.

65 X Q. When did you first become acquainted with Mr. Tomlinson, attorney for the Edison Company? 2291

Same objections and notice.

A. I was introduced to Mr. Tomlinson on the occasion of Mr. Evarts' argument before Judge Wallace in the New York case.

66 X Q. You were present to hear the arguments in court, is that so?

Same objections and notice.

A. Yes, sir.

67 X Q. Early in 1887 did you not go to see Mr. Dyer at his office 40 Wall St., New York city?

Same objections and notice.

A. I think I did in 1887.

68 X Q. Did you not see Mr. Dyer?

Same objections and notice.

A. I did.

69 X Q. Were you not by him introduced or reintroduced to Mr. Tomlinson?

Same objections and notice.

A. I do not remember; I may have been.

70 X Q. When you went to the office, 40 Wall street, the first time did you not see Mr. Dyer, and subsequently as part of the same interview, Mr. Dyer and Mr. Tomlinson together?

Same objections and notice.

A. I think I did.

71 X Q. Did you not tell them substantially that you were in possession of some important information as to the Sawyer and Man patent in suit?

Same objections and notice.

A. Well, I don't understand what you mean by "information." If you will be a little more explicit as to what you mean by information I will be able to answer your question; I have no objection to telling you the precise motive in seeing Messrs. Dyer and Tomlinson in relation to the Flanagan contract.

72 X Q. You spoke to them then about the Flanagan contract?

2292 & 2293 Same objections and notice.

A. I did.

73 X Q. What did you tell them as to that contract?

Same objections and notice.

A. I requested them to consider a proposition to purchase Mr. Flanagan's three-fifths interest in the contract between himself and

Mr. Sawyer in order that they might have the right to use the same if they should think it wise to do so in their own interest.

74 X Q. Did you not tell them substantially that you were in possession of information which would show that the patent in suit was entirely invalid?

Same objections and notice.

A. No, sir; and it was for that very reason that they declined to consider the proposition.

75 X Q. Did you not tell them that you were in possession of information which would show that so far as any invention had been made, it was the sole invention of Mr. Sawyer?

Same objections and notice.

A. Prior to 1878, before Mr. Man and Mr. Sawyer came together.

76 X Q. Did you not inform them that you were in possession of information which would show that the invention of the Sawyer and Man patent in suit was made by Mr. Sawyer prior to his association with Mr. Man?

Same objections and notice.

A. I do not remember that I did.

77 X Q. Will you swear that you did not?

Same objections and notice.

A. To the best of my recollection I did not. I do not see how I could from what was represented to have been done under the Flanagan contract.

Complainant's counsel calls witness's attention to the fact that the questions related especially to the inventions of the patent in suit.

2294 78 X Q. After hearing the statement of your counsel, do you wish to alter your previous answers?

Same objections and notice.

A. No, sir.

79 X Q. Did you not state to them that the contract between Sawyer and Man dated May 11th, 1878, by which Sawyer and Man were stated or believed to be joint inventors was made by Mr. Man so as to defraud Mr. Flanagan of his interest in the Sawyer invention which Mr. Man knew at that time to have been perfected?

Same objections and notice.

A. Before they came together in January, 1878, not at the time of May 11, 1878, as Mr. Sawyer and Mr. Man had been working together since the first of March, 1878.

80 X Q. Did you not tell them that Mr. Man when he was shown the Flanagan contract after his association with Mr. Sawyer, said

that the only way to get over the Sawyer obligation to Flanagan was by Man and Sawyer taking out inventions jointly?

Same objections and notice.

A. Mr. Man refused to go on with the construction of an electric lamp unless Sawyer and he should take out patents therefor jointly as under the Flanagan contract which had terminated in February, he thought that Mr. Flanagan might claim some rights. Mr. Man had not seen the Flanagan contract until about the 11th of May, 1878.

81 X Q. Now will you kindly answer my last question?

Same objections and notice.

A. Yes, as stated above.

82 X Q. Did you not tell them that Mr. Man in your presence, when he was shown the Flanagan contract, said the only way to get over that was by Man and Sawyer taking out joint patents?

Same objections and notice.

A. Mr. Man refused to continue; I think I did tell them practically that.

2295 83 X Q. Did you not state to them that some of these matters you were able to prove by drawings and papers in the possession of Mr. Schuyler?

Same objections and notice.

A. I think I did.

84 X Q. Did you not meet them at Mr. Schuyler's office and did not Mr. Schuyler produce photographs of these alleged drawings?

Same objections and notice.

A. Yes, sir, I did, and Mr. Schuyler produced the original drawings and photographs of them.

Adjourned to Tuesday April 16, 1889, at 11 a. m.

NEW YORK, *April* 16, 1889.

Met pursuant to adjournment.

Present: Mr. Broadnax for complainant and the witness Mr. Church and after waiting fifty minutes and no one appearing for defendant the examination was adjourned till Wednesday, 17th inst., at 11 o'clock a. m.

NEW YORK, *April* 17, 1889.

Met pursuant to adjournment.

Present: Mr. Broadnax for complainant and the witness, no one appearing for defendant and the complainant's counsel states that he has received no notice from defendant's counsel of his desire to further cross-examine the witness; he therefore takes it for granted that he has closed his cross-examination and proceeds with the redirect without waiving objections.

Redirect examination:

2296 85 R. D. Q. You have related upon your cross-examination something about an interview between yourself and Messrs. Tomlinson and Dyer, defendant's counsel; what was your object in calling upon these gentlemen at the time you did in 1887?

A. My object was to sell them the interest under the Flanagan contract.

86 R. D. Q. At whose instigation did you do that?

A. At the request of Mr. S. D. Schuyler.

87 R. D. Q. What price did Mr. Schuyler fix upon for the interest covered by the Flanagan contract?

A. About sixty thousand dollars.

88 R. D. Q. What portion of that was he to give you in the event of your succeeding in selling the contract?

A. One-third of whatever might be obtained. |

89 R. D. Q. And as I understand you Mr. Tomlinson and Mr. Dyer declined to purchase it?

A. That is so.

90 R. D. Q. Either for themselves or for the Edison Company?

A. That is so.

91 R. D. Q. What reason did they give for declining to purchase it, after seeing the papers and drawings pertaining to it in the possession of Mr. Schuyler?

A. That it was of no value to them or to the Edison Company.

92 R. D. Q. Did you offer to sell this same contract or the interest covered by it to any one else and if so to whom?

A. Yes, I first offered it to the Consolidated Electric Light Company, the complainant here, and they declined to purchase it for the same reason. I then presented it to Mr. Curtis of the United States Electric Light Company and he declined to purchase it for the same reason, that it would be of no value to them.

93 R. D. Q. Upon what did you predicate your statement to Messrs. Tomlinson and Dyer mentioned on your cross-examination?

2297 A. On the papers pertaining to the Flanagan contract in the possession of Mr. Schuyler, which they examined.

94 R. D. Q. And any other statement which you may have made to them as I understand you were merely in support of your effort to sell the contract, acting as negotiator for Mr. Schuyler?

A. Yes, sir.

95 R. D. Q. In your interview with Messrs. Tomlinson and Dyer what if anything was said by them to you as to your assisting them in the defence of this case?

A. They said that while there was nothing in the Flanagan contract of any value to them they would like to employ me personally to assist them in the defence of this case and that they would pay me handsomely for my services and they offered me a thousand dollars a day for any time that I might be employed in such service which I declined for the reason that I had already testified in the Sawyer-Man interference on behalf of Sawyer and Man.

Redirect examination closed.

New York, *April* 26, 1889.

Met pursuant to agreement of counsel.

Present: Mr. Broadnax for complainant, and Mr. Griffin for defendant, and the examination of Mr. Church was continued as follows:

Recross-examination of Mr. Church by Mr. Griffin:

96 R. X Q. Did you not at or about the time of your first interview with Mr. Tomlinson and Mr. Dyer leave with them printed copies of the record of the interference between Sawyer and Man, and also copies of agreement between W. E. Sawyer and Albon Man, dated respectively, March 19, and May 11, 1878; and also a copy of an agreement between W. E. Sawyer and Messrs. Smith and Flanagan, dated January 2, 1877.

2298 Objected to as not cross-examination, and not material or competent on any issue in the case.

A. I did not leave with them any printed copies of the testimony taken in the interference, but I left with them written copies of the contracts between Sawyer and Man, and also with Flanagan.

97 R. X Q. Did you not at one of your interviews with them or either of them leave a printed copy of the interference record just mentioned?

A. No, sir.

98 R. X Q. You never left or sent them such a copy?

Same objections.

A. I never had in my possession a copy of that record of interference; therefore, could not have left it with them.

99 R. X Q. Did you not leave with them a printed copy of the interference record in Sawyer and Man *vs.* Weston?

Same objection.

A. I never saw it in my life. I don't recollect of ever having seen such a copy.

100 R. X Q. Didn't you tell them, or either of them that you were desirous of making an arrangement with the Edison Company by which they should pay you a large amount of money provided you furnished testimony that would defeat the patent now in suit?

Same objections.

A. After they declined to purchase the Flanagan contract, on the ground that it was of no value to them, they requested me to engage in their service, in trying to defeat the patent in suit. I told them that I didn't see how I could be of any service to them, as I had already testified in behalf of Sawyer and Man. Mr. Tomlinson thereupon produced a printed record of my testimony in that case, and he agreed with me that I could not testify in their behalf, so, as to be of any value to them, and he then wanted me to think the matter over and see if I could not see some way in which I

could be of service to them. He said they would pay me handsomely and proposed to hire me by the day, and named as
2299 compensation one thousand dollars a day.

101 R. X Q. Now will you please answer directly whether or not you did not tell them when you went to them that you were desirous or anxious to make an arrangement with the Edison Co. by which they should pay you a large amount of money provided you furnished testimony that would defeat the patent at present in suit?

Same objections.

A. I told them that I had never contemplated entering their service in any such matter, that I had come to them for the purpose of disposing *off* the Flanagan contract, that if they could show me wherein I could be of service to them I should expect to be paid by them very liberally. I do not recollect any sum of money being named.

102 R. X Q. Did you not tell them that your terms were five thousand dollars cash and ten thousand dollars in the event of success, provided you would furnish testimony that would defeat the patent at present in suit?

Same objections.

A. I do not recollect. The whole scheme on their part appeared to be feeling around as to whether I could recollect anything that would be of any service to them, and we separated with the understanding that I was to see them again after trying to recollect whether I could be of any such service, and a few days afterwards I received a telegram from Mr. Tomlinson requesting me to call at their office at a certain hour. I think, 11 o'clock, a. m., on a certain day, I called in response to this telegram, and not seeing either Mr. Tomlinson or Mr. Dyer I left a note stating that I must decline to enter the service of Mr. Edison as I could not see any way to be of service to him in this suit.

103 R. X Q. Going back again to your early interviews with Mr. Tomlinson and Mr. Dyer did you not propose to them for five thousand dollars in cash and ten thousand dollars in the event
2300 of success to furnish them with testimony that would defeat the patent at present in suit?

Same objections.

A. I do not recollect any such proposition.

104 R. X Q. Will you swear you did not make such a proposition?

Same objections.

A. Whatever was said was predicated upon the provision that they should show me wherein I could be of service to them.

105 R. X Q. And upon that predication what was your offer to them?

Same objections.

A. I do not recollect. I told them they would have to pay me handsomely if I could be of any service which I did not then and have not since seen any way of accomplishing. Their proposition was a very great surprise to me.

106 R. X Q. How much did you ask them to pay you for the Flanagan interests?

Same objections.

A. Sixty thousand dollars.

107 R. X Q. And that they declined, did they not?

Same objections.

A. They did.

108 R. X Q. I hand you a typewritten paper and ask you whether the same is not a copy of a statement of facts drawn up in your handwriting and handed by you in manuscript to Messrs. Tomlinson and Dyer or one of them at or about the time of your first interview with them?

A. Without reading it all through I should think it was a copy of this was left by me in my handwriting.

109 R. X Q. And this you left with them at or about the time of your first interview?

Same objections.

A. Yes.

110 R. X Q. From whom did you derive the alleged facts set forth in that paper?

2301 Same objections.

A. From W. E. Sawyer.

111 R. X Q. How many times did Mr. Tomlinson and Mr. Dyer to your knowledge examine the Flanagan drawings at Mr. Schuyler's, or elsewhere?

Same objections.

A. Once.

112 R. X Q. And they refused the terms of sixty thousand dollars?

Same objections.

A. Yes.

113 R. X Q. When did they so refuse?

Same objections.

A. Some time after; a long time after.

114 R. X Q. Independently of the terms of this Flanagan offer, did you not try to make with them an arrangement by which you were to receive five thousand dollars cash and ten thousand dollars in the event of success provided you would furnish testimony that would defeat the patent at present in suit?

Same objections.

A. I never seriously contemplated rendering any such service to the Edison Company.

115 R. X Q. Did you not state exactly the terms I have mentioned?

Same objections.

A. I told them that if they could show me wherein I could be of service, I should expect very liberal compensation, but I do not recollect any amount of money or amounts of money being named; that I had not thought of this subject for a great many years, had then very little recollection, and would rely upon them to refresh my memory upon the subject.

116 R. X Q. Will you swear that you did not name the exact terms I have mentioned?

Same objections.

A. I do not recollect any amounts. It rested in my mind very lightly, as I had no idea of entering their service, and
2302 & 2303 not see how I could be of any service to them.

117 R. X Q. Did you not tell them that the five thousand dollars was necessary to reimburse you for the loss you would sustain, as you were a stockholder in the Consolidated Co.?

Same objections.

A. I might have told them that I was a stockholder, and that the success of their case would destroy the value of the stock which I held in the Consolidated Co.

118 R. X Q. How much stock did you then hold?

Same objections.

A. I have always held about the same. I guess about fifty or sixty shares of one hundred dollars each. I guess I held more. I must have held from fifty to eighty shares. On thinking it over, I think I held about eighty shares.

119 R. X Q. Did you not tell them that you felt bound to reimburse Mr. Schuyler and some other gentlemen as part reason for the amount you demanded?

Same objections.

A. I told them that the only thing I could consider would be a purchase of the Flanagan interest in which Mr. Schuyler was also interested.

120 R. X Q. Again I ask you whether you will swear that you did not demand five thousand dollars cash, and ten thousand dollars in the event of success, provided you furnished testimony that would defeat the patent?

Same objections.

A. I had no idea that I could furnish any testimony that would defeat the patent, and therefore do not see how I could have demanded any money beyond such services as they might designate for me to render.

121 R. X Q. Did you not name five thousand dollars in cash and ten thousand dollars in the event of success?

Same objections.

A. I do not recollect.

122 R. X Q. Did you not call at Mr. Tomlinson's office several times up to about June 30, 1887?

2304 Same objections.

A. I called as often as he made an appointment for me to call. He was never ready to give me an answer in relation to the Flanagan contract. He requested me to call, and call which I did about a dozen times, receiving each time the excuse that he was either too busy, or that the matter had not received sufficient consideration.

123 R. X Q. Did you not at one interview leave your address with him, and ask him to telegraph you when he wished again to see you?

Same objections.

A. I left my address with Messrs. Dyer and Tomlinson the first time I called at their office with these papers. I have no recollection of ever asking Mr. Tomlinson to telegraph me.

125 R. X R. Did you not leave your address and ask him to telegraph you at the occasion of your visit of June 24 or 25, 1887?

Same objections.

A. I don't recollect doing so.

125 R. X Q. Can you say whether you did or not?

Same objections.

A. I remember that I was surprised to receive a telegram the latter part of June from Mr. Tomlinson, so do not think I could have requested him to send me a telegram. He had promised to let me know when he would like to see me again.

126 R. X Q. Did he not telegraph you June 28, 1887, to call at his office the following morning at 11 o'clock?

Same objections.

A. He did.

127 R. X Q. Have you still the telegram?

Same objections.

A. I have.

128 R. X Q. In whose possession is it?

Same objections.

A. At present in Mr. Broadnax's

2305 129 R. X Q. When did you hand it to him?

Same objections.

A. A few days ago, possibly last Saturday.

130 R. X Q. In answer to that telegram you went, did you not?

Same objections.

A. I did.

131 R. X Q. Did you not see Mr. Tomlinson and Mr. Dyer, and have quite a long interview with them?

Same objections.

A. I called, but did not see either of them.

132 R. X Q. You are positive you did not see them when you called in response to that telegram?

Same objections.

A. I am.

133 R. X Q. When did you call again?

Same objections.

A. I called again, a week or so after this, and got the papers in relation to the Flanagan matter that had been left in their hands. I do not recollect ever seeing Mr. Tomlinson or Mr. Dyer again after the receipt of the telegram.

134 R. X. Q. Then you swear positively that in response to the telegram you did not have a long interview with Mr. Tomlinson and Mr. Dyer.

Same objections.

A. I do, and am sure of this, because I left a note addressed to them, or one of them, and took a copy of this note away with me, and I have this copy now in the possession of Mr. Broadnax, with the telegram.

135 R. X Q. Was not that note left July 1st, 1887?

Same objections.

A. Yes, sir; it is dated July 1, 1887.

136 R. X Q. Then you wrote in Mr. Tomlinson's office?

Same objections.

A. I did; in their offices.

137 R. X Q. On the day on which it is dated?

Same objections.

2306 A. Yes, sir.

138 R. X Q. And the time you called in response to the telegram of June 28th, was June 29th, was it not?

Same objections.

A. I am not sure whether I called June 29 or July 1st; I should think I called July 1st, as the note is dated on that day.

139 R. X Q. When did the telegram request you to call?

Same objections.

A. I think it was on the following day.

140 R. X Q. As a matter of fact, did you not call on the following day, June 29th, and have a long interview with Mr. Tomlinson or Mr. Dyer?

Same objections.

A. I have no recollection of calling then. A friend of mine was then laying at the point of death, and he did die, and I was with him most of the time. So I do not think I could have had any long interview with Mr. Tomlinson or Mr. Dyer in response to this telegram.

141 X Q. Did you not on June 29th have a long interview with them and after the interview inform them that you would call again July 1st and did you not call July 1st according to your promise and without seeing Mr. Tomlinson or Mr. Dyer and did you not then leave a letter for Mr. Tomlinson?

Same objections.

A. I do not think I did have an interview with them on the 29th of June, as a postscript to my letter states that I was unable to call on them at 11 o'clock as I had to attend to the funeral of my friend.

142 X Q. Did you not on June 29th, 1887, at the conclusion of your interview make an appointment to call July 1st at 11 o'clock and did you not, as a matter of fact, call on July 1st later in the day and fail to see Mr. Tomlinson and write and leave the letter for him?

Same objections.

2307 A. As a matter of fact I had no appointment to call upon Mr. Tomlinson before I received his telegram and in response to that I did call and failing to see either Mr. Tomlinson or Mr. Dyer I did write in their office a letter which I left for Mr. Tomlinson.

143 X Q. You are positive then that after you received that telegram you never called on either Mr. Tomlinson or Mr. Dyer until the occasion of your writing and leaving the letter July 1st, 1887?

Same objections.

A. I am.

144 X Q. Whether you had a long interview June 29, 1887, or not, did you not about that time have a long interview with them as to the subject of your giving testimony for the Edison Co.?

Same objections.

A. I recollect an interview but not that it was a very long interview.

145 X Q. Did you not at this or some other interview with them state in substance that your prior testimony in the Sawyer and Man interference was false?

Same objections.

A. No, sir. I couldn't recollect what that testimony was. How could I say it was false when I couldn't recollect it.

146 X Q. Then you swear that you did not so state to Mr. Tomlinson and Mr. Dyer or one of them?

Same objections.

A. I do.

147 X Q. Did you not tell them at this, or some other interview that prior to your giving testimony in the interference Mr. Man had dictated to you memoranda of what he had done and had tried to impress you with the fact that you had seen it done, or words to similar effect?

Same objections.

A. I never had but one interview with Tomlinson or Dyer upon
the subject of my employment by them in the interest of Mr.
2308 Edison and I told them that I had no recollection then of
what I had testified in the interference case between Sawyer-Man and Edison.

148 X Q. Now, will you please answer my last question?

Same objections.

(Question re-read to witness.)

A. I answer such question, no, sir.

149 X Q. Do you swear that you never made such statement to Mr. Tomlinson or Mr. Dyer, or either of them?

Same objections.

A. I do.

150 X Q. Did you not tell them of Mr. Man dictating memoranda for you prior to your giving your testimony?

Same objections.

A. No, sir.

Adjourned for lunch.

Resumed after lunch.

151 X Q. Then you are positive that you never mentioned either to Mr. Tomlinson or Mr. Dyer that Mr. Man had dictated memoranda, or have given you written memoranda connected with the subject-matter of your testimony in interference?

Same objections.

A. I am.

152 X Q. And your answer applies to all interviews which you had either with Mr. Tomlinson, Mr. Dyer, or both.

Same objections.

A. It does.

153 X Q. Did you not tell Mr. Tomlinson or Mr. Dyer, or one of them, that Mr. Man had endeavored to impress you with the idea that you had seen what Mr. Man spoke of, or gave you memoranda of, before your testifying in interference.

2309 Same objections.

A. No, sir.
154 X Q. That you will swear positively?

Same objections.

A. Yes, sir.
155 X Q. Did you not tell Mr. Tomlinson or Mr. Dyer, or one of them, at the time of your giving testimony in interference, you were interested in the success of Sawyer-Man, and in testifying, as you actually did, that you were, in fact, merely stating, what had been told you by Mr. Man, or words substantially to that effect?

Same objections.

A. No, sir.
156 X Q. Did you not tell Mr. Tomlinson or Mr. Dyer, or one of them, that at the time of your testimony in interference, you did not have, and at the time you talked with Mr. Tomlinson or Mr. Dyer, you did not have any recollection of having actually seen the things as to which you testified in interference, or words substantially to the same effect?

Same objections.

A. I told them I had no recollection of what I had testified to in the interference between Sawyer and Man and Edison; that it was about ten years ago, and the incidents and facts had passed from my mind.
157 X Q. To what incident and fact do you refer in your last answer?

Same objections.

A. The details and facts that transpired from the time Sawyer left the employ of Flanagan in February, 1878, up to the present time.
158 X Q. Those things you told them you did not remember?

Same objections.

A. I told them I did not remember them.
159 X Q. Please answer recross 156 as directly as possible?

Same objections.
2310 (Question re-read to witness.)

A. I did not.
160 X Q. Do you swear that you told them nothing of that kind?

Same objections.

A. Nothing of that kind. I did not recollect what I had testified to.
161 X Q. You miss the point of my question, which is as follows: Did you not tell Mr. Tomlinson or Mr. Dyer, or one of them substantially that when you testified on interference you testified as to matters as to which you had no recollection?

Same objections.

A. No.

162 X Q. Did you not substantially tell them that your testimony on interference was not given from your own recollection, but from memoranda and suggestions and information given to you by Mr. Man?

Same objections.

A. No, sir.

163 X Q. Did you not tell them in substance that you had been led or influenced to give your testimony by Mr. Man and by Mr. Broadnax, and that the testimony you had so given was false?

Same objections.

A. No, sir.

164 X Q. Did you not offer to testify as to this on behalf of the Edison Company in the New York case, brought against them by the Consolidated Company providing you were paid the amount you demanded?

Same objections.

A. No, sir.

165 X Q. Did not Mr. Tomlinson or Mr. Dyer, or one of them, inform you in substance that they did not wish to be in the position of purchasing testimony, or doing anything that was improper, and that they could not use you and would not use you, if you
2311 were put on the stand without stating just what the arrangement was and how it came about, and that you would have to state on the stand that your previous testimony was false, if the story you were telling then was true, and that this would place you in a very bad position?

Same objections.

A. No, sir; there was no arrangement to explain.

166 X Q. Did not Mr. Tomlinson or Mr. Dyer, or one of them, inform you that the Edison Company would be very reluctant to make any such arrangement as to pay you a sum down and a sum in the event of success, and that they considered it your duty to testify to the truth, whatever it might be, whether for or against them, and that all that could be properly done, would be, to pay you reasonably for such time as you might devote to testifying or procuring evidence, or words substantially to this effect?

Same objections.

A. No. They said they would employ me by the day, and would pay me very liberally to assist them in procuring testimony, and I told them to indicate what services they would require of me, which they promised to do, but I have never seen them from that hour to the present on that subject.

167 X Q. Did you not then make a counter-proposition to the effect that they should pay you twenty-five hundred dollars down

and fifteen thousand dollars in addition, in case of success in defeating the patent at present in suit?

Same objections.

A. No; this terminated the interview.
168 X Q. What terminated the interview?

Same objections.

A. The interview terminated with the understanding that they should indicate to me what services I would be expected to render.
169 X Q. What interview terminated?

Same objections.

2312 A. The only one we ever had upon this subject at the time when they declined to purchase the Flanagan contract.
170 X Q. What was the date of that interview?

Same objections.

A. In June, 1887, a few days prior to the receipt of the telegram which I received from Tomlinson.
171 X Q. Did you not at some time make to them the proposition substantially as stated in X Q. 167?

Same objections; (same read to witness.)

A. No, sir.
172 X Q. Did you not state to them or one of them that the reason of your willingness to take less in cash down and more by way of contingency was because you were entirely confident of success in beating or destroying the Sawyer-Man patent in suit?

Same objections.

A. No, sir.
173 X Q. Did they not reply to you substantially that they could not know the value of your testimony or of information which you represented to them you were able to procure until they knew what it was?

Same objections.

A. No, sir. I had no information.
174 X Q. Did you not represent to them that you had sources of information unknown to them which you could work up, and which you were confident would destroy the Sawyer-Man patent in suit?

Same objections.

A. No, sir. I had no recollection on the subject at the time they spoke to me upon this matter.
175 X Q. Did you not tell them that until they paid you what you demanded you were unwilling to give them further information?

Same objections.

A. No, sir.

2313 176 X Q. Did you not tell them, or intimate to them, that within fifteen minutes you could put them in the way of obtaining information which would destroy the patent at present in suit?

Same objections.

A. No, sir.

177 X Q. Did you not tell them that if you put them in possession of this information you could not be protected, and that they would no longer be dependent upon you?

Same objections.

A. No, sir.

178 X Q. Did you not for these reasons decline to send them further information unless they agreed to your demand?

Same objections.

A. No, sir.

179 X Q. Did they not then ask you whether this proposition would be satisfactory to you, to pay you so much down whatever it might be, for you to make a truthful statement to them, whether they used it or not, and then if they decided to avail themselves of your services, to pay you reasonably for the time you devoted to this service?

Same objections.

A. No, sir.

180 X Q. Did you not then leave without accepting or refusing this proposition, but saying substantially to them that they should ask their company what they thought of your original proposition and demand?

Same objections.

A. No. There was nothing to accept or reject. I left them with the understanding that they would indicate what way I could be of service and from that day to this I have never seen them.

181 X Q. Did you not leave them promising to call again, July 1st, at 11 o'clock in the morning?

Same objections.

A. No, sir.

2314 182 X Q. Did you not as a matter fact, call at their office July 1st, 1887, at a later hour than 11 o'clock in the morning?

Same objections and also that the witness has answered the same question two or three times.

A. Yes. I did call July 1st, and left the letter already referred to.

Defendant's counsel offers in evidence the copy of the statement of alleged facts referred to in cross-question 108 and the same is marked Defendant's Exhibit Church Statement of Facts, April 26, 1889.

Counsel for complainant does not intend to waive his objections or notice of motion to strike out the so-called cross-examination, but insists that the cross-examination has no reference whatever to the examination-in-chief, and that in pursuing the course defendant's counsel has pursued he has made the witness his own, and is not at liberty to contradict him, proceeds to ask the witness a few questions on redirect, and to put in two exhibits, viz: the telegram received by the witness from Mr. Tomlinson, and also a copy of the letter left by the witness at the office of Tomlinson & Dyer for Mr. Tomlinson on July 1st, 1887.

185 R. D. Q. Please to look at the telegram I now hand you and state if you identify it, as the telegram you received from Mr. Tomlinson.

A. I do.

Telegram offered in evidence and marked Complainant's Exhibit Tomlinson Telegram, April 26, 1889, W. T. F., sp. ex'r.

186 R. D. Q. Please to look at the letter now shown you, and state if you identify it as a copy of the letter left by you with Mr. Tomlinson.

A. I do.

187 R. D. Q. Was this copy of that letter made at the time the letter was written in the office of Mr. Tomlinson?

A. It was.

2315 Letter offered in evidence and marked Complainant's Exhibit Church Letter to Tomlinson, W. T. F., special examiner, April 26, 1889.

188 R. D. Q. Referring now to Defendant's Exhibit Church Statement of Facts. Please examine it and state if you recognize that as a copy of one of the papers given by you to Mr. Tomlinson as one of the papers upon which you predicated any statement, you may have made to Tomlinson about the Sawyer-Man patent in your effort to sell the Flanagan contract.

A. I do.

WILLIAM H. CHURCH.

DEFENDANT'S EXHIBIT CHURCH STATEMENT OF FACTS. April 26, 1889. W. T. F., S. E.

January 2nd, 1877. Agreement between Sawyer and Flanagan, in which Sawyer assigned $\frac{3}{5}$ interest in certain patents then already taken out by him, also $\frac{3}{5}$ths interest in a number of inventions contemplated but not patented; also agreed to assign $\frac{3}{5}$ths of all inventions and improvements which he should make during the exist*a*nce of this agreement.

February 15th, 1887. This agreement continued in force until the 15th of February, 1878, during which time Sawyer kept his office with Flanagan in the Coal and Iron Exchange building on Cortlandt street, N. Y. city, where the laboratory for experiments was situated.

In the months of November and December, 1877, Sawyer invented and made full drawings of the improvements and ideas contained in the "Sawyer-Man" patents and fully experimented upon them, testing their practicability, and these original drawings are now in the possession of S. D. Schuyler, No. 44 Broadway, N. Y city.

2316 These valuable discoveries were secreted by Sawyer from Flanagan though he continued in his employ and received his salary weekly till February 15, 1878.

In the early part of February, 1878, Wm. E. Sawyer was introduced to Albon Man, before he had left the employ James Flanagan, and Albon Man was shown all these drawings, fully representing the "Sawyer-Man" patents and went to the laboratory in the Coal and Iron Exchange building, and there saw the experiments made by W. E. Sawyer, showing the practical workings of these inventions.

About February 15, 1878, Albon Man made arrangements with Wm. E. Sawyer and on March 19, 1878, they entered into a written agreement.

See copy of this agreement, as taken from an exhibit in the interference between Thomas A. Edison and Sawyer and Man.

In the month of May, 1878, Albon Man, for the first time, saw the agreement between Sawyer and Flanagan of January 2d, 1877, and discovered that all that Sawyer has which was of any value belonged to the extent of $\frac{3}{5}$ths to Flanagan, and after devising various modes of getting around this agreement, among which was to get a statement from Flanagan of his expenditures and reembursing him under certain provisions of the agreement, Albon Man decided that they could not get rid of the agreement in that way because these inventions had been kept concealed from Flanagan so that he had had no opportunity to decide whether he would accept and patent the invention or not.

Albon Man finally hit upon the mode which was adopted, which was to take out these patents for the inventions as joint inventors, and then the second agreement between W. E. Sawyer and Albon Man was made on the 11th of May, 1878.

See copy of this agreement, as taken from an exhibit in the interference between Thomas A. Edison and Sawyer and Man.

2317 The original drawings made by Sawyer in 1877, before he saw Albon Man, with affidavits made by W. E. Sawyer and also by James G. Smith who was associated with Sawyer in the agreement with James Flanagan, are in the hands of Spencer D. Schuyler at 44 Broadway, N. Y. city, who has the power to transfer all rights, titles and interests in and to the agreement between W. E. Sawyer and James G. Smith with James Flanagan of January 2d, 1877, and the party possessing this will have the right to use these facts, as stated above, against the "Sawyer-Man" patents.

See copy of the agreement between W. E. Sawyer, and James G.

Smith with James Flanagan of January 2d, 1887, as taken from an exhibit in the interference between Hiram S. Maxim *vs.* Sawyer and Man.

As the reason for having these patents issued for a joint invention was to avoid any obligation under the Flanagan agreement.

COMPLAINANT'S EXHIBIT TOMLINSON TELEGRAM. April 26, 1889. W. T. F., Spe. Ex'r.

JUNE 28, 188–.

Dated New York, 16 Broad St., 28.

To W. H. Church, 536 E. 87 :

Please call at my office at eleven to-morrow.

JOHN C. TOMLINSON.

2318 COMPLAINANT'S EXHIBIT CHURCH'S LETTER TO TOMLINSON. April 26, 1889. W. T. F., Spe. Ex'r.

JULY 1, '87.

MY DEAR SIR : Any attempt to prove that Man was not a joint inventor with Sawyer on the ground that he proposed himself as a joint inventor to avoid Sawyer's obligations to Flanagan will be met by the question : whether the obligations between Sawyer and Flanagan were ever of any interest to Edison or to his company, and if not, then how do they become relevant to their interests now?

On reflection, I have decided not to engage in Mr. Edison's matter, as I do not see my way clearly to be of service to him.

Yours, &c., W. H. CHURCH.

P. S.—Have to attend the funeral of an old friend this morning so could not be here at 11. I will call on you next Tuesday at 11 a. m. for the papers which were left in your hands when these negotiations commenced.

Yours, W. H. C.

2319 NEW YORK, *April 23d*, 1889.

Met pursuant to notice.

Present, Mr. Broadnax for complainant, and no one for defendant.

Amos Broadnax Recalled.

AMOS BROADNAX of counsel for complainant being recalled testifies as follows:

The statement made by me on the record following the answer to question 34 of Mr. Church's deposition is true of my own knowledge, said statement referring to Complainant's Exhibit Rockwell-Kent Letter produced by said Church in his deposition.

I desire to say further, that on or before January 7, 1888, I, as counsel for the Consolidated Electric Light Company, retained Wm. Hochhausen as electrical expert, and gave him a general retainer for services to be rendered by him as such expert for the Consolidated Electric Light Company, the sum of two hundred and fifty dollars, as appears by his voucher for that amount of money on that day, the said voucher being in the words and figures following:

"$250. New York *Jan'y* 7, 1888.

"Received of Sawyer-Man Electric Co. two hundred and fifty dollars in full, general retainer for services as expert for Consolidated Elictric Light Co.

"WM. HOCHHAUSEN."

The foregoing is a true copy of said voucher; the said Hochhausen being retained to testify as an electrical expert, and for no other purpose, and he was under such retainer when he was called to testify for defendant herein.

Mr. Lowrey appeared for defendant and waived cross-examination.

AMOS BROADNAX.

2320 New York, *April 22nd*, 1889.

Met pursuant to notice.

Present: Mr. Broadnax for complainant, and Mr. Donnelly for defendant.

Testimony of Edward Berry.

Edward Berry, a witness called on behalf of complainant and duly sworn, testifies as follows:

1 Q. What is your name, age, residence and occupation?

Edward Berry, 41 years of age, I live at Rutherford, N. J. I am manager for a fishing-tackle house, J. B. Crook, of New York. Their place is at 50 and 52 Fulton street.

2 Q. Were you employed by them in the year 1878?

A. Yes, sir.

3 Q. Are you acquainted with Albon Man?

A. Yes.

4 Q. How long have you known him?

A. To the best of my knowledge for at least twenty-five years.

5 Q. State whether or not you have furnished Mr. Man with any kind of woods.

A. Yes.

6 Q. State if you knew what use Mr. Man made of such woods.

A. No, sir; not at the time he got the sticks from me.

7 Q. Please to give the names of the different kinds of woods you furnished him, and furnish specimens of the woods, if you can do so.

Objected to as immaterial, irrelevant and incompetent.

A. He took every kind I was using: logwood, lancewood, hickory, greenheart, bamboo. I have with me three kinds: lancewood, greenheart and bamboo, all of which I produce.

Specimens offered in evidence and marked respectively "Complainant's Exhibits Lancewood Produced by Berry, Greenheart Produced by Berry, and Bamboo Produced by Berry, W. T. F., special examiner, April 22, 1889." 2321

Said exhibits objected to as immaterial, irrelevant, and incompetent.

8 Q. State, if you recollect, when it was that you furnished these woods to Mr. Man.

A. It was in the fall of 1878. It was either in September or October, I won't say emphatically which month or which day; but it was within one of those two months.

9 Q. Where did this bamboo come from?

A. It comes from China; we call it Calcutta bamboo to distinguish it from Japanese bamboo.

10 Q. Where did the bamboo come from that you furnished to Mr. Man in 1878?

Same objection as to 7th question.

A. It is Calcutta bamboo, same as the exhibit.

Cross-examination by Mr. Donnelly.

8 X Q. How long have you been in the employ of J. B. Crook?

A. Since 1859.

9 X Q. What was your position with J. B. Crook in the year 1878?

A. Manager.

10 X Q. Manager of what?

A. Of the business.

11 X Q. What did that include?

A. Buying and selling of goods and taking care of the business financially.

12 X Q. How extensive a business did you do at that time?

A. Doing a business of about twenty thousand dollars a year.

13 X Q. Where did J. B. Crook then reside, and where does he now reside?

A. He then lived at Rutherford, N. J. He is dead.

14 X Q. In whose employ are you now?

2322 A. Of his estate.

15 X Q. When did you first become acquainted with Albon Man?

A. I am sure that it was as early as 1870.

16 X Q. Where did you first become acquainted with him?

A. At No. 50 Fulton street, New York.

17 X Q. Did you know him personally and intimately in 1878?

A. Yes.

18 X Q. Did your acquaintance arise simply in the course of dealing or selling him goods?

A. That is all.

19 X Q. You simply knew him in 1878 as you did other customers to whom you from time to time sold goods?

A. Yes, sir.

10 X Q. These woods which you speak of as having furnished Mr. Man in 1878; did you sell them to him or did you give them to him?

A. I gave them to him.

21 X Q. When was your attention first called to the fact of your having given these woods to Mr. Albon Man after you furnished them to him as you have stated and by whom?

A. I think it is about 18 months ago by Mr. Man.

22 X Q. Between the time that you furnished the woods in 1878 and 18 months ago, when you say Mr. Man called your attention to the fact, had your attention been directed to the circumstance that you had furnished such woods to Mr. Albon Man as stated?

A. No, sir, not before that time.

23 X Q. I suppose that you hadn't thought about it after you let Mr. Man have the woods until he called your attention to it about eighteen months ago.

A. I hadn't thought anything about it; no, sir.

2323 24 X Q. The fact that he obtained such woods of you had not been a matter of consideration or reflection after you let him have the woods in 1878 until he spoke to you about it?

A. No, sir.

25 X Q. Mr. Man, you say, called your attention to the fact that he had obtained certain woods of you about eighteen months ago. Did he then state what woods he got of you in 1878?

A. Mr. Man asked me if I remembered giving him some pieces of wood, and I told him yes.

26 X Q. Did Man state to you at that time what wood or particular woods he had obtained of you in 1878?

A. I don't think he did.

27 X Q. There was no special circumstance connected with the furnishing of the woods to Mr. Man in 1878, was there?

A. No, sir.

28 X Q. And you hadn't thought about the woods you furnished him in 1878 until he asked you about it eighteen months ago?

A. No, sir.

29 X Q. You made no written memorandum of the fact that you furnished Mr. Man those woods in 1878, did you?

A. No, sir.

30 X Q. And you testify wholly from recollection?

A. Yes, sir.

31 X Q. Have you now, or have you ever had, any business relations with Albon Man other than furnishing these woods?

A. Nothing but selling him fishing tackle.

32 X Q. When were you subpenæed?

A. I came on the application of Mr. Broadnax.

33 X Q. Have you received any fees as a witness?

A. No, sir.

34 X Q. Mr. Man is an old customer of yours and you came

voluntarily as a matter of friendship and regard for Mr. Man, I suppose?

2324 A. Yes, sir.

35 X Q. Do you mean to say that there has been no conversation between you and Mr. Man in which he referred to the different kinds of woods which your furnished him in 1878?

A. Well at the time that he spoke to me first, he asked me if I remembered the kinds of wood I gave him, and I told him yes, I named over the same woods I have spoken of in my testimony.

36 X Q. At that time or at any other time prior to this examination did Mr. Man mention the fact that he had obtained bamboo of you in 1878?

A. I acknowledged to Mr. Man at the time he asked me that I had given him bamboo among the other woods.

37 X Q. Did he also acknowledge that you had done so?

A. Yes, sir.

38 X Q. What did he say to you about getting bamboo of you in 1878, at the time of this alleged interview?

A. He said nothing at all about bamboo.

39 X Q. Then Mr. Man at the time of this interview of which you have testified, manifested no interest whatever in the fact that he had obtained bamboo of you in 1878?

A. No, sir.

EDWARD BERRY.

2325 NEW YORK, *April 26th*, 1889—10.30 a. m.

Met pursuant to adjournment.

Present: Counsel as before.

It is stipulated by counsel that the volume entitled "Report from the select committee on lighting by electricity; together with the proceedings of the committee, minutes of evidence and appendix," portions of which have been quoted by Mr. Pope in his answer to question 193, may be read from at the hearing in this case, with the same force and effect as if the volume had been duly offered in evidence, so far as the same relates to the matters referred to by Mr. Edison and Mr. Pope with respect to the evidence given before the parliamentary committee on the subject of the subdivision of the electric light.

Cross-examination of the witness by defendant's counsel:

202 X Q. In your answer to question 193, you have referred to three applications of the incandescent electric light. To which of those applications does Complainant's Exhibit Defendant's Lamp relate?

A. It relates to the first application; that is to say, central-station lighting. It might be used without any particular disadvantage for isolated lighting also.

203 X Q. It, however, is not adapted for the third application described by you?

A. It is not. A lamp for the third application should have a shorter and thicker carbon.

204 X Q. With regard to the Sawyer patent No. 194,111, referred to by you, do you consider that patent as describing a fundamentally correct system of distribution in parallel or multiple arc for incandescent lamps such as you seem to be of the opinion by your answer 193, had been described in the Sawyer or Sawyer & Man patents prior to September, 1878?

A. The patent referred to does not describe a system of
2326 distribution in parallel at all, but a system of distribution in
series.

205 X Q. Is it such a system as has been practically used in the first application of the incandescent lamp referred to by you, namely, "general domestic or house-to-house lighting, now generally termed central-station lighting," or for the second application of incandescent lamps referred to by you?

A. It shows one prominent feature of modern central-station distribution by direct currents, which consists in leading more than one conductor for supplying lamps from each terminal of the electric generator, but it does not show this system carried out in detail in any of the separate circuits supplied from a common generator.

206 X Q. What is the kind of electric lamp shown and described in this patent?

A. The only lamp shown in the drawings is an arc lamp, but in the specification this is referred to as an "electric lamp or other apparatus" and various other kinds of apparatus are elsewhere suggested in the specification as for electroplating, heating and motive power.

207 X Q. The electric lamp, however, specifically described and shown is an arc lamp?

A. Yes.

208 X Q. Do you consider that the Sawyer patent No. 196,834, referred to by you, describes a fundamentally correct system for incandescent lighting?

A. It certainly does so far as concerns the distribution of the current through parallel mains and parallel cross-branches, each of which can be opened and closed without affecting the others. It is not correct, or at least not in accordance with good practice to provide resistances for shunting the lamps, as these are of no use. Therefore I should express my opinion by saying that the system is correct in its general plan and incorrect in the details of the lamp connections.

209 X Q. Would not the use of the continuity-preserving
2327 switches, as shown in figures 1 and 4, involve a fatal error in
principle, which would be destructive of the operation of the
system for any practical purpose?

A. I would hardly be willing to go so far as that. The objection to the device is that practically the same amount of energy is consumed, irrespective of the number of lamps lighted, whether one or many. Subsequent to the date of this patent, means were invented or discovered of regulating the supply of current at the generator in accordance with the requirements of consumption, and as soon as this had been done, such devices as those shown in the patent now under consideration at once became useless and unnecessary.

210 X Q. Would not the substitution of a short circuit, such as would be formed by closing the continuity-preserving switch F G, for the resistance of the arc lamp B B, have the effect of short-circuiting the lamps in the system, so as to deprive them of a proper amount of current, and to cause an abnormal flow of current which might be destructive of the conductors which carry the current?

A. Such would probably be the case if it were applied in what is known as a multiple-arc system of distribution, such for instance as figure 4, or figure 5, if we assume the latter to be a multiple-arc circuit.

211 X Q. Is not the object of this patent No. 196,834, as shown by the matter beginning with the bottom of the second column of the first page of the specification, and continuing on the second page, to substitute a multiple-arc arrangement for the series arrangement of the earlier patent, No. 294,111?

A. Unquestionably.

212 X Q. Then this patent, No. 196,834, so far as the apparatus shown in figures 2, 4 and 5, is concerned, describes an absolutely inoperative arrangement?

A. Yes, I think it may be so considered.

2328 213 X Q. With respect to the apparatus shown in figures 1 and 3 of this patent, is that arrangement used in practice in multiple-arc systems of lighting by incandescence?

A. It is not. The modern arrangement is to place the lamp and the switch for turning it on and off, directly in the cross-circuit, and to omit the resistance E which bridges over the switch and the lamp in figures 1 and 3.

214 X Q. The effect of the arrangement of figures 1 and 3 is to cause the consumption of just the same amount of electrial energy when one lamp is burning, as when the total number in the system are burning?

A. Yes, nearly that.

215 X Q. Isn't it exactly that, as shown from the following quotations from the patent itself?

"The operation of my invention will be readily comprehended from the drawings, the current from the generator J having a constant flow through each of the branches, whether the apparatus in that branch is or is not operating."

A. If the words quoted mean that the flow is constant as to quantity, then the assumption in your question is correct. If it means constant as to time, which meaning would accord better with the drawing, then the consumption of current is somewhat greater when each lamp is in action than when it is not. Of course it is not an economical arrangement in either case.

216 X Q. I should have completed the quotation in my last question by adding the closing words of the sentence, which are as follows:

"So that a single generator may be used to operate any number of apparatuses without the interference of one apparatus with another."

In view of this language, which of the two assumptions of your last answer do you consider the more reasonable?

A. Evidently the first one, because such interference would 2329 not exist unless the currents in the several branches were maintained at a constant strength, or there was some means of regulating the current at its source, which last is apparently not contemplated by the patentee.

217 X Q. Then the system described in connection with figures 1 and 3 of the patent, is one in which the same amount of current would have to be generated when one lamp is burning as when a thousand lamps are burning?

A. Yes.

218 X Q. Would you consider such a system practicable?

A. It would be entirely so for some purposes, but of course not for general lighting. It might be applied for example, to the lighting of streets, squares, markets, railway stations, and the like, where a large number of lamps are to be turned off and on at the same time. Of course in general domestic lighting, in which the lamps must be individually under the control of the consumers, it would be impracticable for economical reasons.

219 X Q. What would make it applicable to the lighting of streets, etc.?

A. The circumstance that when one lamp in the system is required, all the lamps are required, and *vice versa*.

220 X Q. That is, the whole current would be cut off or turned on at the source, and the resistances E would not be used at all; is that your idea?

A. My idea is that it might be used as the system of arc lighting in series was first used, all the lamps being as a rule turned on and off together, but devices being provided whereby an individual lamp could be discontinued if desired, though not with any decrease in the cost. It was not an economical system, as I have said, but on the other hand it was not without utility in the state of the art at that time.

221 X Q. It is a fact though, is it not, that the patent contemplates the use of the system for general house to house distribution, as shown by the second page of the specification?

2330 A. Yes, that was no doubt the intention of the patentee among other things; it was evidently designed to apply under any circumstances in which electric lights fed from a central station might be required.

222 X Q. You would hardly call it then a fundamentally correct system of distribution, as we understand the requirements of such a system at the present day?

A. Not in its details, certainly. It only marks a certain stage in the gradual development of the art.

223 X Q. In the patent of Sawyer & Man No. 205,305, you find "for the first time an apparatus for automatically regulating the production of electricity at its source," which you think is "a plan

which is now in universal use," and which you regard "as lying at the very foundation of all the approved modern systems." Is it not a fact that in the Edison central station system, the regulation is performed by hand?

A. It is partially performed by hand, I think, in the Edison and in all other central stations. In my answer referred to, I did not mean to say that it was especially the automatic regulation which was important, although the language is open to that construction, but the regulation of the production at the source in accordance with the consumption. It should be stated also that after the date of the Sawyer & Man patent 205,305, improvements were gradually introduced in the construction, and especially in the proportions of dynamo machines, due to a better knowledge of the mathematical principles governing the flow of current, by which these machines were rendered self-regulating to a very large extent, by the law of their construction, thus rendering the use of special apparatus for the purpose less important, so that in practice the self-regulation of the machines, with occasional assistance from the attendant, is perfectly competent to deal with the widest range of variation in the consumption.

2331 224 X Q. Then as a matter of fact, aside from the capacity of the dynamos to regulate themselves, the regulation in central station systems is performed by hand and not automatically?

A. Yes, I believe that this is true of all incandescent systems in which the units of light are small and the changes in consumption consequently somewhat gradual. The automatic method of regulation has found its widest application in series lighting, especially with arc lamps in which the changes are comparatively sudden; it is, I believe, in very extended use in connection with such systems.

225 X Q. The apparatus of this Sawyer & Man patent 205,305 has not then had an extended use for incandescent lighting?

A. No, I do not know that the particular apparatus described by them is in use at all, but this patent, nevertheless, is the first of which I have any knowledge, which contemplates the regulation of the production of electricity at its source, in accordance with the requirements of consumption, whether by the means described, or equivalent apparatus of other construction.

226 X Q. The apparatus shown and described in this Sawyer & Man patent is not an operative one, is it?

A. If the description and drawings be literally followed, I do not think it is. The person who prepared the specification has inserted a misdescription in a certain part of the mechanism, apparently not fully understanding the principles involved, which strictly speaking vitiates the description, so that a machine made in literal accordance with it would not be operative. An exceedingly moderate degree of skill and intelligence would be sufficient to set this matter right and make the machine operative. As a matter of legal sufficiency it may be that the specification is defective.

227 X Q. What portion of the apparatus do you refer to as misdescriptive?

A. I refer to the pulley C and cap D, in figures 1 and 2, one of
which is described as carrying the other along with it, by
2332 direct magnetic attraction, the two not being in contact.
This is of course absurd, and no such action could take
place. If, however, the parts were permitted to come in frictional
contact, then I have no doubt the machine would be an operative
one.

228 X Q. And you think this change would be made by the application of an exceedingly moderate degree of skill and intelligence and without the exercise of invention?

A. I think so. It does not seem to me that any invention is required to set the thing right, in view of the fact that the description in the specification is plainly erroneous, inasmuch as it would seem as if any one having any knowledge of the laws of magnetic attraction would know that the result set forth could not be obtained when the parts were not in contact.

229 X Q. Is it your view then that by rectifying the mistakes as to the pulley C and cap D, the apparatus of the patent would become operative?

A. I am very well satisfied that it would, as I have seen it tried, and it did operate successfully.

230 X Q. Did you not testify as an expert for the complainant in the suits pending in the U. S. circuit court for the southern district of New York, entitled The United States Electric Lighting Company and The United States Illuminating Company, complainants, against The Edison Company for Isolated Lighting, defendant, in equity Nos. 3415 and 3419, in which the Sawyer and Man patent No. 205,305 was set up as an anticipation by the defendant of the Farmer patent sued upon?

A. I did.

231 X Q. Did you not in that case testify as follows, with respect to the said Sawyer and Man patent:

50 X Q. This patent No. 205,305 describes, does it not, the invention of the Farmer patent in suit, or all that is essential to it, in your opinion?

A. It describes substantially a similar invention which was evidently designed to accomplish the same result.

2333 51 X Q. It describes the same method of regulation applied to the same kind of an electric lighting system as that set forth in the former patent, does it not?

A. It purports to describe the same method, although I have not been able to discover how the result can be effected by means of the apparatus described by the patentees. Assuming the apparatus to be operative, then, in my opinion, the method of regulation is the same, and it is applied to the same kind of lighting system as that described in the patent of Farmer.

* * * * * * *

53 X Q. Assuming the Sawyer & Man patent No. 205,305 to antedate the invention of Farmer, and bearing in mind the fact to

which I understand you have testified, that the separate elements of the Farmer regulating apparatus were not new with Farmer, would it, in your opinion, have required the exercise of invention, as distinguished from mere mechanical skill, to produce the apparatus described in the Farmer patent?

A. I think it certainly would require invention to pass from the Sawyer & Man apparatus to that of Farmer. In the first place I do not see how it is possible to effect the result aimed at by means of the apparatus described by Sawyer & Man, and even if it be assumed that the apparatus is operative, yet the substitution of more suitable mechanical devices would exhibit invention. Of course, in a broad sense, it might be said that the invention had been made by Sawyer and Man, and in this sense it could not be made again by another party in the capacity of a first inventor.

* * * * * * *

84 X Q. In what respect is the apparatus of the Sawyer & Man patent 205,305, defective?

(Objected to as not open.)

A. It is stated on page 2 of the specification, seventh line from top of first column that "the flange A' pulley C' and hub C' also become magnetic, and the tendency of the hub C' is to att-act the cap D in the direction of rotation of the pulley C, and thus to overcome the retractile force of spring F."

2334 It is stated in the second column of page 1, about two-thirds of the way from the top of the column, that the hub C', here called a flange, does not touch the cap D. In my opinion the statement above quoted to the effect that the hub C' will tend to attract the cap D in the direction of rotation of the pulley C, and thus overcome the spring F, is not true. The attraction will not be in the direction of rotation, but will be parallel to the axis and cannot in any way act to overcome the retractile force of the spring F. This is an essential point in the operation of the apparatus, and I am perfectly satisfied that it cannot possibly be made to operate in the manner and by the means set forth in the specification and shown in the drawing.

* * * * * * *

"106 R. D. Q. Do you find in the Sawyer & Man patent the organization of circuits described in the Farmer patent and referred to in the claim, or any equivalent therefor?

"A. The patent of Farmer describes a number of circuits in parallel or multiple arc, each containing a lamp, and one containing an electro-magnet, which acts to control, simultaneously, the current in all the branches of the system, without producing any other effect upon the branch in which it is itself situated than it does in any other branch. There is no circuit in the Sawyer & Man apparatus which fulfills this condition. The operation of the controlling device, assuming it to be operative, which it is not, would act to vary the resistance, and consequently the strength of the current in its own branch of the circuit independently of its action upon the system as a whole, and it would thus introduce an element of error and uncertainty in the regulation. There is no controlling branch of uniform resistance in the Sawyer & Man apparatus.

"107 R. D. Q. Would this difference, in your opinion, be a material one so far as the action of the regulator is concerned? You may assume for the purpose of this question that the controlling device of the Sawyer & Man patent operates to open and close the local circuits in the manner described in the specification.

2335 "A. I think it would. I think it would introduce an error into the regulation, that is to say, it would permit of a variation in all parts of the system, above and below the normal strength of currents, which would be fatal to the successful operation of incandescent lamps.

* * * * * * *

"112 Re-D. If the controlling device of the Farmer apparatus were substituted for the controlling device of the Sawyer and Man apparatus; would the Sawyer and Man apparatus be, in your opinion, operative, without any further changes? In this connection I call your attention to cross-question 87?

"A. My answer to cross-question 87 was based upon the assumption which I have since discovered to be an erroneous one, that the Sawyer and Man apparatus was an operative one, except in the particulars specifically pointed out in my answer to cross-question 84. As I said in my answer to cross-question 85, I had not then minutely examined the patent in its other details. I now give it as my opinion that the substitution of Farmer's controlling mechanism for that described by Sawyer and Man, would not be sufficient to render the Sawyer and Man apparatus an operative one.

* * * * * * *

"118 Re-X Q. I understand from your cross-examination that at the time you gave your answer to cross-question 44, you were of the opinion that the Sawyer and Man patent described 'the invention of the patent in suit or all that was essential to it,' that later on in your cross-examination you modified your opinion to the extent that you found the primary controlling device of the Sawyer and Man patent inoperative, but that if it were replaced by the primary controlling device of the Farmer patent (which you admitted was old before the patent in suit), the Sawyer and Man apparatus would then be operative. Then when it comes to your redirect examination you had still further changed your opinion with regard to this Sawyer and Man patent, and had made up your mind that
2336 the arrangement of circuits in the Sawyer and Man patent
was also inoperative. This last opinion is expressed in your answer to redirect question 106. Am I safe in assuming that you have now reached your ultimate conclusions in regard to the Sawyer and Man patent?

"A. When making my answer to cross-question 44, I was aware of the inoperative character of the primary controlling device of the Sawyer and Man patent, and I ought to have stated explicitly in my answer that it was based on the assumption that the apparatus operated in the manner evidently contemplated by the patentees. I had not at that time observed the effect of the peculiarity in the arrangement of the controlling circuit referred to in my answer to redirect question 106. My study of the specification has not as yet developed any other essential defect in the construction and intended mode of operation of the Sawyer and Man apparatus. I am willing to let my answer to redirect question 106 stand as my ultimate conclusion in regard to this patent.

"119 Re-X. Q. To what specific features of the Sawyer and Man apparatus do you refer in your answer to redirect question 106?

"A. To the branch circuit, which contains the resistances *q r* and *s*, and the lamp X. These resistances are placed in series in the branch, and two of them, that is to say *r* and *s*, are bridged or shunted by the operation of the regulating device in either direction, and this operation disturbs the relation of the current in the regulating branch to the other current in the other branches every time it takes place."

* * * * * * *

"126 Re-X Q. Taking the arrangement and connection of the apparatus as shown in the Sawyer and Man patent, and assuming the primary controlling device to be an operative one, please state explicitly why the Sawyer and Man apparatus would not be operative in your opinion?

"A. If the current from the generator U should tend to become too strong, this abnormal strength of current would tend to distribute itself equally between the several branches. 2337 The regulating mechanism would be brought into action, shunting out the resistance *r*, thus diminishing the total resistance of the regulating branch to a certain extent, and then the rheostat *s* would also be shunted out, still further decreasing the resistance and increasing the current in that branch, so that before the regulating apparatus could be brought into action at all to diminish the current, the current in the regulating branch would become considerably stronger therein than in the other branches, and thus the lamp or lamps in that branch would receive too much current. This inequality of division would continue so long as the regulator was at work diminishing the total supply. Hence when the current in the regulating branch had been reduced to the normal point, there would be too little in the other branches. Again, as soon as the current in the regulating branch had been brought to the normal point, the shunt would be taken off the rheostats *r* and *s* again, increasing the current in that branch only, which would, of course, set the regulator at work again to still further reduce it. In this way a series of fluctuations would occur, and it would be impossible to keep the apparatus steady at any one point.

"127 R. X Q. The apparatus would regulate, but not regulate very closely, is what I understand your opinion to be, am I correct?

"A. I hardly think it could be made to regulate at all, simply for the reason that the moment the current in the regulating branch is brought to normal, the taking off of the shunt introduces a variation, and this must necessarily take place every time the current is brought to the desired strength. In other words, the apparatus has no position of equilibrium.

"128 R. X Q. With the magnets and resistances properly proportioned, the parts would act to decrease the flow of current when it increases beyond a certain point, and to increase the current when it drops below a certain point, would they not?

"A. Yes; it would in a general way, but I do not think it could possibly act to keep the current at any fixed point. That is to say,
the strength of current would, owing to the action of the ap-
2338 paratus, fluctuate up and down somewhere in the vicinity of
the normal point.

"129 R. X Q. That is, it would regulate, but, in your opinion, not so efficiently as to maintain the current at a definite strength?

"A. I do not think such an apparatus can properly be said to regulate at all, inasmuch as it does not allow the conditions to remain unchanged when the current has been brought to the normal point. It may, perhaps, be said to regulate to this extent, that it would tend to diminish very great irregularities in the strength of the current, but the fact that it cannot remain in a condition of equilibrium prevents it from effecting anything like an accurate regulation."

A. I did.

232 X Q. Are the improvements in dynamos referred to in answer to 223 X Q. in the direction of providing the armatures with a lower internal resistance and constructing the field magnets of greater magnetic power than in the early forms of dynamos?

A. Yes, both these modifications are very important factors in attaining the result sought for.

233 X Q. Are not all the dynamos used in incandescent lighting at present constructed on that general plan?

A. They are.

234 X Q. Were not machines of this character first publicly proposed for use by Mr. Edison?

A. I cannot say positively that he was the earliest but he was certainly one of the earliest to propose them and to employ them in practice.

235 X Q. You never heard that Sawyer and Man or either of them, had produced machines of this kind?

A. Not to my knowledge.

236 X Q. With reference to the Sawyer meter patent No. 210,151, has such a meter as that described in this patent been introduced commercially?

A. Not in the United States; I think that I have heard of such a
meter being used to a limited extent in Europe. Other more
2339 economical, or rather, less expensive and more convenient
devices have been introduced since that date.

237 X Q. Is it not a fact that in all systems of electric lighting employing direct currents and covering large areas, feeding circuits

are employed, such as are described in Mr. Edison's patent No. 264,642, as well as indicators for indicating at the central station the pressure at the outer ends of the feeders, and regulators for regulating the flow of current upon the feeders, as described in Mr. Edison's patent 266,693?

A. I believe so.

238 X Q. Are not such features at present considered essential in general systems of lighting by direct currents, in order to effect the proper distribution of current to all the lamps?

A. They are in very extensive use for that purpose, although I should think it might be possible to do without them; probably they form the most economical arrangement known in respect to first cost of conductors in a direct system.

239 X Q. These features are not indicated by the Sawyer-Man patents, are they?

A. They are not.

240 X Q. Is it not a fact that in all systems of electric lighting employing direct currents and covering large areas, electric generators employed connected in multiple arc as described in Mr. Edison's patent 369,280?

A. I believe so.

241 X Q. And is it not a fact that the generators employed in such system have each an armature of low resistance, revolving in a magnetic field of great strength, as described in the same patent of Mr. Edison?

A. It is.

242 X Q. Are not the features referred to in my last two questions essential to a practical and economical system of the character referred to?

2340 A. A generator having an armature of small resistance in a strong field is essential or at least highly important in any system of incandescent lighting by direct currents. The arrangement of these armatures in parallel, two or more, is useful, convenient and economical, when the district to be lighted exceeds a certain size, and is perhaps essential when the district is very large in order to effect an economical distribution.

243 X Q. Are not the feeders, feeder regulators and indicators described in Mr. Edison's patent- No. 264,642 and 266,793 essential in direct-current systems, as a means of producing a uniform pressure over an extended area of distribution, irrespective of the number of lights in use?

A. Yes, I think it may be said that it would be a difficult matter to do this without these or equivalent appliances.

244 X Q. Do you find these or equivalent appliances in Sawyer and Man's patent 205,305?

A. No.

245 X Q. Your sixth criticism of Mr. Edison's position in the art, refers to his statement that at the time he undertook to produce a system of electric lighting, it was necessary to devise an economical dynamo machine; is it not a fact that for multiple-arc lighting it is essential to ecomony that the dynamos should have

armatures of low internal resistance, and the field magnets of great magnetic strength?

A. It is essential to a high degree of economy; that is to say, the nearer the dynamo approximated this ideal type of a field of maximum strength and an armature without resistance, the greater the economy.

246 X Q. Do you know of a description of such dynamo machines prior to February 5, 1880, the date of filing of the application upon which Mr. Edison's patent No. 369,280 referred to by you, was granted?

A. I do not recall any instance of a specific statement to that effect at an earlier date, although it was well known and had been pointed out by others, that the conditions of maximum
2341 efficiency in working with dynamos depended upon the diminution of the resistance of the armature as much as possible, proportional to the external working resistance. My impression is, without assuming to have exact knowledge on the subject, that Mr. Edison and his associate, Mr. Upton, pointed out at least as early as the date of this specification, the importance of modifying the proportions of the dynamo machine in the direction of increasing the strength of its field and of diminishing the resistance of its armature.

247 X Q. Was not the generally accepted theory of construction before that time, based upon the erroneous notion advanced most notably by Werner Seimens, that the most economical conditions under which to work a dynamo machine were reached when the internal resistance and the external resistance were equal?

A. This unfounded and erroneous notion prevailed very generally prior to 1878 and in many quarters for several years later. The fallacy of it was pointed out by Profs. Elihu Thomson and Edwin J. Houston, in 1878, in their discussions of a series of experimental tests made with dynamos of various constructions at the Franklin institute in Philadelphia.

248 X Q. With reference to the seventh criticism of Mr. Edison's position, you do not desire to be taken as stating that the use of safety fuses in electric circuits was original with Sawyer & Man, do you?

A. Broadly speaking, I do not think it was, as equivalent devices, that is to say, pieces of thin wire interposed in the circuit had long been in common use, as for example, for protecting telegraphic apparatus and submarine cables from discharges of atmospheric electricity. It was only new with Sawyer and Man in its application to electrical distribution circuits.

249 X Q. What was the announcement referred to by you at the end of answer 193?

A. I had in mind the announcement in the New York
2342 Herald in evidence herein, describing Edison's apparatus at Menlo Park.

Defendant's counsel offers in evidence copies of the specification and drawings of the three patents of Thomas A. Edison, on electrical distribution system, No. 264,642, dated September 19, 1882; No. 266,793, dated October 31, 1882, and No. 369,280, dated August 30, 1887, before referred to, and the same are marked Defendant's Exhibit Edison Distribution Patent No. 264,642; No. 266,793 and No. 369,280, respectively.

Adjourned to April 27th, 1889, 10.30 a. m.

NEW YORK, *April 27th*, 1889.

Met pursuant to adjournment.
Present: Counsel as before.

Cross-examination of FRANKLIN L. POPE continued:

250 X Q. Returning to the question of the operativeness of the apparatus described in the Sawyer & Man patent No. 205,305. You state in answer 229, that you have seen the apparatus tried. Did you refer to the whole apparatus, or only to the primary controlling element?

A. The apparatus that I saw tried embraced the series of machinery shown in the patent from the primary controlling element to the shaft O, which is intended to control the admission of steam to the driving engine. But in making my answer to X Q. 229, I inadvertently overlooked the fact that other changes had been made in the apparatus which I saw, in addition to the correction of the defect in the controlling element. These changes consisted in operating the electro-magnet, Q R S and T, not by currents derived from the wire in which the controlling magnet is
2343 included, but from a separate source. Therefore, I was in
error in saying in my answer to X Q. 229 that the apparatus of the patent would become operative upon rectifying the mistake as to the pulley C and cap G, inasmuch as the further change which I have just described had also been introduced into the apparatus.

251 X Q. You still adhere to the opinion, then, expressed in the testimony quoted in X Q. 231, that the apparatus of the Sawyer and Man patent 205,305, would not be operative, even if the defect in the primary controlling element C. D. were rectified?

A. Yes, I have re-read the testimony referred to, and see no reason to modify the conclusions at which I then arrived.

252 X Q. In your answers to X Q. 202 and 203, you have stated that Complainant's Exhibit Defendant's Lamp, is not adapted for the third application of the incandescent light which you have set out in answer 193; is it not a fact that the lamp of the patent in suit, by reason of the large size and low resistance of the carbon conductor would not be adapted for use in the first application set out by you in answer 196?

A. It would not be unless the length and thickness of the carbon filament were modified; that is to say, it would need to be much longer and thinner than that shown in the drawing in order to work successfully under such conditions.

253 X Q. That is, the carbon conductor would have to be given the filamentary form described in Edison's patent 223,898?

A. Yes.

254 X Q. In your second criticism of Mr. Edison's position in the art, set out by you in answer 193, you refer to Mr. Edison's statement that it was necessary for him to devise a suitable electric lamp for use in such a system, (which I understand is a fundamentally correct system) of distribution in parallel or multiple arc. You do not mean that the lamp of the patent in suit would be adapted for use in such a system without change, do you?

2344 A. Not if the precise dimensions shown in the patent were retained; what I meant by my statement was that the type of lamp in the patent fulfills the conditions; not necessarily the construction in detail there shown, for as I have said, that would not answer the purpose in a system of general multiple-arc distribution. The incandescent conductor of the lamp requires to be adapted in its length and thickness to the character of service required of it, precisely as does the wire which forms the actuating helix on an electro-magnet.

255 X Q. That is, the carbon conductor would have to be given the filamentary form described in Mr. Edison's patent No. 223,898?

A. Yes.

256 X Q. In your answer to question 196 you have referred to an article published in the Telegraphic Journal and Electrical Review, as showing that "the construction of an incandescent lamp of very high resistance" was not first disclosed in the Herald article of December 21, 1879. How does the paper in the Telegraphic Journal and Electrical Review anticipate that disclosure of the construction of individual lamps of very high resistance?

A. I do not mean to be understood as saying that it does. The article referred to points out the necessity for economical working, of making the resistance of the apparatus in which the work is done, what we nowadays call the translating device, as high as possible in proportion to that of the generator; that is to say, it tells us what ought to be done, but does not tell us how to do it.

257 X Q. It does not tell us that by making individual lamps of very high resistance, a multiple-arc arrangement of the lamps can be employed, does it?

A. It does not; but then I consider that that was a part of the common knowledge of the art. It was well known that whatever kind of translating devices might be employed, their resistance should be made high if they were to be connected in multiple arc,
and made low if they were to be connected in series, upon
2345 the assumption, of course, that the electrical energy to be
expended in each device was equal in either case. It was at that date a simple and ordinary matter of mathematical calculation.

258 X Q. The conditions of the article, however, would be fulfil-ed by securing the high external resistance by arranging arc lamps or low-resistance incandescent lamps in series, would they not?

A. They could be so fulfilled. The law laid down is a general one, and equally applicable to series or multiple-arc distribution.

258 X Q. Incandescent lamps having individually a very high

resistance not being known at the date of the article, it is a fact that to reach the conditions of high external resistance set out in the article with such incandescent lamps as were then known, it would have been necessary to arrange the lamps in series, would it not?

A. It would if any considerable number of them were to have been used. A moderate number might probably have been successfully arranged in parallel or multiple under the conditions then known, but not a very large number.

260 X Q. In answer 196 you refer to the Lane-Fox patent, No. 3988 of 1878. I understand your position to be that this Lane-Fox patent describes lamps of high resistance in a multiple-arc system. You do not pretend, of course, that the Lane-Fox patent describes suitable and operative apparatus for carrying out the general principle referred to, do you?

A. No, I don't think it does; it simply marked a certain stage of progress in the development of the art.

261 X Q. The lamp described is not a practicable lamp, is it?

A. It is practicable in the sense that it might be used so as to be serviceable in an electric-lighting system. It is impracticable in that the cost of the light produced by it would probably be more than the consumers would be willing to pay for it.

262 X Q. Such a lamp has never been used practically, has it?

2346 A. Not to my knowledge. That is to say, not commercially.

263 X Q. Would you consider it feasible to make a high-resistance lamp of platinum-iridium wire for the incandescent portion?

A. No, I think not.

264 X Q. The regulator described in the patent is not operative, is it?

A. I think not. It is little more than a suggestion, and in my opinion not a practical suggestion.

265 X Q. The system of conductors described does not have the feeders necessary for producing substantially equal pressure throughout the system, does it?

A. There is no systematic organization of the circuits, as shown in the drawings, for the purpose of securing uniform distribution, although such distribution would be largely secured by the interconnection of the conductors in the manner shown. The general principles of arranging each lamp so that it draws an independent portion of current from the central station, which does not pass through any other lamp, and the interconnection of the main wires to aid in the uniformity of distribution, are both plainly present in the diagram; but the interconnections are made in a haphazard way and not as the result of any orderly and systematic computation. I therefore consider that while the distribution in such a system would be fairly uniform, it would not be as much so as if it were systematically arranged, nor would it be done with so great an economy, either in first cost of conductor, or in subsequent working, as if — had been properly organized.

266 X Q. In the conclusion of your answer 196, you state:

"In view of these publications"

(which I understand you to mean the paper published in the Telegraphic Journal and Electrical Review, and the Lane-Fox English patent, No. 3988 of 1878).

"I cannot concur with Professors Barker and Brackett, in 2347 the opinion that the idea of making the incandescent conductor of very high resistance was first made known in the New York Herald article and in Mr. Edison's patents No. 233,898 and 227,229."

Is it not a fact that the article from the Telegraphic Journal and Electrical Review does not describe an incandescent conductor of very high resistance, and that the Lane Fox patent does not describe such a conductor which can be practically made and used?

A. It is true that the Telegraphic Journal article is general in its terms and only points out the desirability of high resistance in the consumption circuit, without attempting to inform us how it may be accomplished. The Lane Fox patent is more specific and points out the necessity and desirability of high resistance in incandescent lamps for multiple-arc circuits most explicitly, but does not inform us how to make a lamp which shall have a high resistance which can be practically or at least commercially, made and used.

267 X Q. Two other patents of Lane Fox have been referred to by Dr. Morton on behalf of complainant, namely, No. 4043 of 1878 and No. 4626 of 1878. The first patent describes the use of an incandescing conductor, "made of asbestos or similar non-conducting material saturated or impregnated with some refractory conducting material, such as carbon or iridium." The second patent No. 4626 describes an incandescent conductor of platinum-iridium alloy or of the impregnated asbestos. Have lamps of these kinds ever been practically made and used?

A. Not within my knowledge.

268 X Q. In what respects, if at all, do you desire to change the testimony given by you in making out the *prima facie* case for complainant?

A. I do not now recall anything that I wish to change or modify in said testimony, other than the answer to X Int. 130, which, as I have once before stated, was made under the misapprehension that there were only three claims in the original specification, the 2348 fourth one having been overlooked by me at the time of making the answer, because it was on the other side of the leaf. I have already explained this matter and will therefore not repeat the explanation.

269 X Q. What specific material named in the original specification itself do you consider is referred to by the fourth claim?

A. Carbonized paper and wood carbon.

270 X Q. If the material referred to by the fourth claim is the wood or paper of the specification, how can the fact that you overlooked the fourth claim change your opinion as to what is described in the specification?

A. In X Q. 130, I was asked as to what there would be in the original specification and claim, to indicate such and such things if all mention of paper were left out; the answer related to the specification and claim, which term I understand to include all the clauses of the claim, and what I now say is that my answer then would have been different if I had had the fourth claim under consideration, which I did not, because the fourth claim embraces an incandescent arc made of carbonized fibrous or textile material. The use of a textile material necessarily implies that it would be formed before carbonization and that it would possess other qualities which are essential and which give it its value for an incandescent conductor.

271 X Q. Then if you were asked over again question 130 with the words "and claim" omitted, so that you would be referred to the original specification and not to the claims at all, your answer to question 130 would be a correct answer to the question as amended?

A. So far as I can now see it would be.

272 X Q. In your answer to Q. 200 you agree with Prof. Cross and Dr. Morton, that the word charcoal has a certain technical meaning to electricians, different from its ordinary meaning. Does such technical meaning exist with practical electricians at the present time?

A. I do not think it can be said to. Within ten years the practical application of electricity has grown into an enormous in-
2349 dustry, and the technical terms employed in connection with
it have, of course, received well-defined meanings, which was not the case prior to that time, when the whole matter was rather a laboratory experiment than anything else.

273 X Q. When did you first learn that any confusion existed in the art with reference to the use of the word charcoal?

A. My attention was first particularly directed to it in the course of a careful examination of the patents and publications in evidence in this case. I have been aware for many years that the word charcoal was loosely used and applied to hard carbon, but I did not know the extent to which this misapplication of the term prevailed in the literature of the art until I came to examine it carefully.

274 X Q. It did not occur to you as a practical electrician that such a confusion existed in the minds of electricians at the time you gave your testimony in the *prima facie* case?

A. I was aware at that time that the term charcoal was more or less used in patents and in text books when the thing actually meant was hard carbon; but I did not know that the use of the word with that meaning had been common. It has not been common among practical electricians since arc lighting came into ordinary use.

275 X Q. What is the date referred to in your last answer?

A. No exact date; say about 1878.

276 X Q. Is it not a fact that in many of the publications which have been referred to by yourself and the other experts for the *the* complainant, the text itself does not show that word charcoal has

other than its ordinary meaning, but that you and the other experts infer that it refers to gas-retort carbon, because you believe gas-retort carbon or other forms of hard carbon completely superseded the use of wood charcoal or wood carbon, for the production of the arc light?

A. I have made that inference in some, at least, of the publications cited, and I think myself warranted in doing so, for the reason that so far as I have been able to discover there is no instance on record in which an arc lamp having an automatic or self-operating feeding mechanism has been supplied with anything but electrodes of gas carbon, either cut out of the solid mass or moulded and baked.

277 X Q. Is it not a fact that gas carbon is exceedingly difficult to work?

A. It is.

278 X Q. And it does not produce so brilliant an arc light as one formed from wood-carbon points?

A. I do not know how that would be, but I should expect to find that the softer-wood carbon gave the more brilliant illumination.

279 X Q. Is it not a fact that down to the date of commercial arc lamps, which you fix at about 1878, the arc light was frequently produced as a lecture-room experiment and for popular illustration, by means of simple apparatus similar to that shown by figure 2, of Dr. Morton's lecture upon the electric light, and that on account of the difficulty of working gas carbon, wood-carbon points were frequently used for the purpose?

A. I do not think that they were used to any great extent, if at all, so recently as that, but still they may have been. Hard-carbon pencils have been regular articles of manufacture in France since 1845 or 1850, and they began to be made in this country at least as early as 1859, so that I should suppose, as the hard carbons are much the most convenient and could be obtained without much difficulty that wood carbon would hardly have been used after 1859 or 1860.

280 X Q. Under the head of "Electric Light," in the work on "Electricity," by Robert M. Ferguson, Ph. D., F. R. S. E., of the Edinburgh Institution, published in London in 1873, occurs the following statement: "The various forms of carbon are well suited to this purpose; the more compact forms of charcoal answer very well; baked carbon (85) answers better; but the coke that is sublimed inside of the retorts in the distillation of gas, both for durability and conducting powers, makes by far the best poles. What is meant by the expression "compact forms of charcoal" in this quotation?

A. The natural inference from the context would be, I think, that it meant wood charcoal made of hard and compact wood, boxwood, for instance.

281 X Q. This statement also indicates, does it not, that wood carbon was in 1873 in Dr. Ferguson's opinion, at least, suitable material for exhibiting the electric light?

A. Yes, although he expressly says that it is the least suitable of the various forms of carbon which were then known to be applicable to the purpose.

282 X Q. In the extract you have quoted from Pynchon's Chemical Physics, what material do you think is referred to by the words "well-burned charcoal"?

A. Apparently wood carbon.

283 X Q. Referring to Sawyer and Man's patent, 211,262, which describes what has been called the hydrocarbon treating process, does not this patent indicate a clear preference on the part of Sawyer and Man for use in incandescent lamps of exceedingly hard dense carbon?

A. A statement occurs in the specification to the effect that pencils of carbon which have been moulded and baked are not sufficiently hard and dense, and the patent describes a process by which the exterior of such carbons is increased in hardness and density. Accurately speaking, I should say that the patent indicated a preference for carbons having a hard dense exterior.

284 X Q. Does not the patent refer to the two kinds of carbon used for arc lamps, namely, gas-retort carbon and moulded carbon, and then state that neither of these is suitable for lighting by incandescence, because there is a lack of homogeneity, and the pencil is not sufficiently hard and dense?

A. Yes, that is the substance of the statement.

2352 285 X Q. And do you not gather from the patent that it was the notion of the patentees that a carbon harder and more dense than gas-retort carbon, was the proper kind of carbon for lighting by incandescence?

A. It is perhaps possible to infer from the statement of the patentees that such was their notion, but the process which they describe is stated to deposit a perfectly homogeneous layer upon the external surface. There is no doubt that this increases the hardness and density of the surface, but the general tenor of the specification seems to be that the principal object sought for is to obtain homogeneity and that the hardness and density are incidental to this.

286 X Q. I call your attention to a publication in the New York Tribune of January 2, 1880, which purports to be an interview with W. E. Sawyer, and is as follows:—

Mr. Sawyer Skeptical.

His views in regard to the practicability of the new Edison lamp.

Mr. W. E. Sawyer, of No. 78 Walker street, in this city, who has made long and careful researches into the problem of the electric lamp, was found at his office yesterday busily engaged in the perfection of a new invention designed for illumination. He is very much interested in the new claims of Mr. Edison and was quite willing to express his opinion in regard thereto. He said:—

"The public has received from Menlo Park the following positive assertions. (1) That Mr. Edison's new lamp consists of a horseshoe of carbon about two and a half inches long, clamped in

platinum holders and hermetically sealed in a glass globe from which the air has been exhausted. (2) That the horseshoe consisting of carbonized bristol-board is so tough and flexible that it can be twisted nearly half way round without breaking. (3) That the horseshoe of carbon, no oxygen being present in globe, will last an ordinary lifetime; that it has already been run over 100 hours
without suffering deterioration. (4) That the light from
2353 each lamp is about equal to an ordinary gas-jet, or say ten
or twelve candles. (5) That no dynamo machine known
can generate sufficient electricity to destroy one of Mr. Edison's horseshoes. (6) That the chief point of advantage in the new lamp is the high resistance—140 ohms. There are other statements, but the foregoing cover the ground pretty thoroughly. Having during the past three years made the most complete series of experiments respecting electric lighting by incandescence that have probably ever been made, I am enabled to speak positively about many points that to those unfamiliar, or only partially familiar with the subject may seem uncertain, or else correct, when entirely wrong."

"First then" asked the reporter, "what is your idea about the use of platinum for conducting wires?"

"The use of platinum as a holder for the incandescent carbon conductor" replied Mr. Sawyer, "is fatal to the durability of a lamp. Carbon only, of larger section than the incandescent carbon can be employed, for the reason that at a white heat the carbon combines with the platinum to form the platinic carbide and disintegration takes places with great rapidity. The same is true of any metal. I have welded carbon pencils in all shapes, and the best way to establish the connection of the incandescent carbon with its holder is to weld the two together. This I have done by first clamping the horseshoe in carbon-holders, then inverting the lamp and immersing horseshoe and holder in any hydrocarbon, preferably pure olive oil; finally turning on a torrent of electricity so that the horseshoe is made intensely incandescent. With great violence the oil is decomposed the hydrogen escaping and the carbon being deposited most rapidly at the points of contact of the horseshoe and its holders, the weld is so perfect that the horseshoe will break anywhere else rather than at the joints.

"Mr. Edison's paper carbon is very much longer than yours, Mr. Sawyer?"

"Yes; and when a length of incandescent conductor of
2354 one-half inch is reached the current can no longer be econom-
ically used because to increase the radiating surface, and the
short carbon can be made to give all the light desired, viz., from 25 to 250 candles."

"What do you think of the kind of carbon which Mr. Edison employs?"

"The denser, harder and more homogeneous the *the* carbon the tougher it is and the more durable the lamp for the reason that the whole action of the current (that very action which produces light, an intense vibration of the atoms or molecules of *of* the carbon amounting to several hundred millions of vibrations per second) is

to disrupt and disintegrate the carbon. The carbon formed by the process discovered in my experiments is the only one thus far that offers hope of permanency—a fine pencil of carbon being immersed in olive oil or any hydrocarbon gas or liquid and electrically heated as in the process of welding before described, whereby it is built up with carbon so hard and homogeneous that it may be polished like jet. As we descend from this we get less durable material, the order of durability being, *a* carbon deposited by electric action; *b* the hardest retort carbon, *c* the best artificial carbon, *d* hard coke, *e* dense charcoal (charcoal impregnated with syrup and the syrup carbonized), *f* willow, paper and other fine charcoal, *g* ordinary charcoal, *h* graphite. Mr. Edison's carbon belongs to the class *e* or *f*, and as carbon in all its forms is exceedingly brittle, his statement that his paper carbon is so tough and flexible that it can be twisted half way round, etc., without breaking, is open to criticism. The best carbon of the charcoal order we have produced by impregnating with syrup the finest French willow charcoal used by artists and carbonizing the same, repeating this process a sufficient number of times. This is substantially the process of Peyret and of Gaudoin. In pencils of one-eighth in diameter and one-half in length, with perfect carbon connections, and in an atmosphere of pure nitrogen, not even the 100,000,000 of oxygen being present, these carbons will last as follows under the action of the electric current: *a* at red heat
giving a light of perhaps ½ of a candle, 100 to 200 hours; *b*,
2355 at between a red and a white heat, giving a light of 1 or two
candles, 20 hours; *c*, at a white heat, light 4 candles, 5 hours;
d, at true carbon incandescence, when the pencil has the limpid appearance of the sun to and gives a light of 25 or 30 to 250 candles, 2 to 5 minutes, or even less than 1 minute, disintegration occurring very rapidly, but no consumption taking place. The smaller the section of the pencil the shorter its life. The larger the pencil the more current required. The longer the pencil the more current required."

"Do you think the horseshoe lamps are liable to be injured by an accidental and sudden increase in the strength of the current?"

"When a carbon is in high state of incandescence," replied Mr. Sawyer, "double the current invariably ruptures or disintegrates the carbon. If Mr. Edison will only bring the current necessary for ten of his lamps, suddenly into one of them he will be surprised at the beautiful manner in which it will disappear. Experience has demonstrated that within reasonable bounds the less the resistance of an electrical circuit—which includes the resistance of the wires, of the machine and that of the lamps outside of it—the less the power required for effective work. The arrangement of Mr. Edison's lamps in multiple circuit, so as to lessen the external resistance where a large number of lamps are to be run, is hazardous. In running 2,500 lamps by a single generator, the mean will be found in a square of fifty in series and fifty in multiple. This would make the external resistance of Mr. Edison's circuit 140 ohms, requiring an intensity of current that would give violent shocks to those who might by accident touch the conductors, and a most costly insulation of the main wires. To place less of the lamps in series and more in multiple is as hazardous as to go the other way, inasmuch as it would increase the chances of a short circuit extinguishing lamps in other series. No lamps can be practical unless of low resistance."

Does not this publication contain the statement tending to confirm the idea contained in the Sawyer & Man patent No. 2356 211,262, that hard, dense carbon, similar to gas carbon and deposited carbon, is better for incandescent lighting than soft carbon such as would be made from paper or wood?

Objected to as incompetent, hearsay, irrelevant, immaterial, not subject of cross-examination, and motion will be made to strike out the newspaper account of the alleged interview, at the hearing.

A. Yes, I think the statements made in the article referred to as coming from Sawyer tend to support that opinion.

287 X Q. What is the process described and claimed in the Sawyer & Man patent No. 211,252, with regard to the character of the hydrocarbon from which the deposit is to be made?

A. The electrical heating of the carbon while immersed in a hydrocarbon liquid; the specification says that almost any hydrocarbon will answer.

288 X Q. Do you consider the electroplating process referred to near the top of the second column of the second page of the patent an operative one?

A. I am unable to say whether it is or not, I know nothing about it.

289 X Q. Have you ever heard of a process of this kind being practiced?

A. Not so far as I now recollect.

290 X Q. From your knowledge of electrolysis, do you consider it possible to deposit carbon in this manner?

A. My knowledge of electrolysis is not very extended nor complete, and I do not feel that it justifies me in expressing an opinion on this point.

291 X Q. In your answer to question 198, you disagree with defendant's experts in the opinion expressed by them that the lamp structure shown and described in the patent in suit would be unsuitable for practical use, and you think that it would be immeasurably superior to any of those which are described in prior patents and publications. You also express the opinion that an incandescent lamp may be made in accordance with the de- 2357 scription of the patent, which would have sufficiently long life to be of value for many practical purposes. How long a life do you think would be necessary to make the lamp of value for many practical purposes.

A. I can conceive of useful purposes to which the lamp might be adapted even if it did not last twenty hours, but speaking in the ordinary acceptation of the term, a lamp which would run 50 or 100 hours would have a considerable degree of utility.

292 X Q. Would a lamp which continued to burn not more than five minutes be of value for many practical purposes?

A. I should say not.

293 X Q. What connection, if any, did you have with the writing or publication of the book entitled "The Speaking Telephone, Electric Light and Other Recent Electrical Inventions," by George B. Prescott, published in New York in 1879, which I now hand you?

A. I had no connection whatever with the preparation or publication of the book, although it contains considerable matter which was written by me for other purposes, among which I recognize the portion from page 183 to 205, and 235 to 259 inclusive. All this matter relates to telephones and harmonic telegraphy. I also wrote the description of the Jablochkoff system, commencing with the bottom of page 481, and ending in the middle of page 495. I think this embraces all the matter in the book which I had anything to do with in any way.

294 X Q. Do you consider the book to be substantially reliable in its statements?

A. I think it is, as a general thing, although I cannot undertake to vouch for it in every particular. It is a compilation of the views and opinions of a good many different persons, and naturally some of them are more careful in their statements than others.

295 X Q. Is not the following statement made with reference to the Sawyer-Man lamp at page 510 of this book?

2358 "We have seen five or more of these lamps in operation at one time, and were much pleased with their performance. Our investigation of the various details connected with their construction and maintenance was, however, too limited to enable us to judge of them from an economical standpoint. One or two things which came under our observation did not impress us quite so favorably as we had reason to anticipate from what we had heard of them. Possibly a poor adaption of means to ends, which is so often noticeable with new and hastily introduced apparatus, is in part responsible for this, but it is certainly remarkable that the continuance of the light on the occasion of our visit was not prolonged beyond five minutes at the most; and this fact, taken in connection with the sound from the dynamo-electric machine, which indicated both a high rate of speed and the production of a powerful current, was not calculated to greatly astonish any one familiar with the subject of electric lighting."

Objected to as incompetent and immaterial.

A. Yes.

296 X Q. The lamps which you say you have examined in answer 199, were lamps lately built, were they not for the purposes of this case?

A. I understood that they were partly old lamps, originally made by Sawyer and Man, and partly new ones recently constructed; all the incandescent conductors being of recent make.

297 X Q. They are the lamps which have been testified about by the witnesses Packard, Shallenberger and Smith?

A. The same.

298 X Q. Is your opinion that the lamp structure of the Sawyer-Man lamp is immeasurably superior to any of those described in prior patents and publications, in harmony with the following statement, quoted from page 199 of Du Moncel on electric lighting trans-
lated by Routledge and published in London in 1882; the
2359 same being apparently a translation of the statement con-
tained in the original French publication published in Paris
in 1880 at page 226?

"Sawyer-Man's Lamp.—This lamp is nothing more than King's or Lodyguine's in all its simplicity, except some insignificant arrangements for lessening the calorific radiation, and we are surprised at the long accounts we read in the English journals about this lamp, which is probably not better than the older ones. In this system, the vessel containing the incandescent carbon is filled with nitrogen to avoid combustion and the deposition of volatile products on the surface of the vessel. The carbon itself is rather short; its resistance does not exceed 0.95 ohm, and each light is supplied with a derivation, in order that the conditions of the distribution of the current may not be changed when any one of the lamps is extinguished. The commutator used for lighting and extinguishing the lamp is, moreover, arranged in such a manner that the current gains its full intensity only by degrees, and after having passed through successively weaker resistances. It is, according to Sawyer-Man, from neglect of this precaution that the carbons of incandescent lamps are so soon spoiled. Finally, an electro-magnetic register is included in the circuit, and has the same effect as a gas meter."

"We shall not speak of the system of distributing the current among all those lamps, for it is founded on the principle of derivation, and is identical with that of Werdermann, which we shall presently consider. A detailed description of this lamp may, however, be seen in the Telegraphic Journal of 1st January, 1879. We think it unnecessary to say more about it, than to express our surprise that English and American inventors trouble themselves so little about the earlier inventions."

Objected to as incompetent and immaterial.

A. No, I do not altogether agree with the statement of the author of the extract.

299 X Q. I call your attention to a publication in the New York World of December 24, 1879, the same purporting to be a letter from W. E. Sawyer and being as follows:

2360 *Edison's Electric Light.*

Mr. Sawyer questions the novelty and the practical value of the discovery.

To the editor of the World:

SIR: My attack upon Mr. Edison in the Monday's Sun was provoked by his constant appropriations of the credit due to others, not that he never accomplished anything himself, for we know that he has done a great deal in the advancement of science. It does not follow because he has made some correct deductions that all he says must be correct; nor because he has made many failures that he is not, as I believe him to be, a mechanical genius. What I claim is that he is not what he professes to be, an electrician.

"The credit of electric lighting does not belong to any one man. Its present degree of perfection is due to the labors of a hundred experimenters as brilliant as Mr. Edison, and probably more so than I am. My own position in the matter is that which follows three years of study, and in that time I have taken out a dozen or fifteen patents on electric lighting alone, so that when Mr. Edison made his startling announcement fifteen months ago, he must have known from the printed records of the Patent Office, with which he never fails to provide himself, that what he claimed was not his own. His system of distribution, his means of regulating the current in his lamp, etc., had been fully covered by my patents. The very platinum lamp that was so noised about had been made a years before Edison's announcement of it, shown to everybody and cast aside as worthless by Mr. H. S. Maxim of this city. It was cast aside because platinum shortly disinte*rg*ates, and because it takes three horse power to produce the light of a first-class gas jet from it with the best machines known. Mr. Edison afterwards secured a patent upon it because Mr. Maxim had not considered it worth patenting himself.

"I would not dare to allege that Mr. Edison's scheme
2361 was not a genuine one; nor that it has been used to humbug
the people in subscribing to worthless interests; nor that the gasmen are at the bottom of the whole scheme, and mean to show by the failure of a gentleman popularly supposed to be supernatural, that no one else can ever accomplish anything to injure the gas interests. I simply point out the facts that the Sawyer-Man lamp and various improvements upon it, as fast as made, have been successful for more than a year, and that the brilliant lamps of other inventors are notoriously in practical use in our streets to-day, while all we have heard from Menlo Park is that Mr. Edison, a great and eccentric genius, who divides his time between eating herrings, wearing old hats, rolling tar abstractedly in his fingers, going without his dinner and finally founding his great achievement upon, as has always really been the case, cotton thread and paper.

"This does not prove, however, that Mr. Edison may not some day do something. I only allege that up to this time he has done absolutely nothing that is new or valuable in electric lighting, and I am prepared to stake my reputation as an electrician upon this statement.

"The immediate cause of my challenge to Mr. Edison was my information that friends of his saw in my laboratory months ago the identical horseshoe lamp that is set up as his latest and grandest achievement, and my belief that he could not have failed to know that it was my invention. I object decidedly to his claiming my invention as his own, especially when it seems clear that the object of the announcement was to raise money. Over a year ago I experimented with the horseshoe lamp, and found it a failure even with the carbon much harder and more tenacious than paper carbon. Some dozen of these lamps were constructed. The average life of the horseshoe was an hour. One of these lamps, with the horseshoe complete (except at the point where rupture occurred when the lamp broke down), is still hermetically sealed in its glass tube, and still charged with nitrogen just as it was taken from the bracket in January last. I handed it to Messrs. Arnoux 2362 and Hochhausen, 2 Howard street, yesterday morning at nine o'clock, in order that no loop-hole may be left for prestidigitation at Menlo Park. If this does not settle the question of priority, I don't know what will settle it. A further fact about the horseshoe lamp is that it is so complete a failure that we decided nearly a year ago it would be wasting money to spend thirty-five dollars for a patent upon it.

"The time has passed for any more electric light sensations. The only thing that can revive the subject is proof—practical demonstration, with the lamps kept out of the hands of those whose interest it may be to manipulate them. I accept the situation; I am more than anxious to try conclusions with Mr. Edison; I reiterate my challenge to him, and I don't propose that Mr. Edison shall escape the issue he has drawn upon himself.

"He says he proposes to exhibit his light at Menlo Park, next week. Next week I shall exhibit my light in New York in practical household use. The public can then judge for itself whether my system is a failure, and whether Mr. Edison has not been either himself deceived or persistently deceiving the community. Until then I shall have no 'more last words' on the subject."

Respectfully yours, W. E. SAWYER.

New York, December 23d.

Are the statements contained in this letter as follows:

"Over a year ago I experimented with a horseshoe lamp, and found it a failure even with the carbon much harder and more tenacious than paper carbon. Some dozen of these lamps were constructed. The average life of the horseshoe was an hour. * * * A further fact about the horseshoe lamp is that it is so complete a failure that we decided nearly a year ago it would be wasting money to spend $35 for a patent upon it,"

in harmony with your opinion that the Sawyer and Man 2363 lamp would be immeasurably superior to those which preceded it?

Objected to as incompetent and immaterial.

A. My statement as to the superiority of the Sawyer and Man lamp referred to in this question was intended to apply to the lamp structure, as the question shows. The quotations from Mr. Sawyer's letter relate to a certain horseshoe carbon, which I judge from his description was a hard carbon, although he does not state expressly what it was. The fact that the life of the horseshoe was only an hour is not necessarily due to defects in the lamp structure, for a defective carbon will often give way soon after the current is turned on, even in the most perfect lamp structures known in the art at the present day; hence I do not see anything in Mr. Sawyer's statements in the above letter which necessarily conflict with the opinion I expressed with reference to the lamp structure.

300 X Q. If the lamp structure were defective, the life of the carbon would be shortened, would it not?

A. Certainly.

301 X Q. Does not the statement contained in this letter, that the horseshoe lamp was found to be a failure, "even with the carbon much harder and more tenacious than paper carbon," show a preference in Sawyer's mind for the harder carbon as being a more perfect carbon?

A. Yes, I think that inference may be drawn from the language.

302 X Q. Do you agree with Professor Cross in the definition he gives of an arc incandescent lamp in his answer to 97 X Q. of his deposition in this case?

A. Yes.

303 X Q. Does not the lamp described and shown in the Sawyer and Man patent No. 205,144, come within Professor Cross's definition of what constitutes an arc incandescent lamp?

A. I should say that it did.

2364 304 X Q. Would not a lamp having a burner constructed of two pieces of carbon with their lower ends secured to their respective supports, and having their upper ends brought together so as to form an inverted-V-shaped burner, be an arc incandescent lamp?

A. If the light were produced, as I understand from your description it would be, at the point of mechanical contact between the two carbons, then it might properly be regarded as an arc incandescent lamp. It would fall within the definition of Professor Cross, which seems to me to be an accurate one.

306 X Q. If the pieces were simply brought together into surface contact, without being so perfectly united by a connecting clamp as to convey the current from one to the other without arcing, then the lamp would operate upon the arc incandescent principle, would it not?

A. Yes, I think it would fall within that class.

306 X Q. Referring to the description of the V-shaped burner contained in the patent in suit, beginning at line 78 second column first page. Is there anything contained in this statement of the patent which necessarily excludes the idea that a lamp working on the arc incandescent principle is intended?

A. There is nothing in this specific statement which necessarily excludes that idea, but in the general statement of invention, the invention is said to relate more especially to the incandescing conductor, which implies a continuous conductor of greater or less length rendered uniformly incandescent. In speaking of the upper ends being united, the patentees may have referred to the process of uniting by hydrocarbon deposition described in one of their earlier patents, which would unite the conductor in such manner as to form one continuous conductor.

307 X Q. That is, the character of the union would probably determine the character of the lamp?

A. Yes, that is my idea of the matter.

2365 308 X Q. Where, in any earlier patent of Sawyer and Man, do you find any description of producing such a union by hydrocarbon deposition?

A. I was under the impression when I made the above answer that I saw this in one of the patents examined to-day; I now find this an error and that it is not described in any of the prior patents, so far as I can discover.

309 X Q. There is nothing to indicate by the language of the patent in suit itself, what the character of this union is to be?

A. No; it is entirely a matter of inference from the general statement of the invention.

Defendant, by its counsel, gives notice of record, that it wishes, without delay, and at the convenience of complainant's counsel, to call and examine John C. Tomlinson and Richard N. Dyer, referred to in the cross-examination by Mr. Griffin of the witness Church, for the purpose of impeaching the credibility of said witness, and as to the matters set forth in said cross-examination, more particularly the interviews between said Church and Messrs. Tomlinson and Dyer. Defendant requests that complainant consent to this examination, so as to avoid the otherwise necessary delay of a motion to the court for leave to so examine said Tomlinson and Dyer.

Adjourned subject to notice.

NEW YORK, *May 4th*, 1889.

Met pursuant to agreement.
Present, counsel as before.

Cross-examination of F. L. POPE continued:

310 X Q. I call your attention to the following extracts from English and other periodicals:

Extract from a paper entitled "The Electric Light. By W. H. Preece, memb. Inst. C. E., V. P. Soc. T. E., electrician general post office, &c." Philosophical Magazine, vol. 7, page 29, 1879.

2366 After discussing the mathematical theory of the electric light as applied to light by incandescence, and to the electric arc, the paper concludes:

"We have assumed W′ to be constant; but this is only the case when a certain limit is reached, and when the velocity of the rotating coils in the dynamo machine has attained a maximum. This limit will vary with each dynamo machine and each kind of lamp used. With the Wallace-Farmer machine, the limit appears to be reached when six lamps are connected up in series. With the Gramme alternating machine and the Jablochkoff candles, the limit appears to be five lamps. Beyond these limits the above laws will be true. It is this partial success in multiplying the light, that has led so many sanguine experimenters to anticipate the ultimate possibility of its extensive subdivision—a possibility which this demonstration shows to be hopeless, and which experiment has proved to be fallacious.'

Also the following extracts from a lecture delivered by Preece, at the United Service institute, on the electric light, and published in The Electrician for February 22, 1879.

"It is, however, easily shown that in a circuit where the electromotive force is constant, and we insert additional lamps, then when these lamps are joined up in one circuit, *i. e.*, in series, the light varies inversely as the square of the number of lamps in circuit, and when joined up as in multiple arc, the light diminishes as the cube of the number in circuit. Hence the subdivision of the light is an absolute *ignis-fatuus*.

Also the following extract from a lecture delivered by John Tyndall, before the Royal institution, on the electric light, and published in the New York Times for February 16, 1879:

After describing what he understands to be Mr. Edison's system, Mr. Tyndall states:

"Knowing something of the intricacy of the practical problem, I should certainly prefer seeing it in Mr. Edison's hands to having it in mine."

2367 I call your attention also to a report on the electric light at Westgate-on-Sea, signed by W. H. Bennett and William A. Valon, dated June 17, 1879, 22 Great George street, Westminster, S. W.; wherein among other things it is stated:

"The liability of the machinery to derangement at any moment, the defective character of the candles, the incessant variation of the illuminating power, want of diffusibility and means of storage, the constant care and attention the lights require, and the enormous cost of producing the light, all unfit it for a general public illuminating agent. We have seen all the systems that have been introduced in the last eighteen months, and we have no hesitation in speaking that if electricity is to be the light of the future, it must be produced by a radically different system to any yet brought before the public, a system, in *your* opinion, that remains undiscovered."

Also the following extract from lectures delivered by Dr. Redwood in the theatre of the Pharmac*eu*tical Society, Bloomsbury square, and published in the Iron for February 3, 1879. After referring to his lecture delivered thirty years before in the same institution, in which he had pronounced the electric light impracticable, he states:

"What new laws have been discovered to render that practicable now which was pronounced impracticable thirty years ago, he was not aware of any such discovery having been made."

Also the following extract from an article on "The Brush Electric Light," from the Engineering of January 2, 1880:

"More than a year has passed by since the scientific world was startled, and a panic struck into the breasts of the gas companies

by the cablegram announcing that Mr. Edison had solved the problem of the divisibility of the electric light and that he would speedily supply such light to all households at a cost far below that of gas. Enthusiasts in his rare and inventive faculty were disposed to believe this announcement; but more prudent critics throw doubts upon its reliability; as time went on without
2368 bringing with it the promised lamp the public at large began to be skeptical of the alleged discovery; and even the sanguine confidence of Mr. Edison himself and the highly colored reports of Yankee correspondence, could not shake the opinion which gradually gained ground that he had discounted success."

Also an extract from an article in the Engineering of April 16, 1880:

"The grand idea of the divisibility and distribution of electricity in the same manner as gas or water, viz., having large leading wires or mains running through the principal streets with small branches for each consumer—has not for a moment been entertained by any of the electricians, though this is the plan the anxious public are waiting for; the reason being that you cannot have storage for your supply as with gas. * * *

Now, as it is impossible to store electricity in any appreciable quantities, we say the object must be to utilize its power as it is being generated; therefore the greatest difficulty is in the distribution as produced."

Also the following extract from an article in Engineering, volume 29, page 113. After referring to the excuses which the article states had been advanced for delaying the introduction of Mr. Edison's system into public use, it proceeds:

"However, this may be, the public will be glad when the real practical trial comes off and reveals how each of these glowing anticipations are destined to failure or fulfillment. And although there is in all this nothing new in favor of Mr. Edison's wilful choice of an incandescent light, to which he obstinately adheres, we cannot help admiring his ceaseless perseverance in developing the system which he has adopted for better or for worse as his own."

Also the following extract in an article in Engineering for February 21, 1879, p. 161:

"Whether Mr. Edison's system for utilizing electric current can only be satisfactorily demonstrated by actual experiment and
2369 experience, it will be severely handicapped against all electric arc systems by the visible drawback common to all incandescent systems, namely, that for each addition to the number of lights in circuit an enormous reduction is made in the intensity of the light produced. We therefore cannot but believe that we have not yet seen the system by which Mr. Edison states in his more recent letters to this country that he is able to place 678 electric lamps in one circuit."

Also the following extract from a letter written by Silvanus P. Thompson and published in the Engineering for December 27, 1878, p. 517:

"Any system of lighting depending upon incandescence will utterly fail from an economic point of view, and will be the more uneconomical the more the light is subdivided."

Also the following from the Engineering for February 13, 1880, p. 136, the same being a criticism of Mr. Upton's article on Mr. Edison's light published in Scribner's for February, 1880:

"Either as we have said, Mr. Edison and Mr. Upton know little or nothing of electric light, or else they have put forward statements which are in advance of fact and that knowingly and of set purpose. * * * But he understands so little the questions involved in the production of the electric light that he has failed to see the controversies which must ensue from the fact that if the resistances be increased, the power must be increased also."

After referring to specific statements contained in the Upton article the Engineering continues:

"Thus at every turn, the moment Mr. Upton's statements are submitted to the test of calculation, they break down, or appear in the light of wild vaticinations, hardly deserving serious attention."

Also the following extract upon an article on the electric light published in the Engineering for January 10, 1879, p. 30:

2370 "Electricians who are not commercially interested in any form of electric lamp or machine, show that this subdivision could only be effected at an enormous expense for light and material, owing to causes which we need not stop to explain * * * Before the electric light can be subdivided with facility and economy, the operation of some new law must be discovered, and this we hold to be extremely improbable."

Also the following extracts from an article on the Edison electric light published in the Engineering for February 14, 1879, pages 113 and 114:

"All anxiety concerning the Edison light may be put on one side. It is certainly not going to take the place of gas * * * Mr. Edison will no doubt attain much success at Menlo Park where everything will be under his control; but for the ordinary purposes of lighting our houses, the electric lamp is probably yet to be invented. If the current can be successfully divided among dozens of lamps, then the gas-makers quake; but nothing of the kind can be done."

Also the following extract from an article in the Engineering for December 26, 1879, p. 470 entitled "Mr. Edison's Ultimatum:"

"Heated paper is an impure charcoal, and Mr. Edison might just as well use a charcoal from a willow switch as that from his paper horseshoe. Carbon in all its forms has been tried over and over again, and electricians know precisely what can and what cannot be done with it."

Also the following extract from an article by Weisendanger, published in the English Mechanic for February, 1880. Speaking of Edison's light, the article says:

"With our present means and methods of producing the electric current and the knowledge we now possess of utilizing the same, subdivision entails an enormous loss of light. The new Edison light—a vision—a terror to the timid holders of gas shares, a phantom of mischief to ignorant speculators—is such a short-lived incandescent system, a baby, harmless indeed though not innocent, if compared to the giant systems of Siemens, Brush and Gramme."

2371 Do not the foregoing publications form a reasonable basis for the statement made by Mr. Edison and which you have quoted and criticised in answer to Q. 193, with regard to the scientific opinion in 1879 as to the practicability of subdividing the electric light?

Objected to as irrelevant and immaterial.

A. In a general way perhaps this may be the case, but nevertheless I think that the extracts you have cited agree very well in the main with my own statements with reference to the matter. Mr. Preece, whose adverse testimony before the parliamentary committee was quoted by me, placed himself on record many times with the positive assertion that the subdivision of the electric light was an impossibility. At that date Mr. Preece was an experienced telegraph engineer, but it is easy to see that his knowledge of electrical science in its broadest sense could not have been very profound.

The extract given from Mr. Tyndall's lecture is the one which I had in mind in making my answer, when I said he had made substantially the statement attributed to him by Mr. Edison.

Bennett, Valon and Redwood cannot be considered as representative electricians; in fact I don't remember to have ever heard their names before.

Professor Sylvanus Thompson is now considered a very good authority; at that time he was a young man and comparatively unknown.

The various articles quoted from Engineering were the work of some anonymous newspaper writer of the class to which I referred who "create an amount of noise out of all proportion to their real importance." I think it is very probable that the majority of the opinions which were brought to Mr. Edison's notice, which would naturally be those of the journals and publications referred to, may have been such as to have afforded him a basis for his statement; at the same time, I do not think that the authorities thus referred to properly constitute "scientific opinion."

2372 311 X Q. Is not the Engineering a leading English technical journal and was it not such in 1879?

A. It has always been considered excellent authority on matters of engineering and in fact of general science, so far as relates to its own field. The articles relating to electrical subjects at the time now under consideration, were generally understood to be written by Conrad W. Cooke, a civil engineer, but not in any way prominent as an electrician, either at that time or since. Nevertheless I have no doubt that in the minds of the majority of people, Engineering would have been considered good authority upon any subject upon which it undertook to treat.

312 X Q. Was Mr. Cook one of the persons whom you referred to as creating an amount of noise out of proportion to their real importance?

A. Yes, I think that is true to a considerable extent. He appears to have been better informed than many who wrote upon the subject, but not so well as he ought to have been for the position he undertook to fill.

313 X Q. Under the head of notes, in the Telegraphic Journal, February 1, 1879, appears the following:

"American electric lights.—A leading American electrician writes as follows: 'I know of no one here (whose opinion is worth anything), who has any confidence in the practical success of Edison's scheme. The way that the world stands agape waiting for the Edisonian mountain to bring forth its mouse is really absurd. I think you will be safe in not taking much stock in the greatly bepuffed electric light inventions of which the American newspapers are full. I have seen nothing yet as far advanced as what I saw at the Paris exposition.'"

Who is the leading electrician referred to in this extract if you know?

A. The person referred to is probably myself. Although I do not set myself up as a leading electrician. I recognize the extract as
containing the substance, though not the words, of a private
2373 letter which I wrote at that time to a friend in London, not
connected with any journal, so far as I know.

314 X Q. I call your attention to the U. S. patent of J. W. Swan on electric lamps, No. 233,445, dated October 19, 1880, in which appears the following statement:

"The second part of my invention has for its object to prevent the rupture of the carbon within the exhausted glass bulb, as the results of its unequal contraction.

"I have found that when the carbon employed within the lamp is formed of a horseshoe-shaped plate, produced by cutting out the horseshoe-shaped piece from a sheet of cardboard, and afterwards carbonizing it by heat, the horseshoe-shaped carbon plate so produced is liable to become distorted and ultimately to break, in consequence of the unequal contraction caused by the unequal heating of the inner and outer portions of the arch during the use of the lamp."

Do you agree with the statement made by Mr. Swan in this patent?

A. I differ with him to this extent, that the objections set forth by him are not necessarily inherent in a paper carbon cut out in the manner described. My opinion is that the objection is largely, if not wholly a theoretical one.

315 X Q. Whether the objection is an important one or not, depends upon the amount of difference in length between the inner and outer edges of the arch or horseshoe, does it not?

A. I should say it depended upon the effect it had upon the life of the lamp. The difference in length between the inside and the outside of the horseshoe might have no material effect, either upon the life or the efficiency of the lamp.

316 X Q. The unequal contraction and expansion will be greater

the greater the difference in the length between the inner and outer edges of the arch or horseshoe?

A. Undoubtedly.

317 X Q. Who is the patentee, J. W. Swan, and do you 2374 consider him a person of practical experience in incandescence lighting?

A. He is an English inventor of incandescent lamps. I should say that he had had a very extensive experience, experimental and otherwise, in incandescent electric lamps.

Defendant's counsel offers in evidence the extract from Ferguson's work on electricity, published in London in 1873, and the same is marked Defendant's Exhibit Extract from Ferguson's Electricity. Defendant's counsel also offers in evidence the publication in the New York Tribune of January 2, 1880, purporting to be an interview with W. E. Sawyer, and the same is filed in evidence and marked Defendant's Sawyer Tribune Interview, January 2, 1880.

Objected to as incompetent and immaterial.

Also, the extract from Prescott's book on The Speaking Telephone, Electric Light and Other Recent Inventions, published in New York, in 1879, and referred to in X Q. 295, and the same is marked Defendant's Exhibit Extract from Prescott's Book.

Also, the extract from Du Moncel on electric lighting, published in London in 1882, entitled "Sawyer-Man's Lamp" and referred to in cross-question 298, and the same is marked Defendant's Exhibit Extract from Du Moncel's Electric Lighting.

Also, a copy of the publication in the New York World of December 24, 1879, purporting to be a letter from W. E. Sawyer, and referred to in cross-question 299, and the same is marked Defendant's Exhibit, Sawyer's World Letter of December 24, 1879.

Objected to as incompetent and immaterial.

Also, an extract from a paper entitled The Electric Light, by W. H. Preece, published in the Philosophical Magazine, volume 7, page 29, 1879, and the same is filed in evidence and marked Defendant's Exhibit, Preece's Philosophical Magazine Article.

Also, an extract from a lecture delivered by Preece at the United Service institute on the electric light, published in the Elec- 2375 trician, February 22, 1879, and the same is filed in evidence and marked Defendant's Exhibit, Preece Electrician Extract.

Also, an extract from a lecture delivered by John Tyndall before the Royal institution on the electric light, published in the New York Times, February 16, 1879, and the same is filed in evidence and marked Defendant's Exhibit Tyndall Extract, February 16, 1879.

Also, report on the electric light by W. H. Bennett and William A. Valon, January 17, 1879, and the same is filed in evidence and marked Defendant's Exhibit Bennett and Valon Report.

Also, extract from a lecture by Dr. Redwood, published in the

Iron, February 3, 1879, and the same is filed in evidence and marked Defendant's Exhibit Redwood Extract.

Also, an extract from an article, on the electric light, from the Engineering, of January 2, 1880.

Also, an extract from an article from Engineering of April 16, 1880.

Also, an extract from an article in Engineering, volume 29, page 113.

Also, an extract from an article in Engineering, February 21, 1879, page 161.

Also, an extract from Engineering, February 13, 1880, page 136.

Also, an extract from an article on the electric light published in the Engineering, January 10, 1879.

Also, an extract from an article on the Edison electric light published in Engineering, February 14, 1879, pages 113 and 114.

Also, an extract from an article published in Engineering, December 26, 1879, and the same are all filed in evidence and respectively marked, Defendant's Exhibits Engineering Extracts, No. 1, 2, 3, 4, 5, 6, 7, and 8.

Also, extract from a letter written by Silvanus P. Thompson, published in Engineering, December 27, 1878, page 517. The same is filed in evidence and marked Defendant's Exhibit Thompson Extract.

2376 Also, an extract from an article by Weisendanger, published in the English Mechanics for February, 1880, the same is filed in evidence and marked Defendant's Exhibit Weisendanger English Mechanic Extract.

Also, an extract from the Telegraphic Journal, February 1, 1879, on "American electric lights," and the same is filed in evidence and marked Defendant's Exhibit Telegraphic Journal Extract.

Also, copy of U. S. letters patent of J. W. Swan, No. 233,445, and the same is filed in evidence, and marked Defendant's Exhibit Swan Patent.

Complainant's counsel admits that the various publications and papers referred to were published and circulated at the dates mentioned, and consents that copies of the original publications or documents may be used in place of the originals, subject to the correction of any errors that may be found therein, and subject to objections to incompetency and immateriality.

Complainant's counsel objects to all of the above exhibits as incompetent, irrelevant, and immaterial.

NEW YORK, *May* 6, 1889.—2.30 p. m.

Met pursuant to agreement.
Present: Counsel as before.

Redirect examination by Mr. CURTIS:

318 R. D. Q. In the quotation from the Telegraphic Journal contained in X Q. 313, which you say you recognize as containing the substance, although not the words of a private letter written by you, reference is made to general lack of confidence in the practical suc-

cess of Edison's scheme; to what scheme did you refer, and in the light of present knowledge, would you desire to express any different opinion in regard to the probable success of a system of lighting like that to which you then referred?

2377 A. I am at the present time perfectly satisfied of the justice of the opinion which I expressed in the letter from which the publication purports to be a quotation. In justice to myself, I ought to state that the letter was written in answer to an inquiry from a party in England who proposed to interest himself in the matter, and who asked me for a candid opinion. While the manner of expression is not such as I should have chosen, had I supposed that the letter was to be made public; nevertheless the substance of it embodies my opinion, and I think is a true statement as to the opinion of others. The scheme referred to was that upon which Edison was engaged in the early part of 1879, and comprised lamps of incandescent platinum, such as those shown in figures 1 and 2 of the article in the New York Herald in evidence herein, in which each lamp was designed to be controlled by a thermostatic regulator. I was at that time entirely familiar with the work which had been done by Professor Moses G. Farmer some years earlier, and with his apparatus in which he had placed some 30 or 40 incandescent lamps of platinum wire in multiple arc with a dynamo-electric machine, the system being provided with an automatic regulator common to the whole system, for regulating the current at its source. I knew that the "scheme upon which Mr. Edison was then engaged was much less practical than that of Professor Farmer, for the reason that although he employed the multiple-arc distribution as Farmer had done, he combined with it the impractical idea of an automatic regulator at each burner. The justice of my criticism is, I think, shown by the fact that within a year Mr. Edison completely and definitely abandoned the entire scheme upon which he was then at work as commercially impracticable, with the exception of the general idea of distribution in multiple arc, which in itself, as I then supposed, and as I now believe, formed no part of his invention.

319 R. D. Q. Please examine British letters patent No.
2378 4705, dated Nov. 19, 1878, to Frederick John Cheesbrough, a communication by William Edward Sawyer of New York, and Albon Man of Brooklyn, and state whether or not in the automatic regulating apparatus there described, any of the defects referred to in X Q.'s 226 to 231, inclusive, and your answers thereto, including the quotations from your testimony in the suit on the Farmer patent.

A. I am familiar with the patent referred to, and in my opinion the apparatus described therein, although embodying the same general principle, is wholly different in the details of its construction from the one to which my testimony in the Farmer case had reference, and is free from the defects which appertain to the latter. I think the Cheesbrough patent describes beyond question an operative and practical apparatus, if constructed with ordinary mechanical skill.

Complainant's counsel offers in evidence a Blue Book copy of the British patent No. 4705, of 1878, referred to, and the same is marked "Complainant's Exhibit Sawyer and Man British Patent 4705, of 1878."

Defendant's counsel consents that a typewriter copy may be used in place of the Blue Book, which forms part of a bound volume.

320 R. D. Q. I notice that X Q.'s 237 to 243 inclusive, referring to Mr. Edison's patents No. 264,692 and No. 266,693 and No. 369,280 for feeders, feeder regulators and connecting dynamo machines in multiple arc, are confined to systems of electric lighting employing direct currents and covering large areas. Is there any system for central-station lighting in use which does not employ direct currents, and if so, how largely is it used?

A. Another system differing very materially from that known as the direct distribution is in very extensive use at the present day, and is called the alternating system. It does not employ feeders for distribution over large areas, nor are the dynamos placed in multiple arc. This is the system employed by the Westinghouse Electric Company, lessee of the complainant company, 2379 and also by the Thomson-Houston, Fort Wayne and Jenny and United States Electric Lighting Companies, for central-station work. I suppose there are nearly, if not quite as many central-station lights now in operation in this country on the alternating, as there are on the direct systems. Two of the largest stations in the world now being erected in London both make use of the alternating system; and of the central stations erected during the past two years in this country, the greater portion have been fitted up on the alternating system.

321 R. D. Q. Are you familiar with the apparatus used by the complainant and the Westinghouse Electric Company, in central station work for lighting large areas?

A. I am.

322 R. D. Q. Does either company employ feeders, or indicators for indicating the pressure at the outer ends of the feeders, or regulators for regulating the flow of current upon the feeders, feeder regulators, or connect its dynamos in multiple arc in such apparatus?

A. I think not; I have examined a number of the stations, among them some of the very largest ones, and so far as my observation went, nothing of the kind is employed. I am informed and believe that none of these devices are used in any of the plants referred to.

323 R. D. Q. Are these devices, or any of them, so far as you know, employed by other companies, in the alternating system?

A. I think not.

324 R. D. Q. Please describe briefly the difference between the alternating system and the direct system?

A. The essential difference between these two systems is in the manner of distribution. In the direct system, the electric current is produced and conveyed through the conductors, at a pressure differing but little from that at which it is utilized in the lamps. In the

alternating system, the electric current is produced and conveyed to the place where it is to be used, at a pressure usually twenty
2380 times as high as that required in the lamps. At the place of consumption a device known as a reducing converter is employed, which operates by the principle known as electric induction, to reduce the pressure of the current to a point corresponding with the requirements of the lamps. The reducing converter cannot conveniently be operated by a direct current, and this is the principal reason why the alternating current is used.

Now as the electric energy developed, or work done by any current, is the product of its pressure multiplied into its volume, and as the percentage of loss of energy in a given conductor from resistance or electrical friction is in proportion to the volume of the current, irrespective of its pressure, it is evident that a given percentage of a certain volume of current will involve a far smaller loss of energy at a high pressure than at a lower one. For this reason a percentage of loss in the volume of current which would be disastrous in a system of direct distribution, becomes a matter of comparatively little importance in an alternating system of this character, and the careful regulation of the pressure at all points of the system is unnecessary and may be dispensed with, without inconvenience or appreciable loss. For example, dynamos arranged in multiple arc, special feeder wires and feeder-regulator devices, are all dispensed with in the alternating system, in which the electrical pressure is from ten to twenty times as high in practice as in the direct system, while the volume of current is only from one-tenth to one-twentieth as great for the supply of an equal number of similar lamps.

325 R. D. Q. Who first introduced the alternating system into practical use, and about how long ago?

A. So far as I know it was first reduced to practice as a method of subdividing the electric light, as it was called, by Paul Jablochkoff in Paris. He showed it to me in experimental operation in his laboratory in that city one evening in July, 1878. I afterwards read of its having been exhibited by him in England, within a
2381 year from that time. He employed semi-incandescent lamps, as Professor Cross has called them, and used a pressure in his lamps equal to and sometimes in excess of that produced by the generator. In October, 1881, Messrs. Gaulard & Gibbs exhibited in London a system of this kind, in which modern incandescent lamps were employed and a reducing converter, enabling a high pressure to be used in the conductors and a low pressure in the lamps. This was installed on a large scale on the Metropolitan railway in the following year, and from this has been developed the system of distribution by alternating currents, which I have referred to as being in extensive use in this country and abroad.

326 R. D. Q. Who first introduced the system into this country?

A. The Westinghouse Electric Company. The United States patents of Messrs. Gaulard & Gibbs were purchased by myself in behalf of Mr. Westinghouse for the Westinghouse Electric Company in the early part of 1886, and the first central station plant was got into operation in this country before the close of the same year.

327 R. D. Q. Is it as important in the alternating system, as in the direct system, that lamps of very high resistance should be used, and as a matter of fact, what is the practice in that regard?

A. It is much less important in the alternating system, and as a matter of fact the most favorable results are found to be attained by the use in that system of lamps having a resistance less than half that which has proved to be most advantageous in the direct system of multiple-arc distribution.

328 R. D. Q. Referring to your answer to X Q. 240, was the connection of electric generators in multiple arc new in the art on February 5th, 1880, the date of the application for Mr. Edison's patent No. 369,280?

A. I think not. In the number of the Telegraphic Journal and Electrical Review of Nov. 29, 1884, is a reprint of a paper
2382 by Mr. H. Wilde of Manchester, England, which was originally published in the Philosophical Magazine, vol. 37, p. 54, and in the proceedings of the Literary and Philosophical Society of Manchester, vol. 7, p. 62, both published in 1869, in which is described in detail a series of experiments, in the course of which both direct-current dynamos and alternate-current dynamos were connected in multiple arc and applied to the work. The connection of batteries in multiple arc was a very well-known expedient at that date, having been very frequently employed in the telegraphic service.

Complainant's counsel offers in evidence an extract from the paper of H. Wilde referred to, published in the London, Edinburgh and Dublin Philosophical Magazine and Journal of Science at London in 1869, vol. 37, p. 54, and the same is marked "Complainant's Exhibit Extract from Philosophical Magazine."

329 R. D. Q. In your answer to cross-question 263, you say you do not think it would be feasible to make a high-resistance lamp of platinum-iridium wire for the incandescence portion, as described in the Lane-Fox English patent. In what sense would it not be feasible?

A. Purely in a commercial sense. A platinum lamp is an expensive means of producing light as compared with a carbon lamp, because it requires far more mechanical energy to bring it to the required degree of incandescence, while its life is uncertain, and at the best is comparatively short. I did not mean to be understood that under conditions in which economy is unimportant, it would be impracticable and without utility, because I do not think that such is the case.

N. Y., *May* 7, 1889—10.30 a. m.

330 R. D. Q. Taking into account the state of general electrical knowledge prior to 1880, and particularly the discussion of the Franklin institute test by Professors Thomson and Houston in the

article in the Telegraphic Journal and Electrical Review, to
2383 which you have referred, and the Lane-Fox English patents
in evidence, would it, in your opinion, require invention or involve any particular difficulty on the part of a person skilled in the art, to make the carbon conductor of the patent in suit long and thin, or, as defendant's counsel puts it in Q. 253 and 255, give the conductor the filamentary form described in Mr. Edison's patent, and so adapt the lamp for use in the first application set forth by you in your answer 196?

A. The law laid down by Professors Thompson and Houston was a general one, and pointed out the thing which needed to be done and the direction in which the inventor should work. The fact that high resistance is desirable and necessary in the individual lamps of a general system of multiple-arc distribution, is laid down most clearly in the patents of Lane-Fox, with a sufficient explanation of the reasons therefor. The one thing lacking in the organization of Lane-Fox to render it a commonly practical scheme, in the ordinary sense of the term, was a proper incandescent conductor. Lane-Fox ought to make a lamp of high resistance with a metallic incandescent conductor. Such a lamp could be worked to a limited extent in the multiple-arc system, and was not without a degree of utility, if nothing better had ever been found. In short it seems to me, that the patents of Lane-Fox describe a practicable and commercially useful system of incandescent lighting by multiple-arc distribution in every respect, except the material of his incandescent conductor. Hence it seems to me, that when a material had subsequently been discovered which was capable of withstanding a higher temperature in the lamp than the metallic conductor, and also capable of having any required form given to it in the process of its manufacture, no invention in the strict sense of the term, would be required to give to this the same properties which Lane-Fox had already given to the metallic conductor to as great an extent as that material was
capable of. Of course I do not mean to say that there might
2384 not have been room for invention in details of construction,
by which, I mean such things, for example, as particular methods of cutting, shaping and carbonizing or tempering the conductor, or enlarging it at the ends, or the like. I think, therefore, that a person skilled in the art and knowing how to prepare a carbon conductor, would not need to exercise invention in view of the knowledge contained in the Lane-Fox patent to make the conductor long and thin, as distinguished from short and thick, to any extent within the capacity of the material.

331 R. D. Q. Would it, in your opinion, be feasible, commercially, to make lamps of high resistance with conductors made of carbonized-tar putty, as described in Mr. Edison's patent No. 223,898, referred to in X Q. 251 and 255, and have lamps of that kind ever been practically made and used, so far as you know?

A. I do not think it would be commercially practicable in the ordinary sense. I think such a conductor might perhaps be made which would do some service. But it would be difficult, and the life of the lamp would be uncertain and probably short. I have no knowledge of any lamps having been practically used with incandescent conductors of this d*i*scription.

332 R. D. Q. In X Qs. 283 and 284 your attention was called to certain statements contained in the Sawyer and Man patent No. 211,262, in regard to the defects of ordinary carbons. Do you find any other defects of ordinary carbons referred to in this patent which the process there described was particularly intended to remedy?

A. The general defect which the inventors, according to their statement, were seeking to remedy is what they term "lack of homogen*ie*ty;" in explanation of which they say among other things, "that carbons of the ordinary sort, when heated by the electric current, exhibit points and lines of unequal brilliancy. Carbons prepared by our process, when so heated, glow with a uniform brilliancy throughout." I judge from the general tenor of the specification that this effect or result, that of unequal brilliancy,
2385 was the one which they were seeking more particularly to
avoid.

333 R. D. Q. In various ones of the publications referred to in X Q. 310, reference is made to a panic caused in English gas stocks by the announcement that Mr. Edison had invented a system of electric lighting, which would soon supply such light at a cost far below that of gas. When did this occur, and what system was referred to?

A. The panic referred to occurred in October and November, 1878, and the system referred to was that of platinum lamps with thermal regulators placed in the multiple-arc system of distribution, which was afterwards found impracticable and was abandoned without ever having been put in practical use.

334 R. D. Q. How far are the general statements contained in the publication quoted in cross-question 310, in regard to the inability of the incandescent light to supplant gas as a general illuminant, incorrect at the present time, even taking into account all of the improvements that have been made up in electric lighting, since the time of the publications referred to?

A. My own opinion is, although I have never looked up the statistics especially, that in a broad sense the electric light has not thus far supplanted gas at all; that is to say, that it has not materially diminished the number of gas lights in service or the actual profit of the gas industries. It has largely created a new field of its own. It is supplied at a considerably higher price as a rule, and while, no doubt, it has replaced the gas lights and caused their discontinuance in very many instances, yet this loss has been made up, and perhaps more than made up by the general demand which has been created in the public mind for better general illumination. I am quite sure that the returns of the gas companies taken as a whole, would show that their profits had not, as yet, been sensibly diminished by the competition of the electric light.

335 R. D. Q. Is it still true, as stated in these publications,
2386 that a considerable loss is incurred by subdivision, that is to
say, that less light is produced with a given amount of energy,

or for a given expenditure, with a great number of small lights than with a few large lights?

A. It is just as true as it is ever was, and it is true in one sense, not only of electric lights, but of gas lights and even of tallow candles. The same amount of energy which is required to produce say ten 16-candle lights would produce an amount of light much greater than 160 candles if it is all concentrated in one lamp. But this is not important. The question is, whether or not a thousand 16-candle lamps can be lit by the expenditure of 1,000 times as much energy as that required for one lamp or *vice versa.* And this we now know to be the case. In other words, the loss of light by subdivision is not sufficient to make the light cost more than the consumer is willing to pay for it. It might have been argued in the same way, that the steam engine is an impracticable machine because it wastes 80 or 90 per cent. of the energy contained in the coal which it consumes. The comparisons which were in the minds of the authors of the extracts quoted, were obviously between the arc light and the incandescent light. It is true to-day that with the arc lamp we can get at least ten times as much actual light per horse power as with the incandescent lamp, and we may say, if we please, that this 90 per cent. or more, of loss is due to subdivision. But on the other hand a large proportion of the light actually produced by the arc light is wasted after it is produced, because it is not usefully distributed; so that after all the amount of light which is actually utilized is probably as great in the case of the incandescent lamp as in the case of the arc lamp.

Defendant's counsel by consent of complainant's counsel, makes the following objections to redirect questions and answers of the witness, and to exhibits filed in evidence in connection with such examination; viz: objects to R. D. Q. 320 and answer thereto, as immaterial, irrelevant and incompetent. Same objection to R. D. Qs., and answers thereto, 322, 323, 324, 325, 326, 327, 328, 330 and 331.

2387 Also objects to R. D. Q. 319, and answer thereto, and Complainant's Exhibit Sawyer-Man British Patent 4705 of 1878 as new matter, not growing out of or relating to the cross-examination, nor is the same proper redirect examination. Same objection to R. D. Q. 328, answer and exhibit.

Recross-examination by Mr. Donnelly:

Counsel states that he does not intend to waive his objection by cross-examining the witness, but makes such recross-examination, *de bene esse.*

336 R. X Q. In answer to R. D. Q. 325, you state among other things, that so far as you know, the alternating system was first introduced into practical use as a method of subdividing the electric light, by Paul Jablochkoff in Paris. State whether or not such system was introduced into public use and what commercial success, if any, attended it.

A. The Jablochkoff apparatus never went into public use as distinguished from experimental use, so far as I am aware. It only became a commercial system after having been modified and improved by Gaulard and Gibbs.

337 R. X Q. When was the Jablochkoff system modified and improved by Messrs. Gaulard and Gibbs?

A. In 1881 and 1882.

338 R. X Q. When and where was the system of Gaulard and Gibbs introduced into public use, so that it was recognized, if at all, as a commercially useful system?

A. It was put in use on the Metropolitan railway in London, on November 17, 1883, and was continued in operation for several months. A great deal of discussion arose at this time as to whether the results were commercial, that is to say, whether it was a more costly method of distribution than by direct currents, or not: a question which was not satisfactorily determined by the results in this installation. In 1885, early in the year a commercial installation on quite a large scale was put up in London, and the results were such that from that time on, the success of the broad
2388 idea of distribution by high-tension currents and induction coils may be said to have been established. Other improvements have been made since that time in the direction of increased efficiency and perfection of regulation, which have largely added to the utility of the system.

In this connection I wish to correct my answer to redirect question 325. The exhibition in London was in October, 1882, instead of October, 1881.

339 R. X Q. Then if I correctly understand your answer, the practical commercial success and utility of the alternating system was first recognized about the year 1885?

A. That I think is substantially true.

340 R. X Q. When was the alternating system for incandescent lighting first introduced into the United States for practical commercial use, and by whom?

A. The first apparatus was imported by Mr. George Westinghouse in the summer or early in the fall of 1885. The first central station plant erected and sold was at Buffalo, N. Y., and this plant was started on the 30th of November, 1886, by the Westinghouse Electric Company.

341 R. X Q. In redirect question 319, your attention has been called to British letters patent, No. 4705 of November 19, 1878, and you have stated in substance that the automatic regulating apparatus therein described, does not contain the defects embraced in the automatic regulating devices of the United States patent 205,305. Will you please refer to said English patent and indicate by page, or otherwise, that portion of the specification of said patent which describes such automatic regulating mechanism?

A. Provisional specification, page 4, line 23, to page 5, line 8, inclusive, and complete specification, page 12, line 46, to page 13, line 33. The description in the provisional and complete specification appears to be identical. The description is as follows:

"By figures 5, 6 and 7 of the drawing is shown an adjunct of the distributing apparatus by means of which and its connections with the motive power actuating the electric generator, the supply 2389 of current is increased or decreased according to the wants of the lamps or other apparatus in operation. Figure 5 is a side elevation of this apparatus; figure 6, a top view; and figure 7, a cross-section. A is any suitable base piece; B, an electro-magnet; C, an elongated armature upon the end of a T-shaped cog bar D arranged to slide in grooves cut in piece E, which piece is pivoted at P in standard F; H and I are pinion wheels meshing in the cogs D, according as that bar is tipped one way or the other. These pinion wheels are in constant motion (motive power not shown) rotating in opposite directions as indicated by the arrows. When the magnet B is not of sufficient power, the spring M by means of roller L which it carries, depresses the rod D so to cause its cogs to mesh with pinion I. When the magnet B is strong enough to overcome the spring M the cogs of rod D are thrown out of gear with pinion I and into gear with pinion H; G is a steam chest containing valves operated by a rod K jointed at O with rod J, and rod J is jointed at N with the cog bar D. The rod K moves to the right or left and opens or closes the steam valve according as the spring M or magnet B preponderates in power; Q is the generator of electricity; the points *x* and — represent the working parts of the circuits of the conductors R S T. The magnet B is constantly in the circuit of the conductor. When the supply of current is about right the cog bar D will be in a state of vibration over the pinions I and H. When the circuit of conductor S is made, but half the current originally flowing in R passes through R and the effect upon magnet B is lessened; the armature C then rises and rod D meshes into pinion I whereby the valve is moved and more steam let into the engine and the generator correspondingly actuated. When the circuit T is established the flow through R is again diminished and a similar operation of the parts results.

It will be seen that the generator so controls the steam or 2390 other power actuating the generator of electricity, that the power is increased or diminished as the demand for the current is increased or diminished, and while I have shown the result as accomplished in one way, I do not intend to limit the invention to the precise apparatus and the manner of its operation shown and described. It is preferred, as shown and described, to place a sensitive magnetic apparatus in the circuit of the generator, which when a lamp is lighted, so as to speak, automatically takes cognizance thereof and supplies that quantity of steam to the engine which is necessary to drive the generator at that speed which will give the exact required volume of electricity. The apparatus is so constructed, however, that the regulator may be made to start different generators or couple different parts of a single generator in circuit, as may be required to supply the current, or the regulator may be arranged to control the current by the automatic changing of resistance. There are in fact many ways naturally suggestive to vary the application of the invention, and hence the invention is not limited to the employment of any special form of apparatus, but includes also the substance of the form."

342 R. X Q. In making your answer to R. D. Q. 319, do you mean to be understood as saying that an automatic regulating apparatus made in strict accordance with the drawings of said patent No. 4705, would be a practically operative automatic regulating device?

A. I see no reason why it should not; I think it would.

343 R. X Q. Is your opinion based upon the practical use of such an automatic regulating device, or the observation of such an apparatus in actual operation?

A. It is not; I have never seen a regulator of the precise mechanical construction described, though I have seen several embodying the same mechanical principles. The apparatus is so simple that a mere inspection of the drawings would seem to be quite sufficient to determine the question.

2391 344 R. X Q. Have you any knowledge that an automatic regulating apparatus like that shown and described in said British patent was ever constructed or used?

A. No.

345 R. X Q. You have referred to the fact that in the year 1886 you purchased U. S. patents of Messrs. Gaulard & Gibbs in behalf of Mr. Westinghouse for the Westinghouse Electric Company. Were you then in the employ of Mr. Westinghouse, or the Westinghouse Electric Company, and if so, in what capacity?

A. I was not, except from time to time upon special commissions, as my services might be required.

346 R. X Q. How long is it since you were regularly and steadily employed by the Westinghouse Electric Company, and what is the character of such employment?

A. Since the middle of last summer, July 1888, I think it was. Since that time I have been employed a considerable portion of the time in connection with business in Europe, most of my time while in this country has been occupied in miscellaneous service as an expert, making examinations of patents and inventions and giving testimony in suits in the court, and assisting in the prosecution of applications in the Patent Office.

347 R. X Q. Are you a stockholder in the Westinghouse Electric Company, the lessee of the complainant in this suit?

A. Yes.

348 R. X Q. Referring to redirect question 331, wherein you have stated that lamps of high resistance with conductors made of carbonized tar putty, as described in Mr. Edison's patent No. 223,898, would not be practical commercially; state whether your opinion is based upon actual experiment and observation of the behavior of such a conductor in a lamp or lamps.

A. It is not.

FRANKLIN L. POPE.

Subscribed and sworn to before me this 7th day of May, A. D. 1889.

CAROLINE E. DAVIDSON,
Special Examiner.

2392 And now, Lehighton, Pa., March 29, 1889, in pursuance of notice the taking of testimony on part of the complainant is proceeded with. T. B. Kerr, Esq., appears for complainant and H. D. Donnelly, Esq., for respondent.

Defendant's counsel desires to state that while he appears in behalf of defendant under the annexed notice, he reserves the right to cross-examine the witness further at some future day before the plaintiff closes its proofs, for the reason that the notice does not name the witness or witnesses who are to be examined at this hearing, and the defendant has had no opportunity to prepare for the cross-examination of the witness or witnesses under said notice.

Testimony of Tillie J. Sawyer.

TILLIE J. SAWYER, a witness on behalf of complainant, being subpœnaed, produced, and sworn, testifies as follows:

1 Q. State your name, age, residence, and occupation.

A. My name is Tillie J. Sawyer, am twenty-three (23) years of age. I reside at Lehighton, Pa. Have no special occupation. Am the wife of Geo. W. Sawyer, recently deceased.

2 Q. When did Mr. Sawyer die and where?

A. Mr. Sawyer died in New York city at the Mitchell house, February 26th, 1889.

3 Q. When did he go to the Mitchell house?

A. January 24th, 1889.

4 Q. Did you accompany him, and remain with him while he was there?

A. I did.

5 Q. Where was he buried?

A. In Lehighton.

6 Q. Who bore the expenses of bringing his body home to Lehighton, and of his burial?

Object- to by defendant's counsel as immaterial, irrelevant, and incompetent.

A. There are two answers to make to that, if you want me to answer that. The funeral expenses here were paid by the Independent Order of Odd Fellows here, of which he was a 2393 member in good standing. The funeral casket, I suppose was paid for by Mr. Russell. When Mr. Sawyer was dead I told Mr. Russell that if he would get a casket I would get the money here and send to him, and the lodge met the corpse at the station and took care of it after that.

Defendant's counsel seasonably objected to the statement of the witness that she "supposed that the casket was paid for by Mr. Russell." Also that part of said answer relating to what Russell said as hearsay and as a statement by a stranger to this suit, and moves to strike out those portions of the answer for those reasons.

7 Q. Did you send Mr. Russell the money for the casket?

Objected to by defendant's counsel as immaterial and irrelevant and as incompetent, because the question calls for testimony to a transaction between strangers to this suit.

A. I have not. I wrote Mr. Russell one letter, and have received no answer as yet.

Same objections continued as to answer, and motion to strike out the same.

8 Q. When did you first see Mr. Russell?

Same objection as to last question.

A. January 19th, 1889.

Same objection to answer with motion to strike it from the record.

9 Q. When and under what circumstances?

Same objections as — the last questions.

A. He came to Lehighton to visit Mr. Sawyer.

Same objection to answer and motion to strike it from the record.

10 Q. For what purpose?

Same objections as to last questions, also as incompetent and improper, because no sufficient foundation has been laid for the question or the evidence which it calls for, if it is intended 2394 thereby to impeach or contradict the evidence of Geo. W. Sawyer, deceased, the said Sawyer's attention not having been called or directed to the subject-matter inquired about specifically or otherwise when he was on the stand as a witness.

A. I do not know.

11 Q. Did Mr. Sawyer receive any money from Mr. Russell either directly or by remittance from New York, before he went to New York on January 24, 1889, accompanied by you?

Objected to as immaterial and irrelevant, and as incompetent because the question calls for a transaction between the witness and a stranger to the suit. Also that no foundation has been laid for the introduction of testimony concerning a transaction between the witness George W. Sawyer and said Russell, it not having been shown that said Russell had any connection or relations to or with the defendant in this suit. Also for the same reasons stated in the objections to the last question.

A. He received money but I don't know where from: I don't know from whom, I don't know who the money came from.

Same objections to the answer and motion to strike the same from the record.

12 Q. Do you know of his getting one or more post-office orders from New York?

Same objections as to last question.

A. He got one, I think.

Objected to and motion to strike same from the record.

13 Q. What was the amount of that post-office order?

Same objections as last, also as incompetent because the question calls for secondary evidence and not the best evidence.

2395 A. I don't know that it is necessary for me to state that.

Objections repeated with motion to strike the same from the record.

14 Q. Question 13 repeated?

Objections continued.

A. Fifty dollars.

Same objection to the answer and motion to strike same from the record.

15 Q. Did Mr. Sawyer receive any money from Mr. Russell in New York.

Same objections continued.

A. I do not know.

Objections continued.

16 Q. When were you married to Mr. Sawyer?
A. February 24, 1884.
17 Q. Was Mr. Sawyer sick for any considerable period after you were married?
A. He was for a year off and on.
18 Q. Was he able to work during that period?
A. At times.
19 Q. How much of the time?
A. About half of the time I suppose.
20 Q. Have you told one or more persons that during that period of sickness he received several hundred dollars from the Edison Electric Light Company, or from Mr. Russell?

Objected to as immaterial and irrelevant, and because the question calls for hearsay evidence, and the only apparent purpose of the question seems to be to contradict or impeach the complainant's own witness, or to lay a foundation therefor, which is not proper or admissible. Also that the question is leading. Also that the question is improper, in that it does not call for the witness's knowledge concerning a fact but for what she told somebody, which is not competent.

2396 A. No, sir. Not to my knowledge.
21 Q. How much money did he receive at or about the time of that sickness from Mr. Russell, or from the Edison Company?

Objected to as incompetent and improper because it assumes that Geo. W. Sawyer did receive money at or about the time of his sickness from Mr. Russell or from the Edison Company, and assumes that the witness knows that fact, which has not been shown. Also as immaterial and irrelevant. Also as incompetent if offered for the purpose of contradicting or impeaching the testimony of Geo. W. Sawyer, because no sufficient foundation was laid for the question when Geo. W. Sawyer was examined as a witness in this suit.

A. His sickness has been in the last year and he has received no money. It was in 1888 his sickness.

Same objections to the answer, and motion to strike it from the record.

22 Q. Was that the only sickness he has had since he was married?

A. No, sir.

23 Q. When was he sick before and for how long?

A. He was sick for two months in the spring of 1886.

24 Q. Do you know of his having received any money at or about that time from Mr. Russell or the Edison Company?

Same objections as to question 21 continued.

A. No, sir.

25 Q. Do you know of his having seen Mr. Russell about that time and giving him a statement as to his testimony in this case?

Same objection as to last question.

A. No, sir.

26 Q. Who paid your expenses and those of Mr. Sawyer at the Mitchell house, New York?

Same objections continued.

2397 A. I don't know.

27 Q. Is it a fact, or not, that you have informed, either by personal communication or by letter, one or more persons that you are offered instruction in stenography and typewriting, and then to have a place provided for you by Mr. Russell or by the Edison Company?

Same objections as to Q. 20.

A. I think not.

28 Q. Was such offer made to you by Mr. Russell, or on the behalf of the Edison Electric Light Co.?

Same objections as last.

A. No, sir.

Counsel for complainant hereby notifies counsel for respondent that the witness is here for cross-examination, and that he can cross-examine her now, and that complainant denies his right to call the witness for further cross-examination at any other time.

Cross-examined:

29 X Q. Please state when your husband died.

A. February 26th, 1889, at the Mitchell house in New York city.

30 X Q. Of what disease did he die?

A. Pneumonia, I think.

31 X Q. How long was he ill in his last sickness?

A. Six weeks.

32 X Q. Was he suffering from pneumonia during the whole of this six weeks' sickness?

A. No, sir; his disease was cancer of the stomach, pneumonia set in three days before his death.

33 X Q. Before the pneumonia set in, how long had he been ill of cancer of the stomach?

A. He had been doctoring here for consumption. The doctors in New York told him he was suffering from cancer of the stomach.

2398 34 X Q. Was he a great sufferer during the last six months of his life?

A. Yes, sir.

35 X Q. How long before his death was he conscious of the fact that the disease of which he was suffering was incurable and that his recovery was hopeless?

A. Two days.

36 X Q. Prior to that time had he been advised that the nature of this disease was such that he probably could not recover?

A. No, sir.

37 X Q. You say he was a member of the Odd Fellows' lodge here in Lehighton. How long had he been a member of such lodge previous to his death?

A. Nearly four years.

38 X Q. I understand you to have stated on your direct examination that he was a member of that lodge and in good standing therein; was that the fact?

A. Yes, sir.

39 X Q. Prior to your husband's decease, and while he lived in this community was he well known by the members of the lodge of which he was a member?

A. Yes, sir.

40 X Q. And stood well as a citizen and a man, did he?

Objected to as incompetent.

A. Yes, sir; he did.

41 X Q. During the last two months of your husband's life, did he suffer a great deal of pain from cancer of the stomach?

A. He did.

42 X Q. What led you to think that he suffered a great deal of pain?

A. He told me so.

TILLIE J. SAWYER.

2399 Circuit Court of the United States for the Western District of Pennsylvania.

THE CONSOLIDATED ELECTRIC LIGHT COMPANY
against
MCKEESPORT LIGHT COMPANY.

NEW YORK, *May 6th*, 1889.

Testimony Taken under the Order of the Court, Dated May 4th, 1889, *in Impeachment of the Testimony of the Witness Church.*

Present: Amos Broadnax, Esq., for complainant; Walter K. Griffin, Esq., and Grosvenor P. Lowrey, Esq., for defendant.

Deposition of the witness RICHARD N. DYER, on behalf of defendant, taken under the order of the court, dated May 4th, 1889.

By Mr. GRIFFIN:

1 Q. What is your name, residence, age and occupation?

A. Richard N. Dyer; East Orange, N. J.; lawyer; age, 31, and one of the counsel for the defendant in the above suit.

2 Q. Are you acquainted with the witness William H. Church, who has testified on behalf of complainant herein, and if so, state generally the nature of your acquaintance with him?

A. I first met Mr. Church in 1881, I think, about the time the testimony was being taken in the interference case between Sawyer & Man on paper carbons. He was present once or twice at the examination of Edison; witnesses and I met him there. Since
2400 that time my acquaintance with him has simply been a nodding acquaintance, with the exception of an occasional inquiry on his part after the health of my father, whom I believe he met at the same time.

3 Q. Have you read the cross-examination of the witness William H. Church, conducted by Mr. Griffin, being questions 42 to 188 inclusive, with the Defendant's Exhibit "Church Statement of Facts," and the Complainant's Exhibit "Tomlinson Telegram," and "Church's Letter to Tomlinson" offered during the conduct of such examination?

Objected to on the ground that there was no cross-examination of the witness Church.

A. Yes, I read the entire deposition of Mr. Church, taken in this case this morning, including the copies of the exhibits offered with his deposition.

4 Q. In the cross examination of Mr. Church various questions were asked as to interviews had by him with yourself and Mr. Tomlinson, beginning early in the year 1887. Please state generally how those interviews came about and your recollection as to the same.

Same objection.

A. Some time, I think, in the month of May, 1887, Mr. Church called at my office, No. 40 Wall street, and being shown into my private office made a statement to me of the matters covered by the interviews. At that time Mr. John C. Tomlinson occupied the same offices with me. He, Mr. Tomlinson, had charge, as solicitor for the Edison Electric Light Company, of the patent litigations of that company, including the defense of the suit brought in the southern district of New York by the complainant herein against the Edison Electric Light Company on the patent in controversy in this case. I assisted Mr. Tomlinson in work upon these litigations. Mr. Tomlinson having charge of the litigations, I told Mr. Church, 2401 before he had proceeded very far with his statement, that time would be saved if we saw Mr. Tomlinson, and the statement was made to both Mr. Tomlinson and myself. Thereupon I took Mr. Church into Mr. Tomlinson's private office and introduced him to Mr. Tomlinson and a further interview was had lasting for some time.

5 Q. Did Mr. Church come voluntarily, or did he come by invitation or suggestion of yourself or Mr. Tomlinson in any way?

A. Entirely voluntarily.

6 Q. Had you been directly or indirectly cognizant of the subject-matter of his conversation prior to his coming to you?

A. His statement to us on the occasion of his first visit was the first I had ever heard of the matter.

7 Q. After this first interview, how many subsequent interviews were had by Mr. Church with you or Mr. Tomlinson, and up to about what time did those interviews continue?

A. At the first interview Mr. Church made a proposition which he desired taken under consideration. He called frequently at our offices after that time inquiring whether we had reached any conclusion in the matter, and on the occasion of these calls he would sometimes go after a few minutes' conversation, and sometimes prolonged the interview to half an hour. He called so frequently that he finally asked us to telegraph him when we had reached any conclusion in the matter. A final interview was had in response to a telegram from Mr. Tomlinson. This took place in the latter part of June, 1887. The interviews might be stated to consist of two principal interviews, one at the beginning and one at the end, and a number of intermediate interviews arising from Mr. Church's calls to inquire if we had reached any conclusion.

8 Q. At the first interview as to which you have testified, what were the propositions and statements made by Mr. Church to you and Mr. Tomlinson?

A. Mr. Church said that the Sawyer & Man patent on fibrous carbon which had been secured as the result of the interfer- 2402 ence with Mr. Edison was absolutely invalid, and that he possessed information which when proved would make it so. He had with him a statement in his handwriting which appears as "Defendant's Exhibit Church Statement of Facts," and also copies of some of the agreements referred to in that statement. Mr. Church stated to us that the various matters covered by the Sawyer and Man patents, including the fibrous carbon patent in suit in the

New York case, had been invented by Mr. Sawyer before he met Man, but had been concealed from Flanagan, who was entitled to an interest in the inventions under his agreement. Mr. Church also stated that the fact that such an agreement existed between Flanagan and Sawyer was not known to Mr. Man when he became acquainted with Mr. Sawyer, but that experiments were conducted by Mr. Sawyer at Mr. Man's expense with the intention of securing patents in the name of Mr. Sawyer alone. One morning Mr. Church was at Sawyer's shop when he showed Man for the first time the Flanagan agreement. Church stated that Man seemed very much incensed and put out about the agreement, and said that some plan would have to be devised for getting around it. Church stated that Man proposed as one plan that they should give Flanagan some kind of notice or reimburse him under his agreement, but that Man, in discussing that matter, concluded that that plan would not work because the inventions had been concealed from Flanagan, and if the concealment was continued any such settlement would be ineffective. Church also stated that Man suggested the plan which was finally adopted—namely, that he and Sawyer should take out the patents as their joint inventions and in that way the obligation to Flanagan would be avoided. That suggestion Mr. Church stated was adopted by Sawyer, and the result was a certain agreement between Sawyer and Man to which Mr. Church called our attention, in which they agreed to take out the patents as joint inventors. Mr. Church stated that since the patent, including the patent in suit, had been taken out as the joint invention of Sawyer and Man, when they were 2403 really the sole invention of Sawyer, and were taken out in that way to defraud Flanagan under the contract, he thought the proving of those facts would invalidate the patent, but he suggested that in order to take advantage of those facts the Edison Electric Light Company ought to own the Flanagan interests under the contract with Sawyer. That, Mr. Church said, could be purchased, and he would undertake to do it for us. Mr. Church also stated that he had certain other very important information which of itself would be sufficient to invalidate the patent in suit, but which he could not tell us about because the minute he told us what it was we would be able to take advantage of it and would not require his services. That information he stated was not the Flanagan interest, but was an entirely distinct source of information which we knew nothing about. As a part of this interview a discussion of the experiments of Sawyer and Man took place, and of the testimony of Mr. Church in the interference case, and Mr. Church stated to us that he had not actually seen the things done which he testified to in interference case, or at least at the time he testified did not recollect having seen them done, but that Albon Man had told him that such were the facts and had gone so far as to dictate to him memoranda of what the facts were and that he, Church, had gone on the stand and testified upon the information given him by Albon Man and without any recollection himself of the facts. Mr. Church then proposed that the Edison Electric Light

Company should pay him $5,000 down in cash and $10,000 contingent upon the patent of Sawyer & Man on fibrous carbon being declared invalid. He said that Mr. Schuyler, of No. 44 Broadway, had in his possession papers which would show the invention by Sawyer before he met Man, and Mr. Church left us with the understanding that he would make an appointment with Mr. Schuyler for us to see the papers in his possession.

9 Q. State what occurred at the last principal interview after the sending of a telegram to Mr. Church which you have mentioned. I mean the interview that took place at the end of June, 1887?

2404 A. Mr. Tomlinson was about to *be* begin, or had begun, the cross-examination of Albon Man in the New York suit and he telegraphed Mr. Church to call with a view of securing such additional information, if any, that he could make use of in the cross-examination. At this interview the same ground was gone over as at the first interview, but in more detail, as I now recollect it, with regard to the falsity of Mr. Church's deposition in the interference case. In discussing this matter with Mr. Church, Mr. Tomlinson turned over the pages of the interference record, which was before him, and asked Mr. Church in detail with reference to his own deposition as to whether he had at the time of giving the deposition a personal recollection of various important matters about which he testified. One point I recollect was with regard to whether he knew himself, or had only been told, that paper carbons had been employed, and that paper had been carbonized, and that paper had been prepared for carbonization by cutting it out. As to all of these matters Mr. Church replied that he had no recollection at the time of giving his deposition in the interference case, nor had he at the time of our conversation of seeing these things himself, but that Mr. Man had told him that they did occur and he had testified from Mr. Man's statement. With regard to accepting Mr. Church's proposition, Mr. Tomlinson told him in substance that we could not put ourselves in a position of purchasing testimony and could not accept any proposition of the character proposed by Mr. Church. Mr. Tomlinson asked Mr. Church if he could not name a moderate sum for which he would make a statement of the truth, whether in our favor or against us, not only as to the Flanagan interest but as to his own testimony in the interference case, and as to the information which he withheld and which he insisted was of so great importance and would alone be sufficient to invalidate the patent, and after having made such a truthful statement, whether the facts were for us or against us, that we would then, provided we concluded to use his services, arrange with him for a reasonable *per diem* compensation for any time he
2405 might give to obtaining information or testifying in our behalf. Mr. Church did not accept this proposition, but replied that this very important information which he withheld could be used by us without his assistance the moment he gave it to us, and that we would not need his services after he had made the statement, and hence he could not name any moderate sum which would be a sufficient inducement to him to make such a statement. In

return he made a proposition that the Edison Electric Light Company should pay him $2,500 in cash and $15,000 contingent upon the patent being declared invalid. He said that he was willing to leave the much larger sum as contingent upon our success in the litigation because he felt absolutely certain that the patent would be declared invalid if the testimony was given of which he had information. We told Mr. Church that we could not even undertake to carry such a proposition as the one he made to the officers of the Edison Company, but he insisted that we should do so, and left without definitely settling the matter.

10 Q. Was any statement made by either you or Mr. Tomlinson in your presence to Mr. Church as to any intended disclosure by you of any arrangement you might make with him in the event of his testifying?

A. Yes. Mr. Tomlinson and myself both stated to Mr. Church, as an additional reason why any such proposition as that he made could not be accepted, that in using him as a witness we would state fully on the record what our arrangement was with him, so that the court could see the precise conditions under which he was testifying. We thought this explanation might appeal to him even if the explanation based on the moral question did not.

11 Q. What explanation, if any, did you or Mr. Tomlinson in your presence, make to Mr. Church as to the position he would legally be put in by testifying that his previous deposition in interference was either in whole or in substantial part false?

A. We called Mr. Church's attentien to the fact that if he went on the stand to testify as a witness he would be obliged to state that his testimony in the interference case was false. 2406

12 Q. What did Mr. Church say to this?

A. Mr. Church admitted that that would have to be his attitude as a witness. Mr. Church said that he could be of value to us as a witness and we told him that as a witness he would have to confess to having testified falsely in the interference case, and that if he did so testify it was so not likely that the court would believe him anyway; and we told him that before using him as a witness we desired in fairness to him to explain what his attitude must be.

13 Q. What do you mean by your expression in the last answer that Mr. Church would have to admit on the stand that he had previously perjured himself: what compulsion, if any, did you explain to him there was in the matter?

A. We understood that he was ready to tell the truth, and having told us that the things testified to in his interference deposition were not true we explained to him that in order to tell the truth he would be compelled to admit that he had before sworn falsely.

14 Q. Was any proposition at any time made by you or Mr. Tomlinson, or so far as you know by the Edison Company, to Mr. Church, or any inducement direct or indirect held out to him in these matters to testify or to give any information?

A. No, none whatever.

15 Q. In respect to the matter that you have mentioned, of his naming a moderate consideration for giving a statement to you of

the facts, was any inducement direct or indirect of any nature made or held out to him as to what that statement should be?

A. No, none whatever. He was simply to make a statement of the truth, whether the facts were favorable or unfavorable to the Edison Company.

16 Q. I call your attention to X Q. 74, by Mr. Griffin to William H. Church in this suit, and ask you to read in connection therewith X Qs. 71 to 73, with the answers thereto, and state
2407 whether or not the statements of the witness Church, in the answer to X Q. 74, is true or not?

Objected to on the ground that there was no cross-examination of the witness Church.

A. It is not true, as I have already stated, the most important information apparently which Mr. Church had was that which he withheld because he thought we would not require his services, in order to take advantage of it after he had disclosed it to us, and that information he insisted at all his interviews was sufficient to render the patent absolutely invalid.

17 Q. Did you learn from him whether this undisclosed information had any reference to the Flanagan interest?

A. He told us that it was an entirely separate matter from the Flanagan interest. The facts as to the Flanagan interest we understood he fully disclosed to us.

18 Q. I ask you similarly whether the statements of the witness in answers to X Qs. 76, 77 and 78, are true as to the facts?

Same objection.

A. They are not true. Mr. Church always insisted that the proof in his possession was clear that the invention of the patent in suit was made by Sawyer alone before his association with Man.

19 Q. I ask you to read Re-X Qs. 96 to 99 inclusive, and to state whether or not those answers are true as regards the interference records left by Mr. Church with you and Mr. Tomlinson. Please state what interference records Mr. Church did leave with you or Mr. Tomlinson?

Same objection.

A. At the first interview Mr. Church left a statement of facts, Defendant's Exhibit "Church Statement of Facts," and copies of some or all of the agreements referred to in his statement. He
2408 also left a copy of the Sawyer and Man record in the interference of Sawyer and Man *vs.* Keith *vs.* Maxim.

20 Q. Is the statement of the witness Church in answer to Re-X Q. 100 true?

Same objection.

A. This statement is absolutely false. These are the points as to which the statement appears to be untrue; we did not request him to engage in our services in trying to defeat the patent in suit, but he urged himself upon us, insisting that he could defeat the patent. He did not tell us that he did not see how he could be of any service to us, but we told him that we did not see how he could be of any service to us unless he would disclose the truthful information which he said he had and then leave us to judge as to whether the information would be such as we could use. Mr. Church's statement that Mr. Tomlinson produced a printed record of his testimony in that case—which I understand to mean the interference case between Sawyer and Man and Edison on paper carbon—and "he agreed with me that I could not testify in their behalf," contains elements of truth and elements of falsity. The fact is Mr. Tomlinson produced the record of Mr. Church's testimony in the interference case and asked Mr Church whether a number of things he had testified about were true or false, and Mr. Church replied that they were false. Thereupon Mr. Tomlinson explained to Mr. Church what his attitude must be when testifying as a witness, and that since he would have to admit that he swore falsely before, the court would probably not believe him now, and for that reason Mr. Tomlinson thought that he, Mr. Church, could not testify in our behalf so as to be of any value to us. Mr. Church's statement that Mr. Tomlinson then wanted him to think the matter over and see if he could not see some way in which he could be of service to us is entirely unwarranted by anything that occurred within my recollection, since throughout these interviews Mr. Church continued to urge that he could be of value to us and 2409 our effort was to see how he could be. Mr. Church's statement that a compensation of $1,000 a day was named is entirely without foundation. My recollection is that no definite compensation was offered to Mr. Church for his services, even if we should require them. The only discussion as to paying him a *per diem* for his services was in connection with the request I have already spoken of that we made of Mr. Church to name a definite moderate sum for which he would make a statement of the truth whether for or against us, and that then if we should need his services after reading over the statement we would pay him a fair compensation for the time employed. But he never accepted this proposition and never went far enough to name either the sum for which he would make the statement or the *per diem* which he would accept if we should conclude to employ him after the statement was made. There may be other particulars in which Mr. Church's answer to Q. 100 is untrue, but the above are what occur to me at the present time.

21 Q. This statement of Mr. Church—to what matters was it to relate? To the Flanagan matter or the undisclosed information, or to what?

A. More particularly to the undisclosed information. But it was also to include, as I understood it, all matters relating to the case which were within Mr. Church's own knowledge, including the facts as to his testimony that he had given in the interference case.

22 Q. Is Mr. Church's answer to R. X Q. 101 true?

Same objection.

A. It is not true. The Flanagan contract seemed to be a very small portion of the matter which Mr. Church had for sale, an element of larger importance being the other information which he could put us in the way of getting, and in the furnishing of which he seemed extremely desirous to enter our service. His attitude was not at all what he says it was, of being willing to serve, 2410 provided we could show him wherein he could be of service, but he always insisted that he could readily prove that the patent in suit was invalid, and was exceedingly anxious to make an arrangement by which his services could be used for that purpose.

23 Q. Similarly are the statements in the answers to R. X Qs. 102 and 105 true?

Same objection.

A. They are not true. Mr. Church came to us with a proposition that we should pay him $5,000 down and $10,000 contingent upon the defeat of the patent. His statement that our "scheme" "appeared to be feeling around as to whether I could recollect anything that would be of any service to them" carries with it an entirely false impression, since all the interviews were based upon a scheme that Mr. Church had to defeat the patent by the Flanagan interest, by the falsity of his own testimoney and, more especially, by the undisclosed information. We never tried to get Mr. Church to recollect whether he could be of any service, since his attitude always was that the information which he withheld would be entirely sufficient to invalidate the patent. Having forced that fact upon us a great many times we naturally were desirous of getting that information and so proposed to him that he should suggest a moderate sum for which he would make a statement of the entire truth as to the matter. The proposition referred to by Mr. Church in answer to R. X Q. 100 I assume to be the one he speaks of in answer to R. X Q. 100, and which I have before stated has no basis in fact at all.

24 Q. Did Mr. Church ever ask you to pay $60,000 for the Flanigan interest, and did you ever decline said proposition, as stated by the witness Church in R. X Qs. 106, 107, 112 and 113?

Same objection.

2411 A. Mr. Church never made any such proposition, and we never declined any such proposition. In fact, Mr. Church never made a separate proposition as to the Flanagan interest, but his proposition that he should pay $5,000 in cash and $10,000 contingent, which was subsequently modified to $2,500 in cash and $15,000 contingent, was to include everything within his possession and control, that is to say, the Flanagan interest, the use of himself as a witness and the information which he withheld, with his services in procuring that information and getting it properly in form of proof.

25 Q. Read through the questions and answers Re-X. Qs. 114 to

116 inclusive, and state how far, if at all, the answers of the witness thereto are true.

Same objection.

A. With regard to his answer 114 to our X Q., Mr. Church certainly, seriously as we supposed, offered his services to defeat the patent. His answer to 115 X Q. I consider to be entirely untrue, as I have before explained. Mr. Church at no time stated that he had very little recollection of the subject-matter of the interference, and that he would rely upon us to refresh his memory, since his recollection seemed to be entirely clear, at least if his statements represented his recollection, that at the time he testified in the interference case, and at the time of his conversations with us he did not recollect having seen the things he testified about. With regard to the answer to 116, Mr. Church did make the definite proposition that we should pay him $5,000 in cash, and $10,000 in the event the patent was declared invalid.

26 Q. Similarly I ask you whether the witness' answers to X Qs. 117 to 119 inclusive, are true?

Same objection.

A. Mr. Church's statement that he told us that the only thing he could consider would be a purchase of the Flanagan interest is entirely untrue, since he never made any separate proposition for the Flanagan interest, but his proposition covered the entire 2412 matter. He gave as a reason why he wanted such a large amount of money that the invalidation of the patent would entirely destroy the value of the stock of the Consolidated Electric Light Company, and make his shares in that company worthless, and for this he wished to be reimbursed, and he also said he felt under obligation to pay the parties holding the Flanagan interest at least a part of the money they had advanced for the experiments of Mr. Sawyer, under the Flanagan contract.

27 Q. Is the answer to Re-X Q. 122 correct?

Same objection.

A. This answer is entirely untrue, or at least conveys a false impression. Mr. Church called a number of times before June 30th, 1887, but always, as I recollect it, at his own suggestion. He was exceedingly importunate, calling frequently and without any appointment being made. I recollect a number of times both Mr. Tomlinson and myself telling him that when *he* got ready to see him we would let him know, but the suggestion did not seem to be effective with him since he continued to call every few days.

28 Q. You have stated that a telegram was sent to him some time in June, 1887. At whose request or suggestion was such telegram sent?

A. Mr. Church suggested a telegram, I think, as a quicker way of reaching him than by letter. He seemed to be annoyed at the time Mr. Tomlinson and myself took to consider the matter.

29 Q. Did Mr. Church call in response to that telegram, if so, when?

A. Mr. Church called in response to the telegram, and we had our last interview, which I have testified was a long one, at the end of June.

30 Q. Is the statement, then, by the witness Church, in answer to Re-X Q. 135, true or false?

Same objection.

A. It is false.

2413 31 Q. What was the date of this interview by yourself and Mr. Tomlinson with Mr. Church in response to that telegram?

A. It must have been the 29th or 30th of June, 1887. My recollection is that it was the 29th.

32 Q. At the conclusion of this interview, in response to the telegram, did Mr. Church make any arrangements as to seeing you again?

A. He insisted that we should consider his proposition, and said he would call again a couple of days after.

33 Q. Did he so call; and if so, did you see him?

A. I understand that he called, because Mr. Tomlinson afterwards showed me a note from Mr. Church which he had written in our office, but I was out at the time.

34 Q. Are the answers of the witness Church to Re-X Qs. 145 to 163 inclusive, true or false?

Same objection.

A. His answer to X Q. 145 is untrue. He said in substance that his testimony in interference was false. The reason that he advances why he could not have made such a statement is not a good one, because at the interview the matters which he had testified about in the interference case were discussed, and, as I have before stated, his attention was called directly to some of his answers in the interference case. His answer to 146 X Q. is false, as I have just stated. His answer to 147 X Q. is false. He had a dozen interviews at least with us; and at no one of them did he state that he had no recollection of what he had testified to in the interference case, since he seemed to be fully acquainted with the facts in the interference and with his testimony. As to 148, the same answer to 147 applies, also 149. As to 150, Mr. Church's answer is untrue. He did state to us at the particular interview, namely, our last one; and at our first interview, that Mr. Man dictated memoranda to him as to what had been done, and that he, Church,
2414 swore to those facts on Mr. Man's statement. Answers to X
Q. 151 and X Q. 152 refer to these same memoranda. Also answer to 153. Answers to 154 and 163 are untrue, as I have before explained. Mr. Church never stated that he could not recollect what he had testified to in the interference case, but seemed to be fully aware of his testimony in that case, and had his attention called to it during our interviews, as I have before stated. He also

stated to us what he has directly denied in these answers, that he had no recollection of the principal facts about which he testified, but that Mr. Man told him that the things occurred, and that the experiments were made, and went so far as to dictate memoranda of the facts about which he wished him to testify, so that he would not go astray as a witness. He also stated that Mr. Broadnax, who was the counsel for Sawyer & Man, also insisted that these were the facts, and that he ought to know them.

35 Q. Are the witness's answers to X Q. 165 to 167 inclusive, true? Where your previous testimony covers your version of the matter referred to in these answers I will not ask you to repeat the same.

Same objection.

A. They are not true, as I have already explained.

36 Q. Is the witness's answer to cross-question 172 true. Did he or did he not state as indicated in said question?

Same objection.

A. His answer is not true. He did make the statement referred to in the question.

37 Q. Similarly are the witness's answers to the cross-questions 173 to 181 inclusive, true?

Same objection.

A. They are not true. The questions are a fair statement of the facts, and the denials by the witness are untrue.

2415 38 Q. In testifying as you have done on this examination, have you been testifying from unaided recollection, or has your recollection been refreshed by memoranda of any kind; if so, please state what the same are?

A. The principal facts in the interviews with Mr. Church, the statements and propositions made by him, and our replies are all clearly matters of my unaided recollection. As to some of the details, more especially as to the dates of the interviews, my recollection has been refreshed by a statement of the facts which was dictated by Mr. Tomlinson and myself to our office stenographer within a few days after the last interview with Mr. Church. That statement I have in my possession, it having been turned over to me by Mr. Tomlinson with the other papers relating to the Edison litigations at the time he retired from the control of the litigations.

39 Q. I hand you a paper marked for identification Defendant's Exhibit "Tomlinson's Statement as to Church," May 6th, 1889, and ask you whether that is the statement which you refer to?

A. It is.

Cross-examination by Mr. BROADNAX:

40 X Q. The interviews about which you have been testifying, as I understand you, between yourself and Mr. Church, took place in the year 1887?

A. Yes.

41 X Q. How many interviews were there?

A. A dozen or more.

42 X Q. When did the first interview occur?

A. Some time in May, 1887, I think, or early in June.

43 X Q. Who was present at that interview?

A. Mr. Tomlinson, Mr. Church and myself.

44 X Q. Were you all three present during the whole time of the interview?

A. We were with the exception of the opening statement Mr.
2416 Church made to me before I took him into Mr. Tomlinson's
room, and which he repeated in the presence of Mr. Tomlinson when we were all three together.

45 X Q. What was his opening statement? Please to give his words as near as you can recollect them?

A. He said that he had information which would invalidate the Sawyer-Man fibrous carbon patent. He had not gone beyond this point when I suggested that since Mr. Tomlinson had charge of the litigation, it would save time to bring him into the interview and make one job of it.

46 X Q. Were those the first words he said when he came into your office?

A. I do not know whether they were the first words or not; I think not. The ordinary friendly salutation was the first, his usual inquiry after the health of my father, I think followed. But when he came to speak of the matters which brought him to my office, he stated in substance what I have just stated.

47 X Q. Did he state in the beginning the object of his calling *you* upon you seeking an interview with you?

A. Yes.

48 X Q. What did he state that object to be?

A. He said that he had this information which would invalidate the patent, and desired to make an arrangement by which we could avail ourselves of the information as defendants in the suit on the fibrous carbon patent pending in the southern district of New York.

49 X Q. Was Mr. Tomlinson present at the time he said that?

A. You asked me for his opening statement, as I understood you, before I took him into Mr. Tomlinson's room. Mr. Tomlinson was not then present, but the same statement was repeated by Mr. Church to both Mr. Tomlinson and myself after we went into Mr. Tomlinson's room.

50 X Q. What did you say in response to Mr. Church's
2417 statement that he was in possession of facts that would re-
sult, if made known, and proved, in defeating the patent in suit?

A. We told him in substance that we were desirous of getting the facts if we could do so legitimately.

51 X Q. Do you repeat now the language exactly that you used in replying to Mr. Church?

A. Not the language. I do not pretend to recollect the exact words. That was the substance of it, however.

52 X Q. Did you say that, or Mr. Tomlinson?

A. Both of us at different times during the interview. It was an expression that I recollect we repeated several times.

53 X Q. How long did that first interview last?

A. Upwards of an hour, I should think.

54 X Q. And was the whole of that time occupied upon the same statement?

A. In discussing the same matter, yes.

55 X Q. Was anything said at that interview about the Flanagan contract or interest in the Flanagan contract?

A. Oh, yes.

56 X Q. What was said?

A. Mr. Church showed us the statement which he had prepared and which is put in evidence and also the copies of the agreements, and those were read over and Mr. Church said that the disposal of the Flanagan interest under the contract was in his control.

57 X Q. Did he offer it for sale to you?

A. Yes; the interest was to be included in the arrangement which he proposed.

58 X Q. Was his offer to sell the Flanagan contract made separately from the offer to furnish you information that would defeat our patent?

A. No; the proposition covered all the matters.

59 X Q. Is it not true that the proposition to furnish you information regarding the patent in suit was made after you had got through negotiating about the Flanagan contract?

A. No, sir; it is not true.

2418 60 X Q. Was there no sum mentioned to you at which you could purchase the Flanagan contract?

A. No; not separately.

61 X Q. Did you not understand that the Flanagan contract came to you from Mr. S. B. Schuyler through Mr. Church?

A. Mr. Church stated that Mr. Schuyler had an interest in the Flanagan contract and that in including the Flanagan interest in his proposition, he was representing the owners of that interest.

62 X Q. Did you go to Mr. Schuyler's office to look at the drawings or the papers or facts appertaining to that contract?

A. Yes, we did.

63 X Q. What did Mr. Schuyler show you?

A. Mr. Schuyler showed us some photographs of sketches, representing that they were the photographs of original sketches which could be proved had been made in 1877.

64 X Q. Did he not also show you the original drawings from which those photographs were made?

A. He did not.

65 X Q. Did he say that he had them?

A. I think he did.

66 X Q. Did he offer to show them to you?

A. He did not.

67 X Q. And you came away without seeing them?

A. We did.

68 X Q. What conversation did you have with Mr. Schuyler about the purchase of the Flanagan contract?

A. No conversation on that subject. Mr. Schuyler said very little. Mr. Church was present, and asked Mr. Schuyler to show the drawings, and Mr. Schuyler produced them. Mr. Tomlinson and myself looked at them and then handed them back to Mr. Schuyler.

69 X Q. Do you mean the drawings or the photographs?

A. The photographs. Mr. Schuyler stated that the matter was in Mr. Church's hands.

2419 70 X Q. What did you say to Mr. Schuyler upon handing them back, the drawings and papers which you had been looking at?

A. Nothing.

71 X Q. Simply handed them back without remark or comment?

A. That is it.

72 X Q. What did you say to Mr. Church after seeing the drawings and the papers in the possession of Mr. Schuyler?

A. We saw no papers, only a few photographs, not exceeding four or five. We came out of the office with Mr. Church, as I now recollect it, and parted with him on the street, with the understanding that we would let him know when we wanted to see him.

73 X Q. Did you make no comments upon the drawings or papers which Mr. Schuyler had shown you?

A. I do not think we did. Not to Mr. Church.

74 X Q. How long was this after the first interview with Mr. Church?

A. I think it was the same afternoon, or possibly the next morning. Mr. Church left us at the first interview with the understanding that he would make an appointment with Mr. Schuyler for us to see the drawings. He came in either the same afternoon or the next morning, and told us of the appointment, which I think was to be an hour or so after he came into the office, and we met him at Mr. Schuyler's office.

75 X Q. Either that same afternoon or in the next day morning?

A. That is my recollection.

76 X Q. Did Mr. Church or Mr. Schuyler fix any price for the Flanagan contract?

A. No.

77 X Q. After seeing the drawings in the possession of Mr. Schuyler, did you decline to purchase the Flanagan contract then?

Objected to because the witness has stated distinctly that he saw no drawings, but only saw photographs.

A. No.

2420 78 X Q. When did you tell Mr. Church or Mr. Schuyler that you would not purchase the Flanagan contract?

A. We never had any conversation with Mr. Schuyler about the purchase of the Flanagan contract. At our first interview with Mr. Church we told him that we did not see how the purchase of the Flanagan interest would be of any use to us, and the interviews were continued as they were begun, with the understanding that

Mr. Church had information much more valuable than the information with regard to the Flanagan contract, which he could put us in possession of, and which would invalidate the patent.

79 X Q. Did you know what the Flanagan contract was before Mr. Church brought it to you?

A. Yes. It had been put in evidence in some of the interference causes with which we were acquainted.

80 X Q. You had read it, as I understand?

A. Yes.

81 X Q. Was there anything or is there anything in the Flanagan contract that bears in any way upon the invention of the patent in suit?

Objected to because the contract being already of record, shows for itself, and furthermore, because the question calls for an expert opinion, and the witness being called simply as a witness as to facts.

A. I have not the contract before me, and do not know that I would care to express an opinion upon the matter even if I had.

82 X Q. Did you not know as a matter of fact that the purchase of the Flanagan contract by you would not help you any in the defense of the suit?

Objected to as incompetent and specially objectionable under the restriction in the order of the court, and in further view of the fact that the argument of a case before the court at Pittsburgh 2421 requires that the witness leave at six o'clock this evening, and therefore, that he has not time for an irrelevant cross-examination.

A. No, I don't know that as a matter of fact.

83 X Q. Did you not understand that Mr. Church's object in calling upon you was to get money out of the Edison Light Company for some pretended information which he pretended to have?

A. That seemed to be part of his object.

84 X Q. Did you not know at the time of Mr. Church's visit, that he had testified on behalf of Sawyer and Man in the interference and was likely to testify on their behalf in this suit?

A. I knew he had testified, but did not know that he was likely to testify. The fact is he told us several times that he had been asked by Mr. Man to testify in the suit, and had told Mr. Man that he would not testify because he could not truthfully make the statements he knew Mr. Man wanted him to make.

85 X Q. As I understand you, Mr. Church did not tell you what the information was, or evidence was, that he could furnish that would defeat the patent in suit. Is that correct?

A. You are right as to the particular information that he withheld.

86 X Q. Well, did he as matter of fact give you any information that you thought would be of any value in defeating the patent?

Objected to as immaterial, the examination being restricted as to matters of fact, and not as to the value placed upon them by counsel for either party.

A. What he did tell me I have fully stated.

87 X Q. When Mr. Church told you that he had information or could furnish evidence that would defeat the patent in fifteen minutes, did you believe him?

A. He did not say that the patent in suit could be defeated in fifteen minutes, but that he could put us in possession of the
2422 information in fifteen minutes. Whether the information would be so effective or not, and could be so easily put in our possession, we had no means of judging.

88 X Q. Did you believe as a result of your interviews with Mr. Church that he could furnish you any evidence that would defeat the patent in suit?

Objected to as immaterial, the examination being restricted as to facts of the interviews and not to the inference or belief of the counsel.

A. He seemed sincere in his statements. We had no means of judging whether the information was of the character he stated it was or not.

89 X Q. Did you believe his statements?

Same objection.

A. Since he did not give us the information we had no means of judging whether his statements that he had the information were true or false.

90 X Q. Had you no belief upon the subject?

A. None, except his apparent sincerity and his willingness to make his reward largely contingent upon success in invalidating the patent.

91 X Q. Did he tell you how much stock he owned in the Consolidated Electric Light Company?

A. I don't think he did.

91½ X Q. Did not the fact that he refused to furnish you any information unless you gave him a considerable sum of money raise a suspicion in your mind that he was not telling the truth?

A. No, it did not.

92 X Q. Did you not believe at the end of your negotiations with Mr. Church that his sole object was to sell you the interest in the Flanagan contract, and such other information as he pretended to have, simply for the purpose of getting a large sum of money or a considerable sum of money from the Edison Light Company without his really being able to give you any information that would be of any value?

2423 & 2424 A. No, I had no such belief at all. I believed that he sincerely thought that he had information outside of the Flanagan contract and matters relating to it which would show the patent to be invalid, and that part of this information was the fact that he had testified falsely in the interference case. Another and more important part was what he withheld entirely, which he always insisted would of itself invalidate the patent.

93 X Q. Referring to the so-called statement of facts put in evidence by defendant's counsel did you consider that that statement of facts would be of any value to you in defeating the patent?

A. Not the statement alone; but if the fact could be clearly proved that Sawyer was the sole inventor of the invention of the patent in suit, that Man was not a joint inventor with Sawyer in the invention, and that the patent was taken out as a joint invention, not because they were joint inventors in fact, but in order to defraud Flanagan under his agreement, and that the court should find these facts to be proved, then I would consider that the matter would have a very large value in that the patent would be invalid.

95 X Q. Do you not know that those same facts were stated in the interference, substantially those facts, and that the question of joint inventorship was passed upon by the Commissioner of Patents in the face of those statements?

Objected to because the interference record is the best evidence of the fact.

A. No, I don't know that the facts were fully presented in the interference record. My recollection is that it was never proved that Sawyer had made the invention before his association with Man, and that it was never proved that the contract between Sawyer and Man to apply for the patent as a joint invention was made to defraud Flanagan, and it was never proved that Man suggested the making of such a contract and the taking out of the patent in that way in order to defraud Flanagan.

2425 96 X Q. Do you not know that Mr. Sawyer, during the pending of the interference, filed an affidavit with the Commissioner of Patents that he was the sole inventor of this invention of the patent in suit?

A. I believe an affidavit to that effect was filed by Sawyer, but whether during the pendency of the interference or not I do not know, and whether it ever got into the interference record and was considered by the Patent Office in deciding the case, that I do not know.

97 X Q. Your last interview, as I understand you, with Mr. Church, was on June 29th or 30th, 1887; now did it take you and Mr. Tomlinson from the latter part of May to the last of June to determine that you did not want to buy any evidence that Mr. Church had to sell?

A. It did not; that was determined in advance at our first interview. At that interview we distinctly stated to Mr. Church that we could not put ourselves or the Edison Company in the attitude of purchasing testimony, but that we were ready to pay a fair compensation for any time spent by Mr. Church in putting us in possession of the information.

98 X Q. Why did you telegraph Mr. Church on June 28th, 1887?

A. Mr. Tomlinson had commenced or was about to commence the cross-examination of Albon Man in the New York suit on the fibrous carbon patent. He desired to be in possession of all information that he could get as to the experiments of Sawyer and Man. His object, as I understood it, and it was a matter of discussion between us, was to see if we could not get Mr. Church to make a proposition which we could legitimately accept and which would put us in possession of such information as Mr. Church had. Consequently, Mr. Tomlinson telegraphed him to come to our office.

99 X Q. And did you not make any proposition to Mr. Church to put you in possession of such information as he had?

A. We made no definite proposition. We suggested to
2426 him that a proposition from him based upon the payment of
a moderate sum to make a statement to us of the truth, whether in our favor or against us, would be one which we might possibly be able to accept.

100 X Q. You knew, as I understand you, that Mr. Church had testified in behalf of Sawyer-Man in the interference, and in view of that knowledge you, as I understand you, sent for Mr. Church to tempt him to make a proposition to testify against the complainant in this case—such a proposition as you could accept?

A. I think I have already clearly stated our position. We knew he had testified in the interference, and he had come to us voluntarily and admitted that that testimony was not based upon facts within his own recollection. He also stated that he had other information which of itself would be sufficient to defeat the patent. We desired, of course, to know what the truth was, and to know all of the truth, and, the information which Mr. Church withheld being according to his own statement, of very great value, we were naturally anxious in the interests of our client to become possessed of that information if we could get it legitimately and without placing ourselves in the attitude of purchasing testimony. We did not think from the start, as I recollect it, that we could use Mr. Church himself as a witness, since, as I have already explained, we were very careful to show him that if he were used as a witness his attitude would have to be that he had testified falsely in the interference case, and the result would be that the court would probably not believe his more recent deposition. It was more particularly to place ourselves in possession of the information which he withheld that we asked him to tell us for what moderate amount he would consent to make us a full statement of the facts. However you may see fit to characterize it, this proposition did not appear to be sufficient of a temptation to even warrant his naming an amount.

101 X Q. You say that Mr. Church offered to furnish you such information or evidence as he had for $5,000 in cash and $10,000 contingent upon your success in defeating the patent. Now, when
he made you that proposition, did you not consider him a
2427 thoroughly dishonest man, and did you not continue to
tamper with him after that proposition was made to you?

A. We believed he was dishonest, and if my personal feelings had controlled my own action in the matter I would have had nothing further to do with him; but we felt that our duty towards our client demanded that we should obtain all the information we could, even if from a dishonest source. I have fully stated what we did, and will leave it to the judgment of the court as to whether it could be called tampering.

102 X Q. Did you believe that the testimony of a confessed liar would be of any service to your client?

A. No. As I have several times stated, we did not think that Mr. Church's testimony would of itself be of any particular value.

103 X Q. The attitude in which Mr. Church stood before you was that of a man who confessed that he had sworn falsely. Now, in the face of that attitude, as I understand you, you wanted him to make you a reasonable proposition for a truthful statement?

A. We wanted his statement more particularly as to the information which he withheld, the proof of which I always understood rested on other foundation than the testimony of Mr. Church alone. He freely told us the facts with regard to his own knowledge of the experiments of Sawyer and Man and no further statement from him could have benefited us as to those facts. If his statement had related entirely to his own knowledge of the experiments and his testimony in the interference case, it would have been of little value.

Q. Did it not occur to you as very suspicious if Mr. Church had any information that would be of benefit that he would not furnish it to you unless you paid him a considerable sum of money before he did so?

A. It did not strike me as suspicious at all. It struck me as quite in accordance with the character of the man.

105 X Q. What did you know of him as to his truthfulness or dishonesty before this conversation—these interviews?

2428 A. Nothing at all. My acquaintance with him was very slight, only a nodding acquaintance, and so far as I know we had no mutual friends.

106 X Q. If you believed that he could furnish you or would furnish you with information or evidence that would defeat the patent in suit, for $2,500 down and $15,000 in the event of success—I say if you had believed that and he could prove that—would you have been willing to give him the money $2,500 or recommend the Edison Company to do so?

Objected to as irrelevant, a hypothetical question.

Defendant's counsel again calls attention to the fact that the entire cross-examination has consisted of questions having no relation to the actual occurrences between the witness and Mr. Church.

A. No, I would not.

107 X Q. Do you recollect of Mr. Tomlinson asking me in my office during the examination of Albon Man on the cross-examination of him, whether or not I was going to call Mr. Church as a witness?

A. I do not recall it now.

108 X Q. You have related your first interview with Mr. Church, here in your office. How long after that interview did you have your second interview with him?

A. He called within a few days after to see if we were ready to talk to him about it, and continued to call frequently.

109 X Q. Confine your answer to the second interview.

A. On the occasion of some of these calls he would hang around the office for 15 or 20 minutes, and at other times he would stay only a few minutes.

110 X Q. What was said on the occasion of your second interview with him? Please to give his words and your own if you can recollect them.

A. At those various intermediate interviews or calls from Mr.
Church, the conversation consisted principally in his reiter-
2429 ating his statements, and insisting upon the importance of
the facts within his possession. On our part, we told him that we were not prepared to discuss the subject, and had not had time to consider it carefully. My recollection is, that both Mr. Tomlinson and myself were very busy examining witnesses, and that we had little or no opportunity to discuss the matter between ourselves.

111 X Q. Had you made up your mind what disposition you would make of the matter at the time you telegraphed him on the 28th of June, 1887?

A. I cannot say that we had. Mr. Church had not made any proposition which we could accept, but we hoped that we might be able to get him to tell us the truth on terms which we could accept.

112 X Q. At the interview with Mr. Church, who called in response to the telegram—how long did that interview continue?

A. I think he must have been in the office in the neighborhood of a couple of hours.

113 X Q. Were you talking upon this subject during the whole of that time?

A. We were.

114 X Q. And what was said by you and Mr. Tomlinson on the one side, and Mr. Church on the other, during that interview?

A. We went over the entire subject of the several elements of Mr. Church's proposition, as I have before stated. If you desire me to repeat this matter, I will be glad to do so.

115 X Q. I should like to have it repeated, giving the words as near as you can recollect them.

A. As to the order in which the subjects were taken up at the first part of the interview, I cannot now say, since they were discussed and rediscussed—the Flanagan interest was a matter of some discussion, and we told Mr. Church again, as we had at several of the interviews, that we did not see how the purchase of the Flanagan interest could be of any benefit to us. With regard to the use of Mr. Church as a witness to contradict what he had stated in his interference
deposition, we called his attention several times to the fact, that
2430 in testifying in the suit, his attitude would have to be that
he had testified falsely in the interference case, and that we did not see how he could be of value to us as a witness, even if he would consent to place himself in that unenviable attitude.

With regard to the "very important information" which he withheld, we asked him to name a moderate sum for which he would make a full statement of the truth of the matters, whether for or against us, and if, after reading that statement, we should conclude that he would be of service to us, he should, in advance, name a *per diem* amount for which we could have his services. He stated that he could put us in possession of the information which would defeat the patent in a very short time, stating, I think, 15 minutes time, but that the minute that information was given, we would have no need of his services, and hence he did not care to make any proposition of the character we suggested. We told him further with regard to his own testimony as a witness, and as a reason why such a proposition as he made could not be accepted that if he should be put on the stand as a witness we would feel obliged to state the precise arrangement that we had made with him. The facts as to the falsity of his testimony in the interference case were also canvassed somewhat more thoroughly at this interview than at the others, and Mr. Church stated in detail most of the important matters about which he had testified in the interference case that as to them at the time he gave his testimony in that case he had no recollection of those matters as facts within his personal knowledge, but that Albon Man had impressed upon him that such were the facts, and had gone to the length of dictating memoranda of the facts to him, and upon the information received from Mr. Man he gave his testimony in the interference case. At this same interview Mr. Church modified his proposition of $5,000 down and $10,000 contingent upon the defeat of the patent to $2,500 down and $15,000 contingent, stating that he was so certain that the information in his possession would bring about the invalidation of the patent that he was willing that the larger sum should
2431 be made contingent upon the accomplishment of that end.

I think I have stated the substance of what occurred at that interview. There are numerous details upon each topic which I could call to mind, and I might add that at this interview and at the first interview as well, Mr. Church stated to us that Mr. Man had told him that he should want to call him as a witness to carry back the date of the invention of Sawyer and Man of the fibrous carbon in the New York suit upon that patent, and that he, Church, replied to him that he could not testify as a witness, because as he, Man, well knew the facts that he, Church, was expected to testify to were not within his personal knowledge.

116 X Q. Did Mr. Church ever tell you what knowledge he was in possession of that he wanted $2,500 for cash and $15,000 contingent?

A. No, sir. That amount was to cover not only the information that he withheld, but also, as we understood it, what he would expect to pay to the owners of the Flanagan interest and what he would lose by the depreciation of his stock in the Consolidated Company and what he would consider adequate for his own services and a balm to his wounded feelings in placing himself in the position of having sworn falsely.

117 X Q. Who beside yourself and Mr. Tomlinson were present in making the memorandum referred to by you in refreshing your recollection about these interviews with Church—I mean the paper marked for identification "Tomlinson statement as to Church"?

A. Nobody, except the stenographer, our office stenographer, at that time a man by the name of Nugent who is not now in our employ. I do not know where he is at present. I have not seen him even on the street for many months, and do not know into whose employ he went when he left us

118 X Q. How long was this memorandum made after your last interview with Mr. Church?

A. I think within a week.

119 X Q. Made from your memory—Mr. Tomlinson's memory and your memory, as I understand it?

A. You are right.

2432 120 X Q. Mr. Church not being present?

A. Mr. Church was not present, of course.

121 X Q. Was the memorandum ever shown to Mr. Church?

A. No. It was simply designed to put in a permanent form the facts with regard to the interviews with Mr. Church while they were still fresh in the recollection of Mr. Tomlinson and myself.

122 X Q. Designed to be sworn to by you both in case of need?

A. I do not know that we looked so far ahead as that at that time.

123 X Q. Was it ever your intention to call Mr. Church as a witness in this case on behalf of the defendant, or any other case?

A. At the time of our interviews we were considering whether that could be done with advantage to the interests of our client. We never concluded that he could be used as a witness, either in the New York case or in this case, for the reasons that I have several times stated.

RICHARD N. DYER.

Sworn to before me.

WM. T. FARNHAM, *Spec. Ex'r.*

NEW YORK, *May 7th*, 1889—12 m.

Met pursuant to adjournment.
Present: Counsel as before.

Deposition of the witness JOHN C. TOMLINSON, who having been duly sworn, in answer to interrogatories by Mr. WALTER K. GRIFFIN, deposes and says:

1 Q. What is your name, age, residence and occupation?

A. John C. Tomlinson; 33; 128 West Twenty-seventh street, New York city; lawyer.

2433 2 Q. During the year 1887 what was your relation and connection with the Edison Company, and with a certain suit pending in the southern district of New York, wherein The Consolidated Electric Light Company was complainant, and The Edison Electric Light Company and others were defendants?

A. I was the solicitor of record for the defendants in the suit referred to, and was counsel for the electric light company, in charge of all its patent litigations.

3 Q. Did you have during the year 1887 certain interviews with William H. Church in relation to certain alleged information possessed by him as to the invalidity of the Sawyer-Man patent at present in suit?

A. I did.

4 Q. Did you at the termination of those interviews prepare or dictate a memorandum of certain of the occurrences which took place during those interviews, and of the statements of yourself and Mr. Church?

A. I did.

5 Q. How soon after the termination of those interviews was that statement dictated by you for preservation?

A. Within a day or two.

6 Q. Was that statement dictated in the presence of Mr. Dyer or not?

A. It was dictated in the presence of Mr. Dyer.

7 Q. Had Mr. Dyer been associated with you in these interviews with Mr. Church?

A. Yes.

8 Q. I hand you the paper marked for identification "Tomlinson's statement as to Church, May 6th, 1889," and ask you whether that is the statement which you dictated and to which you have referred?

A. I have examined the paper shown me, and I recognize it as the statement which I dictated and to which reference has been made.

9 Q. Please state in your own way, refreshing your memory if you so choose from the memorandum referred to, the course of the various interviews that you and Mr. Dyer had with Mr. Church.

A. I was introduced to Mr. Church by Mr. Richard N.
2434 Dyer in my office at 40 Wall street. Mr. Church, in presence of Mr. Dyer and myself, stated in substance that he was in possession of information which he considered important, and which, in his judgment, would show that the Sawyer-Man patent on fibrous material was invalid; that in so far as any invention had been made, the invention was the sole invention of Mr. Sawyer, and was made prior to his association with Mr. Man. He stated that proof of this existed in certain drawings and papers which were in the possession of one Mr. Schuyler. He further stated that the Sawyer and Man patents were taken out in the names of Sawyer and Man jointly at the suggestion of Mr. Man, in order to deprive one Flanagan of an interest which Flanagan had in Sawyer's inventions growing out of a contract between Flanagan and Sawyer. He further said that Mr. Man, in his (Church's) presence, upon his (Man's) attention being called to this Flanagan contract, stated that the only way that Sawyer could get over the obligations of this contract was by Sawyer and Man taking out patents jointly. He stated also that the Flanagan interest under this Flanagan con-

tract he (Church) could acquire and turn over to parties desiring to purchase it. It was also at this interview that I said to Mr. Church, "If what you say be so, how do you reconcile your present statements with the testimony given in the interference"? He replied in a general way that in giving his testimony in the interference he had been guilty of considerable exaggeration, and had, perhaps, testified to matters which, on further recollection, he believed he was mistaken in. I asked him in substance what he wished done, what proposition he had to make. He replied that he considered the information which he possessed to be of great value to the Edison Company, and that if he could verify his statements they ought to be willing to properly reimburse him. I endeavored to get Mr. Church to speak more in detail and specifically as to the nature of his information and proof and specifically as to what points he now considered his testimony in the interference was in error.

He rather evaded this, and said that he had informa-
2435 tion which he would not disclose until some arrangement
had been made satisfactory to himself. As a reason for not disclosing this, he stated that if we were once in possession of this information his usefulness would cease and we could act independently of him. I repeated my former question, asking what proposition he had to make. He stated that he thought $5,000 in cash would be fair, and $10,000 in the event of the Edison Company being successful in the suit. Subsequent to this interview I called on Mr. Schuyler with Mr. Church and Mr. Dyer to see the drawings and papers which Church had said Schuyler possessed. I was shown by Mr. Schuyler some photographs of alleged incandescent lamps. Whether at this interview with Mr. Schuyler, or whether previously or not I fail to remember, but at about this time I was shown a copy of the Flanagan contract. I do not remember Mr. Schuyler showing me any other papers than the photographs of the drawings to which I have referred. At about this same time (and I may here remark that Mr. Church called at the office three or four times at about the time of the first interview to which I am referring), Mr. Church gave me a printed copy of the record of the interference between Sawyer and Man and Keith and Maxim. Also written copies of the agreements between Sawyer and Man dated March 19th and May 11th, 1878; also a copy of the agreement between Sawyer, Smith and Flanagan, made January 2d, 1877. Mr. Church also prepared a statement of facts relating to this general subject which I believed at the time to be in his handwriting, which was not signed by him. From the time of my first interview until about June 30th, Mr. Church called a number of times at my office to ascertain if I had come to any conclusion in regard to availing myself of his proposition. To all of his inquiries I replied that I had not had time to go into the matter fully, which was the case, as I was very busy with other matters. About June 24th or 25th I saw Mr. Church at my office and told him there was no need of his coming every other day, but if he would

leave his address I would write or telegraph him when
2436 I could take the matter up. On June 27th, I began the cross-examination of Mr. Albon Man, and on or about June 28th telegraphed Mr. Church to call upon me the following morning at 11 o'clock. He did call and I had quite a long interview with him in the presence of Mr. Dyer in my office. Prior to this call I had considered the proposition of Mr. Church, and in the interview to which I am now referring, I stated to him in substance, that I did not think the Edison Company could accept his proposition; that they would be very loath to place themselves in the position of purchasing testimony and I considered that his proposition practically was that they do this. I stated further that if we availed ourselves of his services any arrangement that we made with him would have to be stated in full on the record, and that I doubted if a court would place much reliance upon testimony procured in this way; that the practical effect of his testimony would be that his prior testimony would be exaggerated or mistaken, or to put it plainly, false, and that a court would be very loath to believe a witness who confessed to having made such a serious mistake on a prior examination. I stated to him that the Edison Company were very desirous of having the truth appear and of the real facts, whatever they might be, coming out; that if he had committed an error previously I thought it his duty to correct it at the present time, but that he should not be urged to the performance of this duty by any pecuniary consideration. I added that if his services to the company involved the expenditure of time I had no doubt that the Edison Company would be willing to compensate him for the time which he actually spent. I stated to him that I would advise the company to do so. I remember remarking, "We pay experts $50 or $100 a day for their testimony and for their time and I do not know but I would advise the company to pay you about that amount." Mr. Church made very little response to this proposition but said in substance, "I feel so confident of the value of my information that I would be willing to make the greater part of my compensation contingent on the Edison Com-
2437 pany's success in the suit." He said, "Instead of paying me $5,000 down, as I originally proposed, I will take $2,500 down and $15,000 in case of success." After he had made this proposition I tried to get from him specifically just what this information was which he seemed so confident would defeat the patent. He declined giving it to me and would only talk in a general way as I have before indicated. I remember taking a copy of the record in the interference and going over his testimony and trying to get him to point out specifically just where he had been in error. He rather avoided doing this, but in one or two instances he stated that he now recollected that his testimony as given was incorrect. I asked him how he explained the giving of this testimony. He replied, "Well, I had a good many conversations with Mr. Man and with Mr. Broadnax, and they would say to me, 'Well, now, Church, don't you remember being here and seeing this?' and they were so persistent that I finally said, yes, I did remember it;

but now that I come to think it over, I think I was mistaken." I believe at this interview I made him a proposition of this character; I said, "Suppose we give you a small amount down, and you write out a truthful statement of the facts without consultation with me or anybody else. I don't care whether they make for us or against us. I merely want to know the truth. I might advise the company to pay you a small amount (I think I said $250); then if I determine to use you we will pay you $50 a day, or possibly I might be able to get you $100 for every day you are actually employed; but you must be prepared to have this whole arrangement explained on the record preparatory to your testimony." He neither accepted nor refused this proposition, but said, "Well, perhaps you had better see your company and ask them what they think of my second proposition—$2,500 down, and $15,000 in case of success." He left me, promising to call on the 1st of July, at 11 o'clock. He called on July 1st, and left a letter for me, which letter I believe I now have, but I did not see him. Such is my general recollection
2438 of my interviews with Mr. Church. Mr. Dyer was present at all of them, and that I might remember in the future just what occurred I was very careful when my memory was fresh to dictate in the presence of Mr. Dyer in order that I might make no mistake, the statement which has been produced, and which I now have before me, and by which I am refreshing my general recollection.

10 Q. Were those interviews induced or brought on to your knowledge by any act of yourself or Mr. Dyer, or were they the unsolicited act of Mr. Church?

A. They were entirely the unsolicited act of Mr. Church. He came with a proposition which he wanted us to accept.

11 Q. You have stated that Mr. Church called repeatedly between the first interview and the interview at the end of June at your office. Did he come at your suggestion or request, or unsolicited and of his own accord?

A. He came unsolicited and of his own accord and always to know what I was going to do with reference to his proposition. I may add he was quite persistent, he came every three or four days, so much so that I felt a little annoyed and suggested that there was no need of his coming so often, but that when I wanted him I would let him know, and I obtained from him his address for that purpose.

12 Q. Did you or Mr. Dyer or, so far as you are aware, any one connected with the Edison Company ever offer Mr. Church $1,000 a day for his services?

A. No, sir.

13 Q. Did you make any offer to him of any kind for his services except as you have already stated in your testimony?

A. No, sir.

14 Q. Did Mr. Church ever demand from you and did you refuse a demand for $60,000 for the interest in the Flanagan contract?

A. He never made such a demand and never having made it, I never refused it.

15 Q. Did he ever make you any demand except as you have stated?

2439 A. No, sir.

16 Q. I call your attention to the R. X Q. 100 to William H. Church, and ask you to state whether the answer of the witness Church to that question is true in whole or in part.

Objected to on the ground that there was no cross-examination of the witness Church.

A. I have read the answer referred to, and Mr. Church is in decided error in several particulars. Referring to his first statement that we declined to purchase the Flanagan contract on the ground that "it was of no value to them," I will say that he did make reference to the Flanagan contract, but I never considered seriously the purchasing of it. His statement that we requested him to engage in our service in trying to defeat the patent in suit, is incorrect. I never requested him to engage in the service of the company. The suggestion that he could be of doubtful service to us in view of his previous testimony was mine, not his. I did produce a printed record of his testimony in the interference and interrogated him in regard to it, as I have stated, and he answered as I have stated. His statement that we would hire him and pay him $1,000 a day is entirely wrong. The suggestion of paying him by the day I have previously explained in my answer to question No. 9. The interference record to which I am now referring is the interference record between Sawyer and Man and Edison. It is not the one which he brought to me. That was the record in what we call the Maxim-Keith interference.

17 Q. I hand you a copy of the interference record in the interference proceedings of Sawyer and Man and Edison of the patent in suit and call your attention to the deposition as there printed of William H. Church as the same is offered in evidence as part of the deposition of William H. Church in this suit, and ask you whether you can now remember which of the questions and answers of Mr. Church in that interference record you called to his attention.

2440 A. I remember calling his attention to question and answer 31 at fol. 515, as follows: "31 Q. Please to state when it was that you first saw these different forms of carbon made of paper. A. It was the latter part of February or the 1st of March, 1887." I remember asking him about that, and he said he did not know of his own knowledge that they were paper but that he gave that testimony because they afterwards told him that they were and tried to prod his memory and they were very persistent and he was rather obliging. Then I remember calling his attention to question 39 and answer, as follows: "39 Q. State if know, how these paper carbons were made. I mean how was the paper carbonized? A. They used a small metal box; the one I recollect seeing was of sheet iron, in which there was pulverized carbon and layers of the paper in the form described, alternately placed. And then the box was closed and fastened and put into the fire. I saw this one evening at Mr. Man's house. He came out of his private laboratory, showing me the box and explaining what he was doing. I subsequent saw him bring to the shop one morning a box, which he said he had left in the fire all night, and which he could not get open. It was subsequently opened by one of the workmen, but not in my presence. I, however, saw the carbons after they had been taken out of the box. I, indeed, saw these same carbons treated in oil, being put in oil and a current of electricity being run through them. This decomposed the oil and made a deposit of carbon upon the carbons already made, making them very tough, and making them of a greyish color." Referring to this answer he stated in substance that he now thought he was mistaken in his recollection of these things; that he had confounded what had been told him by others with what he had seen himself and that his present memory was, that instead of seeing these things he had been told them.

18 Q. Did he tell you who had told him?

A. He always mentioned Mr. Man and Mr. Broadnax.

2441 19 Q. Did he say anything to you as to Mr. Man giving him memoranda of facts?

A. Yes. He said that prior to his testimony in the Sawyer-Man-Edison interference Mr. Man would give him memoranda containing statement of facts and would say to him: "Church, you must recollect thus and so," and that when he came to testify he would recollect.

20 Q. Did he state whether this occurred in any cases where he did not recollect the facts here set forth in the memoranda?

A. He stated generally that his own recollection was very meagre and that in giving his testimony he was practically coached and that the testimony that he did give was the result of this coaching rather than of his own recollection.

21 Q. Will you please continue with your references to the matters in the interference record which you brought to his attention?

A. Yes, I called attention to questions and answers 56 to 61 inclusive, on pages 140 and 141 of complainant's exhibits in this case now before you, as follows:

"56 X Q. Referring now as to what you have testified about the making of paper carbons in the shop on Centre street during March, April and May, 1878, did you yourself see any of the forms illustrated in Exhibit No. 1, cut out of paper? A. Did not see them cut, but seen them after they had been cut. 57 X Q. What kind of paper did they appear to have been cut from? A. I should say out of white blotting paper. I did not handle them, but merely saw them; according to my opinion they were blotting paper. All may not have been of blotting paper, for what I know. 58 X Q. Did you yourself see any of these forms put into a box for carbonization, and afterwards taken out of the same box in a carbonized condition? A. I saw the pulverized carbon, which I understood was to go into the box; and I saw the paper which was to go in the box; and I saw the paper after it had been taken from the box; but didn't see a paper put into the box and the 2442 box heated, and carbon taken from the box. 59 X Q. Do you know, of your own knowledge, that you saw at any time at the shop at Centre street, any carbonized paper conductor for an electric lamp? A. Yes; I saw pieces of carbon formed of paper of Figs. 1, 2, 3 and 4, Sawyer Exhibit No. 1, tried in Centre street, during the *the* experiments made there. 60 X Q. How do you know those were formed of paper? A. I saw some of them formed entirely with the plumbago put upon it and stretched across and fastened to the conductors and carbonized in the lamp. In giving a former answer (to cross-question 58) I referred particularly to Figs. 5 and 6, which were never carbonized in a lamp on account of their shape. Figs. 2, 3 and 4—particularly 3 and 4, did not rest upon my mind, as I regarded them as experiments which were not successful. 61 X Q. Please state what the first instance was of your own knowledge that a paper carbon conductor of the character of 5 and 6, Exhibit No. 1, was used in an electric lamp. A. To my knowledge in December, 1878, and not far from the middle of December."

He stated that he now recollected that he could not be sure as to whether the carbon he was referring to were made either of paper or of blotting paper; that he now recollected that he had not seen these blanks put into the box and carbonized; that he now recollected that he had not seen pieces of carbon formed of paper put into lamps and tried. I will add that in going over Mr. Church's deposition with him I directed his attention particularly to those portions of his deposition where he had referred to seeing paper or fibrous material used as the incandescent conductor of an electric lamp, or had seen paper or fibrous material carbonized, and speaking generally he characterized his testimony in these respects as rather what had been told by others to him than what he had actually seen.

22 Q. Please look at the printed telegram, "Complainant's Exhibit Tomlinson Telegram," dated June 28th, 1887, and state whether to your recollection that is the telegram you sent to Mr. Church.

A. Yes; that is the telegram, I believe, I sent.

2443 23 Q. Was it or was it not in response to that telegram that Mr. Church had the long interview with you and Mr. Dyer, as to which you have testified?

A. It was in response to that telegram that he called and I had the interview referred to.

24 Q. At Mr. Schuyler's did you see any original drawings or what purported to be original drawings other than the photographs that you have mentioned in your testimony?

A. My recollection is that I only saw photographs.

25 Q. Was this interview after the sending by you of the telegram the last interview which you had with Mr. Church?

A. I believe it was.

26 Q. About how many interviews had been had before that time?

A. If by interviews you mean to include the number of times Church called at the office and I saw him I should say 15 or so, but those interviews were mostly limited to his asking me if I had come to any conclusion, and my saying, "No, better call again," or something of that general character.

27 Q. Then, as I understand you, after your first interview with Mr. Church, when you were introduced to him by Mr. Dyer, there was no interview of any length other than the calls of Mr. Church until this long interview after you sent the telegram?

A. Such is my recollection; yes.

28 Q. Is then the answer of Mr. Church to the 143d X Q. true?

Same objection as before.

A. It is not.

29 Q. Similarly the answers of the witness Church to X Q. 150 to X Q. 153, inclusive, are they true?

Same objection.

A. Mr. Church's testimony, to which you refer, is incorrect.

2444 30 Q. I call your attention to Mr. Church's answer to Re-X Q. 102. Does that answer truthfully represent the attitude of yourself and Mr. Dyer in your negotiations or interviews with Mr. Church?

Same objection.

A. It is not at all a truthful statement of the facts. There was no scheme on our part, but, as I have explained, Church was a stranger to me and came with a proposition of his own, which, as I have also explained, I never accepted.

31 Q. Similarly are Mr. Church's answers to Re-X Q. 103 and 104 truthful statements of the facts?

A. It is an incorrect statement. Mr. Church did propose that we pay him $5,000 in cash and $10,000 in the event of success.

32 Q. As matter of fact was his offer predic-ted upon the proposition that you should show him wherein he could be of service to you?

A. On the contrary, he came to us with the statement that he could be of service to us and made a demand for money and indicated generally in what way he could be of service, as I have stated.

33 Q. Is the witness Church's answer to Re-X Q. 115 a true statement?

Same objection.

A. It is not. I can only repeat that Church was a stranger to me, and that he came with the proposition asking a large amount of money, and, as a consideration why the money should be paid him, stated that he could furnish us with information which would cause the Edison Company to prevail in their suit.

34 Q. Did he ever tell you that he would rely upon you or Mr. Dyer to refresh his memory upon the subject?

A. He never did.

35 Q. As he states in the answer to Re-X Q. 115?

Same objection.

2445 A. He never did.

36 Q. Are the answers of the witness Church to X Qs. 174 to 178 true or false?

Same objection.

A. The answers referred to are untrue.

37 Q. As a matter of fact did Mr. Church inform you substantially that within 15 minutes he would put you in the way of obtaining information which would destroy the patent at present in suit?

A. He did, and he made a distinct statement of 15 minutes.

38 Q. As a matter of fact did he or did he not tell you that if he put you in possession of this information he could not be protected, and that you would be no longer dependent upon him?

A. He made that statement very distinctly.

39 Q. As matter of fact did he or did he not offer the statement in my last question as a reason for declining to give you the information unless you acceded to the terms of his proposition as to the payment of $2,500 down and $15,000 in event of success?

A. He distinctly stated that he withheld the information for his own protection, explaining that if we were once in possession of it we could act independently of him, and that was why he wanted the money first.

40 Q. You have referred to the statement prepared by you within a few days after the cessation of the interview with Church. Does or does not that statement as dictated by you set forth the truth as to your interviews with Mr. Church according to your recollection at the time the statement was dictated?

A. The statement truthfully sets forth the facts as I remember them at the time the statement was dictated, and I dictated the statement immediately after the interviews, in order that I might, while the subject was fresh in my mind, put down in definite shape exactly what had occurred. I believe the statement is true
2446 in every particular, for I was very careful in the dictation of
it to have Mr. Dyer present in order that I might commit no error.

Defendant's counsel offers the said statement in evidence, and the same is marked "Defendant's Exhibit Tomlinson Statement as to Church, May 7th, 1889, W. T. F., special examiner."

Cross-examination by Mr. BROADNAX:

41 X Q. At Mr. Church's first interview with you, did he make any proposition of sale to you or the Edison Company of the so-called Flanagan contract?

A. He referred to the Flanagan contract as a piece of property which he did not own. He made no proposition regarding its sale, but stated that the Edison Company could acquire it, Flanagan's interest, if they desired it.

42 X Q. Did he name any price at which they could acquire it?

A. He did not.

43 X Q. But I understand you the substance of your interviews with Mr. Church was embraced in your first and last interviews with him?

A. That is my general recollection.

44 X Q. And your last interview you say occurred after the sending of the telegram to him?

A. Yes.

45 X Q. Now, when did he respond to that telegram; the telegram is dated on the 28th of June?

A. I cannot remember the date, but it was very soon after.

46 X Q. Was it before or after his letter was left at your office dated July 1st, 1887?

A. My impression would be that it was intermediate the telegram and the letter, but it is only an impression.

47 X Q. Do you recollect of seeing Mr. Church upon this matter at all after you received that letter?

2447 A. My recollection on the sequence of dates is not very clear. My impression would be that I did not see him after the letter.

48 X Q. What time in the day did the interview occur?

A. That I cannot answer. Probably between 11 and 4.

49 X Q. You are sure that it did not occur before 11?

A. No, I am not.

50 X Q. Is the copy of the letter that Mr. Church produced and that is printed here as an exhibit a true copy of the letter received from you by him?

A. I do not know. I received a letter from him, and it ought to be among my papers. I can hunt it up if you wish.

51 X Q. I wish you would do so and please to produce it.

A. I will.

52 X Q. Please to read Mr. Church's letter or the copy of it put in evidence by complainant's counsel, and explain, if you can, what it means.

Objected to because Mr. Tomlinson is not the proper person to explain the letter which he did not write.

A. I can theorize about it and my theory is this: that Mr. Church had become satisfied that we would not accept his proposition, and in terminating the interviews he made the statement contained in the letter for the purpose of showing in the future what was not the fact, that the discussions between him and myself had related solely to the Flanagan interest. That is my theory in regard to the letter.

53 X Q. Does the letter not express or convey to your mind a true understanding of what has occurred between you and Mr. Church in the several interviews?

A. It does not.

54 X Q. Wherein is it misleading?

2448 A. It is misleading in this: It would convey the impression that the subject-matter of our interviews related solely to the purchase of the Flanagan interest, as it refers to that and that alone; whereas the fact is that the Flanagan interest was very little referred to, and other matters, as I have explained, consumed the greater part of the time.

55 X Q. Is it not true that the discussion or negotiations about the Flanagan contract was disposed of before Mr. Church stated to you, or offered to you for a consideration, to furnish facts which he thought would defeat the patent in suit?

A. Such is not my recollection. My recollection is that all the matters to which Mr. Church has referred were referred to at different times throughout our interviews, a greater time being devoted to some than others.

56 X Q. Is it your recollection that Mr. Church was to sell you the Flanagan contract and furnish you the pretended information, all for the consideration of $5,000 in cash and $10,000 contingent?

A. It never reached that definite point. His reference to the Flanagan interest was general, and to the effect that we could acquire it, and in stating as his reasons why so large an amount of money should be paid him, he would enumerate the Flanagan contract, the early work of Sawyer-Man's joint inventorship with Sawyer as a subterfuge of overcoming the Flanagan interest; the incorrectness of his former testimony and this other important matter, which he could not disclose.

57 X Q. He was to put it all in for a lump sum, as you understood it?

A. As I say, it never reached that point. This was his proposition in a general way and it never got beyond it.

58 X Q. I do not now clearly understand whether Mr. Church separated the Flanagan contract as a property for you to purchase from the information which he proposed to sell you for the $15,000. What I want to know is whether Mr. Church in the first instance offered to sell you for any consideration at all the Flanagan contract, and if so, for how much.

2149 A. I have, I think, answered your question. I have said that Mr. Church put no distinct price on the Flanagan contract as a separate piece of property. I have explained that Church asked money not for Flanagan but for Church, and that the consideration which would come to the Edison Company for the payment of this money would be not acquiring an interest in Flanagan's contract, but the defeat of the Sawyer-Man patent, and he enumerated several elements which either separately or together would result in the defeat of that patent, and mentioned the Flanagan contract as one of them. I am unable to answer your question more fully.

59 X Q. Referring to the statement of facts which you say Mr. Church furnished you and which is not signed by Mr. Church, did you understand that to be an original statement written by Mr. Church, or a copy made by him from some paper in the possession of Mr. Schuyler or somebody else?

A. I doubt if I can answer your question. It was a statement of facts which he furnished me. I understood the writing to be his. Whether the facts were stated from his own recollection, or furnished him by somebody else, or whether the paper was a copy of a paper that had been prepared by somebody else and copied by him I cannot say. I do not remember as I ever tried to understand anything about that.

60 X Q. After you had got through your interviews with Mr. Church what conclusion did you reach in your own mind as to Mr. Church's motive in making you the several propositions he had made you?

Objected to as immaterial, the sole issue being as to the actual facts that took place and not the opinion of any one.

A. I thought he wished to make a large sum of money quite easily.

61 X Q. Do you recollect whether or not at the time that these negotiations were in progress you were engaged in the cross-examination of Albon Man?

2450 A. I think it quite likely I was cross-examining him in some case.

Counsel for complainants states upon the record that he desires the examination to be suspended at this point until the deposition can be written out, the deposition having been taken in phonography and the counsel is unable to conduct the cross-examination without a copy of it, and desires an adjournment until Wednesday, May 8, 1889, at 1 p. m.

Counsel for defendants wish to say upon the record that they have every desire to facilitate counsel for plaintiffs, providing it is not at the risk of their own rights and standing; that they will attend at the time named but that the witness is now tendered by them for a completion of his cross-examination.

Adjourned to May 8th, 1889, at 1 p. m.

New York, *May 8th*, 1889—1 p. m.

Met pursuant to adjournment.
Present: Mr. Broadnax, Mr. Griffin.

Examination of the witness, John C. Tomlinson, continued:

By Mr. Broadnax:

62 X Q. Have you brought with you the letter you received from Church dated July 1st, 1887?

A. I have not. I have looked for it and cannot find it.

63 X Q. Please to state upon the record whether or not
2451 you are now in the service of the Edison Electric Light Company.

A. I am not.

JOHN C. TOMLINSON.

Sworn to before me—

W. T. FARNHAM, *Spec. Ex'r.*

Defendant's counsel asks leave to state of record that on account of the illness of Mr. Edward N. Dickerson during all the time since the day fixed by consent for his examination, and the consequent orders of his physicians prohibiting his appearing or attending to any business, as appears by a letter submitted for perusal of complainant's counsel, it is impossible to take his examination, as wished and intended.

The following is the paper offered in evidence by defendant's counsel which was referred to by the witness Tomlinson and the witness Dyer, and which was marked "Tomlinson Statement as to Church, May 6th, 1889, W. T. F., special examiner."

Statement of John C. Tomlinson as to His Acquaintance with Mr. William H. Church.

My acquaintance with Mr. Church is as follows: I was introduced to him by Mr. Richard N. Dyer some months ago. Mr. Church stated that he was in possession of some important information which would show that the Saw-er-Man patent on fibrous material was entirely invalid; and that so far as any invention had been made, it was the sole invention of Mr. Sawyer, and was made prior to his association with Mr. Man. This he claimed to be able to prove by drawings and papers in the possession of Mr. Schuyler. He also stated that the contract between Sawyer and Man, by 2452 which they became joint inventors, or was stated to have been joint inventors, was made by Man to defraud one Flanagan of his interest in the Sawyer inventions, which Man knew at that time to have been perfected, and in which Flanagan was entitled to an interest. He stated that Mr. Man, in his presence, when he was shown the Flanagan contract, said that the only way to get over Sawyer's obligation to Flanagan was by Man and Sawyer taking out the inventions jointly.

I saw Mr. Schuyler with Mr. Dyer and Mr. Church, but had no conversation with him beyond his producing photographs of these alleged drawings.

Mr. Church was desirous of making an arrangement with the Edison Company by which they should pay him a large amount, provided he furnished testimony that would defeat the patent. His terms were $5,000 in cash, and $10,000 in the event of success. This $5,000, he stated, was necessary to reimburse him for the loss which he would sustain, as he was a stockholder in the Consolidated Company, and he felt obligated to reimburse Mr. Schuyler and some other gentlemen they had. At about the time of my first interview with Mr. Church he left with me a printed copy of the record in the interference between Sawyer and Man, and Keith and Maxim; also copies of agreements be- W. E. Sawyer and Albon Man, dated respectively March 19th and May 11th, 1878; also a copy of an agreement between Sawyer, Smith and Flanagan, dated January 2d, 1877; also a statement of facts in the handwriting of Mr. Church, but not signed.

From the time of my first interview until about June 30th, Mr. Church called a number of times at my office to ascertain if I had come to any conclusion in regard to procuring his testimony and services. To which I invariably replied, in substance, that I had not had time to go into the matter.

About June 24th or 25th Mr. Church called, and I told him there was no need of his coming again until I could take the matter up. He left me his address and asked me to telegraph him.

2453 On June 27th I began the cross-examination of Mr. Albon Man; and on June 28th I telegraphed Mr. Church to call upon me the following morning at 11 o'clock. He did and Mr. Dyer and myself had a long interview with him in which we stated in substance that we did not wish to be in the position of purchasing testimony or doing anything that was improper. We could not use him, and would not use him without stating if we put him on the stand just what our arrangement was, and how it came about. That he would have to state that his prior testimony was false if his present story was true, and that this would place him in a very bad position. Mr. Church stated in substance that his prior testimony was false, but that he had been led and influenced to give it by Mr. Man and Mr. Broadnax. He stated that prior to his testimony in the interference, Mr. Man dictated to him memoranda of what he, Man, had done, and tried to impress Church with the fact that he, Church, had seen it; and that he, Church, being interested in the success of Sawyer and Man at that time, in testifying as to what he was, and knew was in fact merely stating what had been told him by Man; that he did not have at that time, and does not now have any recollection of having seen the things which he testified concerning. We stated to Mr. Church that our company would be very reluctant to make any such arrangement as that proposed; that we considered it was his duty to tell the truth, whatever the truth might be, whether for us or against us. That all I thought could probable be done, would be to pay him reasonably for such time as he might devote to testifying or procuring evidence. He then made a counter-proposition to the effect that we pay him $2,500 down, and $15,000 in case of success, stating that he was willing to leave the much larger amount as a contingency, as he was entirely confident of success. We replied we cannot know the value of your testimony or information until we know what it is. He was reluctant to tell us what his knowledge was, except in regard to his prior testimony, and the question of joint inventorship, as once in possession of the information he could not be protected, and he intimated that 2454 in 15 minutes he could put us in the way of gaining information which would destroy the patent, and that once knowing this we would no longer be dependent upon him. We then asked if this proposition would be satisfactory; pay him so much down to tell us the truth, whatever it might be, and then if we decided to avail ourselves of his services to pay him reasonably for the time he devoted to it. He did not accept or refuse this proposition, but said, "Ask your company what they think of my original proposition," and he left promising to call July 1st, at 11 o'clock.

He called July 1st, but I did not see him. He left a letter for me which I now have.

This statement was dictated in the presence of Mr. Dyer who concurs in the statement made.

2455 EXHIBITS.

COMPLAINANT'S EXHIBIT PENNY ENCYCLOPEDIA EXTRACT.

The Penny Encyclopedia, of the Society for the Diffusion of Useful Knowledge, published at London in 1840, vol. 17, p. 207.

Paper. * * * The art of making paper from fibrous material reduced to a pulp in water appears to have been first discovered by the Chinese about the year 95 A. D. In the time of Confucious they wrote with a style of bodkin, on the inner bark of the bamboo. The Chinese paper has been supposed to be made of silk, but this is a mistake; silk by itself cannot be reduced to a pulp suitable for making paper. Refuse silk is occasionally used with other things, but the greatest part of the Chinese paper is made from the inner bark of the bamboo and some other trees, but chiefly from the bamboo. * * * Only the second skin of the bark of the bamboo is used, which is beaten into a pulp with water.

COMPLAINANT'S EXHIBIT CHAMBERS ENCYCLOPEDIA EXTRACT.

Chambers' Encyclopedia, published at London in 1878, vol. 1, page 654.

Bamboo (bambusa), a genus of grasses, of which most of the species attain a great size, many of them 20 or 30 feet, some 70 or 100 feet in height. The species are numerous, and are found in tropical and subtropical regions, both of the eastern and western hemispheres. They are of great importance to the inhabitants of the countries in which they grow. All of them have a jointed subterranean root-stock (rhizome), which throws up 10–100 stems. These are generally straight and erect; although one large species (*B. agrestis*), common in dry mountainous situations in the
2456 southeast of Asia, has crooked, and sometimes creeping stems.
The stems grow to their full height unbranched, but afterwards throw out straight horizontal branches, especially in their upper part, forming a dense thicket; and many of them being strongly armed with spines, they are planted for defence, presenting a formidable barrier, even against regular troops. Some of the smaller kinds are often planted as hedges. The stems are jointed like those of other grasses, very hard, but light and elastic, hollow, containing only a light spongy pith, except at the joints or nodes, where they are divided by strong partitions. They are, therefore, readily converted into water vessels of various sorts; and when the partitions are removed, they are used as pipes for conveying water. They are also much employed for house-building, for bridges, &c. The smaller stems are converted into walking sticks, and are imported into Europe under the name of B cane, both for that purpose and to be employed in light wicker work. In China, the in-

terior portions of the stem are used for making paper. Some of the species grow to the height of only a few feet: and almost all of them are slender in proportion to their height, although *B. Guadua*, a native of New Granada and Quito, has a trunk 16 inches in diameter. The stems of different species vary also very much in the thickness of the woody part, and so in their adaptation to different purposes. The external covering of the stem is, in all the species, remarkably silicious; the stem of *B. Tabacaria* is so hard that it strikes fire when the hatchet is applied. This species is a native of Amboyna and Java; its slender stems are polished, and used for the stalks of tobacco pipes. The leaves of some kinds are used for thatch, and the Chinese plait hats of them; of the external membrane of the stems of some, they make paper. From the knots of the B. there exudes a saccharine juice, which dries upon exposure to the atmosphere, and which the Greeks called Indian honey. It is also sometimes
named tabaris or tabasheer: but this name more properly
2457 belongs to a phosphorescent substance, containing silica and
lime, and possessing remarkable properties, which forms in
the joints of some species of B., and of other large grasses growing in dry situations. See Tabasheer. The young shoots of some kinds of B. are eaten like asparagus, or are pickled in vinegar. Those of *B. Tulda*, a common Bengalese species, are used for these purposes when about 2 feet long. The seeds of some species are used as rice, and for making a kind of beer. Bamboos are generally of very rapid growth, and they are often found in arid situations, which would otherwise be destitute of vegetation. It is not improbable that they may yet be employed, where they do not naturally abound, to render districts productive which are now little else than deserts, in climates like those of Arabia, the north of Africa, and Australia; and the quality of the grain of different species seems to deserve more attention than it has ever received. The species common in the West Indies (*B. vulgaris*) is supposed to have been introduced from the East Indies. A few species are found in the Himalaya, to an altitude of 12,000 feet, and a dwarf species from that region has been successfully tried in the open air in England.

2458 COMPLAINANT'S EXHIBIT REES' ENCYCLOPEDIA EXTRACT.

Rees' Encyclopedia, American edition, published at Philadelphia prior to 1880, vol. 3, article Arundo.

There is perhaps no plant used for such a variety of purposes as bamboo. In the East Indies great use is made of it in building, and the houses of the lower class of people are almost entirely composed of it. Bridges are also made of it, masts for their boats, boxes, cups, baskets, mats, &c. Paper is also made of it by bruising and steeping it in water, and thus forming it into a paste.

Vol. 27, article Paper.

The preparation of paper made of the barks of trees, may be instanced in that of the bamboo, which is a tree of the cane or reed kind. The second skin of the bark which is soft and white is ordinarily made use of for paper.

COMPLAINANT'S EXHIBIT URE'S DICTIONARY EXTRACT.

Ure's Dictionary, published at London in 1860, vol. 1, pp. 248 and 249.

Bamboo (bambou, Fr. indianiocher Rohr. Germ.) A species of cane, the *Bambos arundinanecea* of botanists. A most important vegetable product in the East where it is used in the construction of houses, boats, bridges, &c. Its grain is used for bread; its fibre is manufactured into paper.

2459 COMPLAINANT'S EXHIBIT DICTIONNAIRE TECHNOLOGIQUE EXTRACT.

Dictionnaire Technologique, published at Paris in 1822, vol. 2, p. 512, under article Bambou.

(*Translation.*)

The Chinese cook it until it reaches the consistency of broth, and make with it a fine variety of paper for the use of pictures and parasols.

Vol. 15, p. 255.

The Other Different Kinds of Paper.

Chinese paper.

The Chinese appear to have been since immemorial antiquity in possession of the art of paper-making. The materials which they use seem to vary with each province. Some use linen rags as in Europe, others the young bamboo, the mulberry tree, the skin which is found in the cocoons of silk worms, a tree unknown to our botanists but which they in this empire call chee or ko-chee, tow, and especially cotton tree.

The Societe d'Encouregement has for a long time offered a prize to any one who should succeed in perfectly imitating Chinese paper. It has felt the importance of this discovery in order to relieve our industry from a considerable tax which we pay to a foreign country for the supply of this paper, indispensable as it is for copper-plate and lithographic engravings.

There can be seen at the "cabinet des estamps" a collection of Chinese paintings representing the manufacture of bamboo paper. One of the paintings represents the bamboo paste, which after being triturated, ground and boiled is set to ferment under mats.

2460 COMPLAINANT'S EXHIBIT ENGINEERS' AND MECHANICS' ENCYCLOPEDIA EXTRACT.

The Engineers' and Mechanics' Encyclopedia, &c., &c., by Luke Hebert, C. E., etc., etc., published at London in 1849, page 139, under the title Bamboo.

Bridges, boats, masts, rigging, agriculture and other implements and machinery; carts, baskets, troughs, pipes for conveying water, pumps, fences for gardens and fields; tables, chairs, bedsteads, beddings, barrows, fences, sacking, cordage, oakum, candle wicks, whips, etc., are made of it.

Macerated in water it forms paper; the leaves are generally put round the tea sent to Europe; the thick inspicated juice is a favorite medicine.

COMPLAINANT'S EXHIBIT NICHOLSON'S ENCYCLOPEDIA EXTRACT.

Nicholson's Encyclopedia, Am. edition, published at Philadelphia in 1819, vol. 2, article Bamboe or bambou.

Paper is also made from it by bruising it and steeping it in water and thus forming it into pulp.

Vol. 9, article Paper.

Chinese paper is of various kinds; some is made of the rinds or barks of trees especially the mulberry tree and elm, but chiefly of the bamboo and cotton tree. In fact, almost each province has its own paper. The preparation of paper made of the barks of trees may be instanced in that of the bamboo, which is a tree of the cane or reed kind. The second skin of the bark, which is soft and white, is ordinarily made use of for paper; this is beat in fair water to a pulp, which they take up in large moulds, so that some sheets are about twelve feet in length.

2461 COMPLAINANT'S EXHIBIT ENCYCLOPEDIA OF CHEMISTRY EXTRACT.

Encyclopedia of Chemistry, published at Philadelphia in 1880 by J. B. Lippincott & Co., article entitled "Paper from bamboo," on pages 533 and 534.

Paper from bamboo.—The following information relative to the manufacture of pulp from bamboo is derived from a paper published in 1876 by Mr. Routledge, who, it should be added, was the introducer of esparto as a material for making paper. He is of opinion that this new material will prove as superior to esparto as that is preferable to straw, and he proposed the following process kind. The second skin of the bark which is soft and white is ordinarily made use of for paper.

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2460 Complainant's Exhibit Engineers' and Mechanics' Encyclopedia Extract.

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The inner bark of the bamboo has long been used by the Chinese for the manufacture of paper of excellent quality, which is celebrated for the clear and delicate impressions, called India proofs, which it takes from engraved plates.

2462 COMPLAINANT'S EXHIBIT MUSPRATT'S CHEMISTRY EXTRACT.

Chemistry, Theoretical, Practical, &c., by Dr. Sheridan Muspratt, published at London, Glasgow, and New York, vol. 2, page 642.

Very little information can now be obtained of the invention and early progress of the art of paper-making. The earliest accounts do not agree, either as to date or place; but all point to the east as the seat of the discovery, leaving almost no doubt that the principle of the mode-n art of reducing vegetable fibre to a liquid state is a Chinese invention. * * *

The paper produced resembles what is commonly called flimsey, but takes a finer and more delicate impression from copper plates and is known by the name of India proofs. A small quantity of it is used in this country for the finest engravings. It is generally made of the inner bark of the bamboo and cotton tree.

2463 COMPLAINANT'S EXHIBIT EXTRACT FROM FARADAY'S LECTURES.

Pages 165, '6.

A COURSE OF SIX LECTURES

ON THE

VARIOUS FORCES OF MATTER AND THEIR RELATIONS TO EACH OTHER

BY

MICHAEL FARADAY, D. C. L., F. R. S.,

Fullerian professor of chemistry, Royal institute,

Delivered before a juvenile auditory at the Royal Institution of Great Britain during the Christmas holidays of 1859–'60. Edited by William Crookes, F. C. S. With numerous illustrations.

Second edition.

London and Glasgow: Richard Griffin and Company, publishers to the University of Glasgow.

MDCCCLX.

Let me now show you what are the properties of that light which make it useful for light-house illumination, and which has been brought to a practical condition by the energy and constancy of Professor Holmes. I will first of all show you the image of the charcoal points on the screen, and draw your attention to the spot where the light is produced. These are the coal points. The two carbons are brought within a certain distance; the electricity is being urged across by the voltaic battery, and the coal points are brought into an intense state of ignition. You will observe that the light is essentially given by the carbons; you see that one is much more luminous than the other, and that is the end which principally forms the spark, the other does not shine so much, and there is a space between the two which, although not very luminous, is most important to the production of the light. Dr. Tyndall will help me in showing you that a blast of wind will blow out 2464 that light; the electric light can in fact be blown out easier than a candle. We have the power of getting our light where we please; if I cause the electricity to pass between carbon and mercury I get a most intense and beautiful light, most of it being given off from the portion of the mercury between the liquid and the solid pole. I can show you that the light is sometimes produced by the vapor between the two poles, better if I take silver than when I use mercury. Here is the carbon pole, there is the silver, and there is a beautiful green light which comes from the intervening portions. Now that light is more easily blown out than the common lamp, the slightest puff of wind being sufficient to extinguish it, as you will see if Dr. Tyndall breathes upon it.

COMPLAINANT'S EXHIBITS EXTRACT FROM MULLER'S PHYSICS.

Page 376.

PRINCIPLES

OF

PHYSICS AND METEOROLOGY.

BY J. MULLER,
Professor of physics at the University of Freiburg.

Illustrated with 530 engravings on wood, and two colored plates.

London: Hippolyte Bailliere, publisher, 219 Regent street.
Paris: J. B. Bailliere, 13 Rue De L'Ecole de Medecine, 1847.

If we fasten to each of the poles of a galvanic circuit, pointed pieces of carbon (of the kind and size used in the carbon cylinders of Bunsen's battery), we shall, as soon as these points come into contact, perceive an uncommonly glittering light. This bright light can be seen by a Bunsen's battery of only four elements: a small, brightly luminous star appearing where the points 2465 of the charcoal come into contact with each other. By increasing the number of the elements, the splendor of the appearance considerably increases; and thus, in a circuit consisting of from 30 to 50 elements, we may obtain a light far exceeding in brightness Drumond's hydro-oxygen light. By the application of this number of pairs of plates, we may remove the points of the pieces of carbon tolerably far from each other, if only the current passes, and we may thus obtain a splendid bow of light, formed by the glowing particles of the charcoal which pass from one pole to the other.

The Telegraphic Journal and Electrical Review for May 15, 1874, Pages 202 and 203.

The new electric light.

On the evening of the 5th inst., some interesting experiments with MM. Ladyguine and Kosloff's electric light were conducted at the engineering works of Messrs. Warner, 10 Diana place, Eastern road. To obviate the difficulty of carbon being consumed when burnt in contact with oxygen, M. Ladyguine placed sticks of carbon in a closed glass chamber filled with a gas not containing oxygen, but owing to the use of metallic connections the carbon was subject to a fracture. The subject was then taken up by M. S. A. Kosloff, of St. Petersburgh, and 6 Great Winchester St. buildings, London, who has succeeded in overcoming the difficulties by using a special metal of which he forms the holders for the carbon rods, and these are placed in a closed glass chamber.

The lamps which were experimented with were nine in number, six of them having two carbon rods, either of which could be placed in connection with the current of electricity. The rods were all
18 millimetres in length, and one in each lamp was 2 milli-
2466 metres in thickness, the others being 1¾ millimetres thick.
The other three lamps contained each a carbon rod 70 millimetres in length, 2 millimetres thick, and also connected with the main current. The first experiment consisted in burning a carbon rod in contact with the atmosphere, the rod being consumed in a few minutes. The current was then turned on to the thicker rod in each of the six lamps, and a brilliant and steady light was produced, which improved as the current was increased in intensity. The reason for lighting the thicker rod first was that it might consume the oxygen in the lamp, by which the rod was reduced a quarter of a millimetre, and was thus brought down to the gauge of the second rod. The current was then directed through the second rod with equally satisfactory results in all the six lamps. The three lamps with the longer carbon rods were then lighted and successfully exhibited, changes being frequently made from the six to the three lamps and back again. The apparatus used for producing the current was Gramme's magneto-electric machine. With the machine running at about 200 revolutions per minute a moderate light was obtained, which was greatly improved at 300 revolutions, the maximum of intensity being obtained at 450 revolutions. The strength of the light depends upon three things—the power of the machine and the number of its revolutions, on the length and thickness of the carbon rods, and on the quality of the carbon. The experiments showed that with the same strength of current and the same number of revolutions, double the amount of light was obtained with the three long carbon rods as compared with the six short ones. The experiments demonstrated satisfactorily the fact that the electric current could be subdivided, and hence, if practice confirms experiment, which it is believed it will, there is a wide field open for the application of Kosloff's system. The form of lamp used by the inventor is experimental, and its variation does not affect the principle. He leaves it to mechanical science to devise a lamp
which shall meet the varied requirements of light-houses,
2467 mines, submarine works, railways and other purposes, to
which it was the general opinion of those present on Tuesday the principle is thoroughly applicable.

COMPLAINANT'S EXHIBIT PHILOSOPHICAL TRANSACTIONS No. 1.

Philosophical transactions of the Royal Society of London for the year 1874, published at London in 1874, pages 513 and 514.

37. I now wished to see the effect of applying to the gravitating masses a hot body inside the exhauted balance tube instead of outside, and accordingly constructed an apparatus shown in Fig. 4.

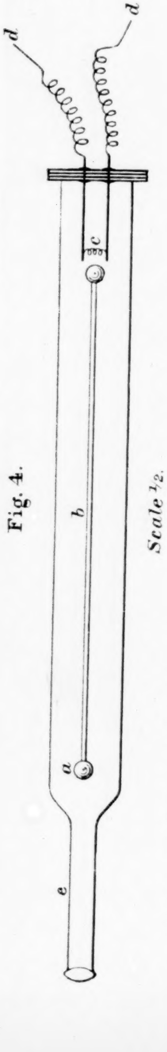

Fig. 4.

2468 *a b* are two balls suspended on a straw beam; *c* is a platinum spiral fastened to two stout copper wires cemented into holes drilled through a plate of glass, which can be cemented to the end of the tube; *d*, *d* are the battery wires; *e* is the extremity of the tube, drawn out for attachment to the Sprengel pump. A single Grove's cell served to heat the platinum spiral to redness. By careful management and turning the tube round the necessary degree, I could place the equipoised brass ball either over, under, or at the side of the source of heat. A contact key enabled me to heat the spiral without removing the eye from the micrometer. With this apparatus I wished to learn more about the behaviour of the balance during the progress of the exhaustion, both below and above the point of no action, and also to ascertain the pressure corresponding with this cal point.

In air of ordinary density the action of the hot spiral was one of attraction both above and below. Not wishing, however, to complicate the action by air currents, I exhausted with the Sprengel pump until the gauge stood about 40 millims. below the barometer. I then tried the following experiments:

2469 38. The brass ball was placed so that its position when in equilibrium was about 1 millim. above the spiral, and the latter was rendered incandescent. The ball was immediately drawn down to the spiral, sometimes touching and then rebounding with considerable force.

39. The brass ball was then arranged so that it was about 1 millim. below the spiral. On turning on the battery current the ball rose to the hot platinum. This latter action might be due to air currents; but it is difficult to imagine that air currents could drag the ball down to the hot spiral when the latter was beneath it (38).

40. The ball was arranged so that the platinum spiral was opposite the end, but a little above, as shown in Fig. 4 A. On igniting the spiral the movement was very slightly upwards. When the spiral was rather below the ball, as shown in Fig. 4 B, the ball moved downwards when contact with the battery was made; the tendency in each of these cases was to bring the centre of gravity of the brass ball as near as possible to the source of heat.

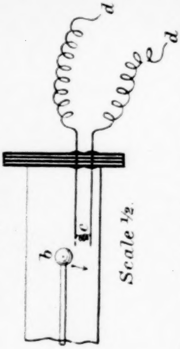

Fig. 4 B.

41. The pump was then worked until the gauge had risen to 5 millims. of the barometric height. On arranging the ball above the spiral and making contact, the attraction was still strong, drawing the ball downwards a distance of 2 millims.

The pump continuing to work, the gauge rose until it was within 1 millim. of the barometer. The attraction of the hot spiral for the ball was still evident, drawing it down when placed below it, and up when placed above it. The movement was, however, much less decided than before, and in spite of previous
2470 experience (30, 31) the inference was very
strong that the attraction would gradually diminish until the vacuum was absolute, and that then, and not till then, the neutral point would be reached. Within 1 millim. of a Sprengel vacuum there appeared to be no room for a change of sign.

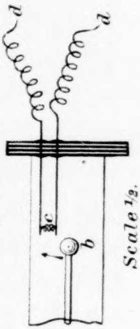

Fig. 4 A.

42. The gauge rose until there was only half a millimetre between it and the barometer. The metallic hammering heard when the rarefaction is close upon a vacuum commenced, and the falling mercury only occasionally took down a bubble of air. On turning on the battery current there was the faintest possible movement of the brass ball in the direction of attraction.

43. The working of the pump was continued. On next making contact with the battery, no movement of the ball could be detected. The red-hot spiral neither attracted nor repelled. I had arrived at the critical point. On looking at the gauge I saw it was level with the barometer.

44. The pump was now kept at full work for an hour. The gauge did not rise preceptibly; but the metallic hammering increased in sharpness, and I could see that a bubble or two of air had been carried down. On igniting the spiral, I found that the critical point had been passed. The sign had changed, and the action was faint but unmistakable repulsion. The pump was still kept going, and an observation was taken from time to time during several hours. The repulsion continued to increase. The tubes of the pump

were now washed out with oil of vitriol,* and the working was continued for an hour.

2471 45. The action of the incandescent spiral was now found to be energetically repellent, whether it was placed above or below the brass ball (Figs. 4 c, 4 d). The finger exerted a repellent action, as did also a warm glass rod, a spirit flame, and a piece of hot copper.

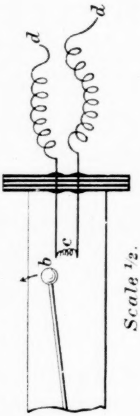

Fig. 4 D.

Scale ½.

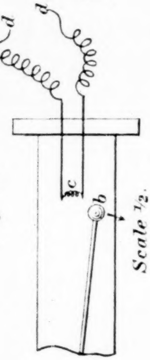

Fig. 4 C.

Scale ½.

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* This can be effected without interfering with the exhaustion. (See Philosophical Transactions, 1873, vol. clxiii, p. 296.

2472 COMPLAINANT'S EXHIBIT PYNCHON'S PHYSICS.

Pages 344 and 345.

INTRODUCTION

TO

CHEMICAL PHYSICS,

Designed for the use of

ACADEMIES, HIGH SCHOOLS AND COLLEGES.

Illustrated with numerous
Engravings.

And containing copious lists of experiments with directions for preparing them.

BY

THOMAS RUGGLES PYNCHON, S. T. D., LL. D.,

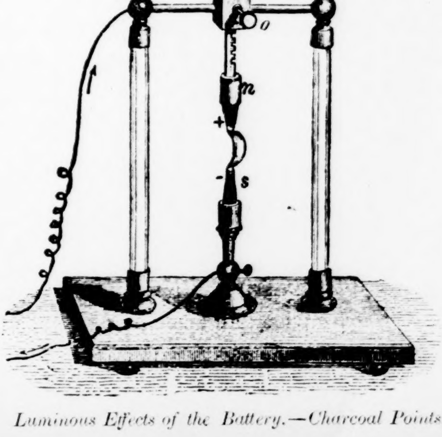
President of Trinity college, Hartford.

Second revised and enlarged edition.

New York:
D. Van Nostrand, 23 Murray and 27 Warren street.
1877.

355. Luminous effects.—All combustible substances, whether solid or liquid, such as ether, alcohol, phosphorous and gunpowder, may be inflamed by passing the galvanic current through them.

FIG. 159.



Luminous Effects of the Battery.—Charcoal Points.

A platinum wire, several yards in length, can be made to glow with intense brilliancy; and the effect is greatly increased if the wire be wound into the form of a spiral helix. Oxygen and hydrogen gases; also, hydrogen and chlorine, are combined by the spark, with a bright flash and loud explosion. When pieces of well-burned charcoal are attached to the wires and become the poles of the battery, on bringing them near each other a most brilliant arc of flame, emitting the brightest artificial light known, flashes between them. The compact coke of gas retorts is better adapted to this purpose than any other form of charcoal. The points 2473 must be brought near each other and then gradually separated. Fig. 159, *a* is the positive pole, *b* the negative. As they are drawn apart by the rack and pinion the light and flame still continue, assuming the form of a curved arc. If the different metals are placed in this flame they are volatilized at once and pass off in fumes. So intense is the light that it may be used in optical experiments in place of the light of the sun. The luminous effect is found to be increased if the upper piece of carbon be made the positive, and the lower the negative pole. And if the two carbon points are arranged in a horizontal position, at right angles to the magnetic meridian, the length of the luminous arc is said to be greater in the proportion of 20.8 to 16.5 when the positive pole is to the east than when it is to the west.

2474 Complainant's Exhibit Extracts from Pepper's Cyclopedic Science Simplified.

Pages 335, 336, 345, 346, and 347.

The Calorific Effects of the Voltaic Current.

When the poles of the battery, or rather the terminal wires, are connected with the arms of the universal discharger, to which crayon-holders, containing hard gas-retort carbon, have been attached, no effect is observed until the carbons are brought in contact, because the intensity of the voltaic current is not sufficient to polarize the intervening air and cause a disruptive discharge; but, once brought in contact, a brilliant spark or intense light is perceptible; and then the carbons may be more or less separated without interrupting the current; and with very powerful batteries, the distance between the two carbons may be increased to several inches.

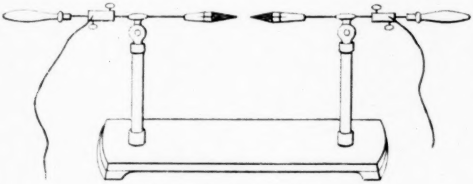


Fig. 303.—*The Charcoal Points.*

By throwing a picture of the charcoal poles on the disc it is seen that a luminous arc extends between the two poles, and there is a constant transference of heated particles going on between the two carbons. It is this passage of divided carbon which serves as a conductor to the current, and preserves its continuity.

De la Rue states that "The length of the luminous arc consequently bears a close relation to the facility with which the material of the poles admits of division."

2475 Scientific men have always agreed that the transference of particles in the same direction as the current, viz., from the positive element to the negative; and the explanation is made clearer by the discovery of Neeff, that the positive is more strongly heated than the negative pole.

Van Breda has shown that incandescent and fused particles are not only propelled from both poles towards one another, but in every direction.

Maas, of Namur, affirms that the transference does not always take place from the positive to the negative pole, but is determined by the density of the charcoal. He states that he succeeded in reversing the direction of the particles by connecting a very hard, fine-grained bit of carbon with the positive, and a coarse, soft piece of charcoal with the negative; and he then found that the incandescent particles moved from the negative to the positive pole.

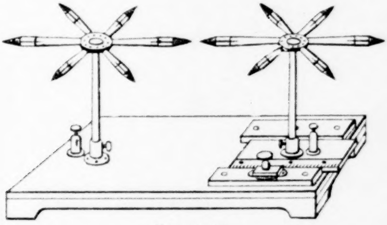


FIG. 304.

The negative cylinder, when examined, appeared slightly excavated; the positive one, slightly obtuse. Amidst this conflicting evidence, the writer states from experience that the wasting of the charcoal points is always unequal, and, provided they are of the same quality, the transference takes place regularly from the positive towards the negative. By arranging a number of
2476 crayon holders, containing various metals, such as zinc, copper, lead (Fig. 304), according to the method proposed by Mr. De la Rue, a number of beautiful colors may be obtained by the intense heating and partial combustion of the metals, copper throwing out a green light, zinc a bluish white, with the formation of a large quantity of smoke—oxide of zinc.

If the charcoal points are brought together in a void space, or vacuum, the light is very peculiar, it appears softer, though still very brilliant, and presents a marked difference to the same light observed in air; the carbons appear to last much longer, and the writer has often thought that when the electric light is required to be very continuous, as in the Duboscq lantern, it would always be better, if possible, to produce the light in small glass chambers from which the air had been removed.

The Electric Lamp.

The young people who may read this book, will no doubt, be glad to hear that they can now experiment with the electric light at a very moderate cost, with a new and beautiful apparatus constructed by Mr. John Browning, of 111 Minories.

The apparatus, Fig. 312, is most simple and effective, and with a small Grove battery and a moderate-sized lamp, an electric light may be procured at about the cost of two or three pounds. There is no clock-work; and the regulator is simply an electro-magnet which cannot very easily be put out of order. The writer can strongly recommend this apparatus to those who want a cheap and good lamp. Of course, when an electric lamp is required to
2477 be constantly used, and is subjected to much wear and tear,
more substantial arrangements are required, as in Serrin's lamp.

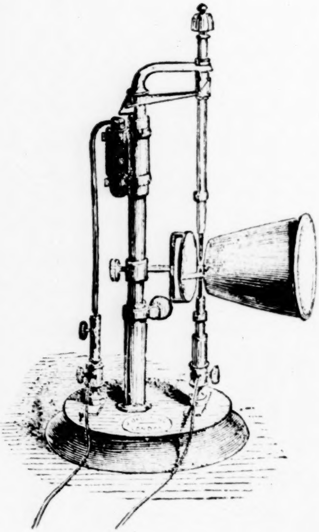


Fig. 312.—*Mr. Browning's New and Cheap Electric Lamp.*

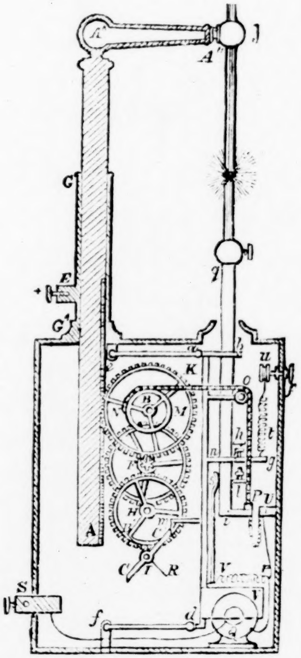


Fig. 313.—*Serrin's Automatic Regulator of the Electric Light.*

In the following description of Serrin's apparatus, Figs. 313 and 314 represent a vertical section and plan (at the height of the electro-magnet) of apparatus; it consists,

First, of a motor or driving power A, A′, A″, forming at the same time the motor and holder of the positive electrode, as a motor; it
is furnished with a toothed rack, and acts by weight on the
2478 moving part of the clock-work. The tube G, G′, serves as a
guide, which carries a binding screw-stud E, which serves to
receive the wire from the positive pole of the battery.

Secondly, of a wheel train, composed of four movable parts, B, F, H, I, the first mover of a single piece forming at the same time a toothed wheel K, and pulley M. The diameter- of these last are as two to one, so as to correspond and be in proportion, as near as may be, to the different consumption of the positive and negative carbon points, and thus maintain the point of light stationary. To effect this, the wheel K, in turning under the action of the motor, A, A′, A″, allows the upper carbon point to descend, whilst the pulley M, by the same movement, winds up the chain N, O, P, and effecting at the same time the ascension of the lower carbon point. The toothed wheel K, in combination with the other movable parts, serves to regulate the approach of the carbon points by the aid of the flyer R, R′, which carries the last wheel. This carries besides a detent C, C′, which acts to prevent or permit the approach of the charcoal points.

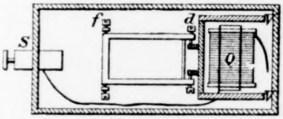


FIG. 314.

Thirdly, of an electro-magnet, Q, wound round with an insolated conducting wire, communicating by one of its extremities to the binding stud S, and by the other to small chains, U, P.

Fourthly, the combination of parts, which I will term the oscillating arrangement, and which forms the particular feature of this improved regulator; *a*, *b*, *d*, oscillating support, properly so called,
which is held by two arms of equal length, *a e*, *d f*, jointed,
2479 at *e f*, to the plates or case of the train; the joints, *e f* and *a*
d, permit of a vertical to-and-fro movement of about half an
inch, which movement is limited by a stop, *g*, oscillating between two screws, *h*, *l*.

The pulley O, which is mounted on the oscillating support and disposed to receive the chain, N, O, P. I call this chain and pulley O, the parts of ascension. The pawl or catch *m*, also fixed to the oscillating support, engages with or disengages from the teeth of the detent C, C′, according as it is to be raised or lowered, thus, when the stop *g* is in contact with the screw *h*, the gearing is free; if, on the contrary, it separates itself a fraction of an inch, the pawl *m* engages with and stops the train: *a*, *b*, *n*, *n'*, collars formed on the oscillating support; they are bushed with ivory, so as to isolate the lower carbon-holder, and serve at the same time to guide the latter in its raising movement.

The armature V, fixed to the oscillating support, is formed of a horizontal plate and two vertical plates of soft iron; the horizontal part covers the electro-magnet Q, and the other two are placed at opposite ends of the soft iron of the electro-magnet, but without touching it. This armature is disposed in such way that its central horizontal line is higher than the usual lines of the electro-magnet, thereby assisting the action of the magnet.

The appendix *i*, P, fixed to the base of the carbon-holder, *i*, *q*, serves to join it with the chain, N, O, P, electrically isolated at P.

The object of the small chains U, P, is for the passage of the electric current, while at the same time they serve as a variable counter-balance by raising the extremity P, and thereby compensating for the loss of weight that the lower carbon incurs by being used in combustion. The fixed support U, of the chains is electrically isolated. The friction surface S, V, is also isolated at V, the helix A, R, serving also to conduct a part of the electric current passing from the lower carbon to the wire of the bobbin.

2480 The suspension spring has for its object to sustain the oscillating frame and effect of the weight; it can be lengthened or shortened at will by the aid of the button *p* and pulley *u*.

Action of the regulator.—The drawing represents the apparatus in action and the carbon points about half used. The carbon points are placed in their supports A'', *q*, while the apparatus has no communication with a battery; the electro-magnet being inactive, the spring *t*, should be lengthened in such way that the stop *q* presses lightly on the screw *h*, or in this case the detent C', C'', being in gear with the hook *m*, is raised to its highest elevation. During this *this* time the gearing is free, and the charcoal points approach and come in contact. By connecting the negative pole of the pile or battery to the binding stud, S, and the positive pole to the screw E, the electricty enters the apparatus by the latter, passes through the motor, carbon-holder, and the carbon itself by reason of the contact which exists between the two carbons; it will continue its course by the lower carbon, the support, *i*, *q*, the small chains, P, U, also the friction surface, *s*, *r*, and helix *r*, *r*, to the conductor wound on the electro-magnet, leaving by the binding screws-tud, S, to reenter the battery, and so on. At the moment of connecting the second pole of the battery, the electro-magnet becomes active, and the armature, V, is attracted and drawn down, thus lowering the oscillating frame or system; the hook then catches the wheel train. By this action the train is stopped and the upper carbon remains stationary, while the lower one being unable to rise, their separation is maintained, and the voltaic arc formed. The arc being formed the carbon points are consumed by transfer and combustion; therefore the interval between them increases, while the attractive force of the bobbin becomes gradually weaker, and the oscillating system raises, its motion being complete when the screw-stud *g*, touches the screw *h*, the train liberated at the same time and acts on the ascending parts, which thus effect the si- 2481 multaneous approach of the two carbons; this approach is effected in relation to the unequal wear of the carbons so as to maintain the point of light stationary. After the approach of the carbons the electricity passes more easily, causing the armature to be attracted more strongly and to overcome the resistance of the suspending spring so as to draw down the oscillating frame, when the hook gears with the train and prevents the carbons approaching until the wear again produces another approach, followed by another stop, and so on. Thus, by the alternate opening and closing of the circuit, the movement described can be reproduced and continued at pleasure, and so forming and determining the voltaic arc by its self-action. After the preceding, it will be seen that it is the oscillating system or frame which determines all the actions of the regulator, and separation and adjustment of the carbons. The seven principal pieces of which it is composed produce the different effects under the action of electro-magnetic apparatus in communication with the voltaic arc.

COMPLAINANT'S EXHIBIT PHILOSOPHICAL TRANSACTIONS NO. 2.

Philosophical Transactions of the Royal Society of London for the year 1876, published at London in 1877, sections 171 to 177, inclusive, on pages 350 to 352.

171. But in case of light falling on the lamp-blacked surface the result is very different. Here, practically, the whole of the light is quenched by the lamp-black. Force is poured into the bulb, but none comes out. What, then, becomes of it? It is changed into motion, and becomes evident in the strong repulsion which is exerted on the black surface.

This I think is clear in the case of light. We can see that 2482 there is an enormous difference in the absorbing powers of white and black pith for light, and we can also see that there is an equally marked difference between the motive power which light exerts on them. But with the heat from boiling water or from a hot copper ball our eyes cannot tell us whether the same difference obtains or not, and we must use other and less direct means of finding out what takes place.

Let me direct attention to the experiments described in paragraphs 128 and 144. Here red-hot copper was seen to repel the black surface with violence, and the white surface only moderately. As the copper ball cooled, the repulsion on each surface became more nearly equal. At 400° C. the differential action was decided, though faint. At 300° C. the black surface was still repelled slightly more than the white surface, but at 250° C. down to 100° C. the repellent action of the radiant heat was the same on the white as on the black surface. The two surfaces were then thermically of the same color.

The fact that the work done on each surface was equal, is, I think, proof that the absortion of the incident rays was equal.

172. Let me now carry the reasoning a step further. Experiments described in pars. 159 to 168 show that when heat of low refrangibility—from the body (159), the breath (160), hot air, or a warm glass shade (161, 165, 168)—falls on the white and black surfaces, the white is repelled more than the black, rotation of the radiometer taking place in the negative direction. The same rays falling on the two surfaces do more work on the white than on the black; and this, to my mind, appears sufficient to make it almost certain that the white pith absorbs more of these low rays than does the lamp-black.

173. Let us imagine that surfaces of lamp-black and pith are carried along the spectrum from the blue to the ultra red. As long as they are in the visible portion we observe an enormous difference between them. In the extreme red we can actually see that 2483 this difference is becoming less. In my mind's eye I picture the progress being continued along the whole length of the ultra-red spectrum. I can see, by the light of the above-quoted experiments, that the absorptive action of the two surfaces gradually gets more equal. Soon they become identified in their action on the incident rays, and after that they enter a portion of the spectrum whose rays are no longer absorbed by lamp-black, whilst they are quenched by the pith. Lamp-black and pith have now changed places; the latter is black, whilst lamp-black has become a white substance.

174. The normal rotation of the radiometer caused by dropping ether on it (163) is perfectly well explained by the above hypothesis. If heat in the act of absorption produces motion in one direction, in the act of radiation, it produces motion in the opposite direction (167). Heat of low refrangibility falling on the radiometer repels the white more than it does the black, and produces negative rotation. When the same kind of heat is drawn out of the black and white surfaces by the chilling action of the ether, movement takes place in an opposite direction, and the arms rotate normally. On stopping this efflux of heat by covering the instrument with a hot shade (163), I changed the direction of movement by causing the surfaces to absorb instead of emit heat.

An irregular emission or absorption of heat (164) stops the movement altogether, for the reasons given in pars. 155 to 158.

175. I have made an apparatus by means of which I hoped to put the above theory to accurate test. The results are not so defi- 2484 nite as they ought to be in order to settle the question; but they are worth giving in detail, as some novel facts have been elicited by them.

Fig. 10.

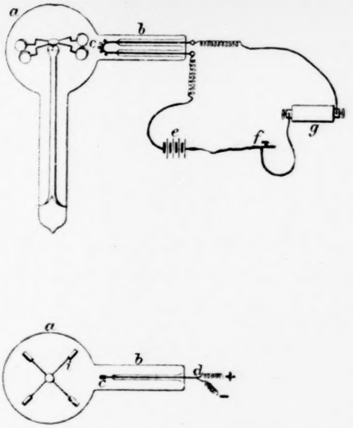


Fig. 10 shows the instrument: *a* is the bulb of a radiometer of the usual construction, having pith disks blacked on one side. *b* is a tube sealed into one side of the bulb, and having two stout platinum wires passing along it, sealed their whole length in glass to prevent leakage of air into the interior of the apparatus. At the ends *c* of the wires, a spiral of fine platinum wire is fastened, and the other ends (*d*) terminate in loops outside. *e* is a battery, *f* a contact key, and *g* a resistance coil, which I can vary at will. The bulb was perfectly exhausted, and the following experiments were tried:

176. The resistance coil was so adjusted that the battery would keep the platinum spiral (*c*) at a bright red heat. The arms of the radiometer, which were before quite still, moved rapidly until two of the disks were one on each side of the hot spiral, the black disks being further off than the white disk, as shown at *i*. The
2485 resistance was then gradually increased, and as the temperature of the spiral diminished, the black disk gradually approached the spiral, until when the temperature was just at the point of visible redness in a dark room, the black and white disks were practically equidistant from the spiral. On diminishing the resistance, the same phenomena took place in inverse order.

177. The resistance was adjusted to give a bright red spiral, and the contact key kept pressed down. The disks stood as at *i*. A lighted match was momentarily brought near the bulb, so as to start a movement. Rotation of the arms commenced, and kept up with some energy, at the rate of about one revolution in five seconds equal to that given by a candle 8 inches off. There was some little hesitation as the white side came up to the spiral, but this was scarcely noticed when the speed had become steady.

The resistance was slightly increased. The speed became slower as the temperature of the spiral diminished, and the hesitation as the white approached the spiral became more apparent. The resistance was further increased with the effect of making rotation still slower. I now brought the temperature of the spiral down to just vis*a*ble redness in the dark. The speed of rotation again slackened; at each approach of the white surface to the spiral it stopped, hesitated, and then got past with a rush. Thus it went on for a few revolutions, until one white disk, a little nearer perhaps than the others, was not able to pass, and the arms after a few oscillations came to rest, the black and white surfaces being, as near as I could judge, equidistant from the hot spiral.

These results fully confirm those obtained in experiments 128 & 144, and I think justify the conclusions arrived at in my discussion of them at par. 171—that at temperatures between 250 and 100 degs. the repellent action of radiant heat is about equal on black and on white surfaces.

2486 COMPLAINANT'S EXHIBIT MILLER'S CHEMICAL PHYSICS.

ELEMENTS OF CHEMISTRY:

THEORETICAL AND PRACTICAL.

BY

WILLIAM ALLEN MILLER, M. D., LL. D.,

Treasurer and vice-president of the Royal Society.
Vice-president of the Chemical Society.
Professor of chemistry in King's college, London.
Hon. fellow of King's college, London.

PART I.

CHEMICAL PHYSICS.

From the third London edition.

New York:
John Wiley, 535 Broadway.
1864.

(Pages 413, 414 and 416.)

280. Disruptive discharge—Electric light.—When the current is greater than the conductor is able to convey, the wire melts and is dispersed in vapor: dis*p*ruptive discharge, in fact, occurs. From a powerful voltaic battery this disruptive discharge may be maintained continuously, owing to the enormous quantity of electricity in circulation.

If the air be rarefied between the interrupted conductors, the interval through which the discharge can be effected may be considerably increased. Thus the heat developed by the passage of the current between two pieces of charcoal when they are in cont*r*act, will enable them to be separated for a considerable distance without interrupting the passage of the current; this distance ranges from ¾ inch to 1 inch when a series of seventy of Daniell's

cell twenty inches in height are employed. Davy, with the great battery of the Royal institution, consisting of 2,000 pairs of
2487 plates on Wellaston's construction, obtained an arc of flame,
between charcoal points, four inches in length, and of dazzling brilliancy.

Despretz, by using 600 cells of Bunsen's construction arranged consecutively, succeed- when the points were placed in a vertical line with negative pole below, in obtaining an arc of 7.8 inches in length. With 100 pairs the arc was only one inch long. The most intense light, however, is obtained when the points are separated but to a small distance, because the resistance then being less, a much larger quantity of electricity passes in a given time, and the temperature is proportionately higher. Despretz found he obtained a much more intense light by employing his 600 cells in six parallel series, so as to form 100 cells of six times the ordinary size, than when they were connected into one continuous series. He estimated the light with the arrangement of 600 in six parallel series to be nearly six times as great as when 100 cells only were employed—a result in conformity with the anticipations of theory. The same observer found that when the charcoal points were disposed in a horizontal direction at right angles to the magnetic meridian, the length of the arc when 200 pairs of Bunsen in two parallel series were employed, was greater in the proportion of 20.8 to 16.5, when the positive pole was to the east, than when it was to the west.

During the production of this dazzling light a considerable mechanical transport of the materials composing the terminals of the pile takes place, and there can be no doubt that the ignition of the solid particles contributes mainly to the production of the intense light thus produced. A cavity is always produced in the piece of charcoal attached to the positive wire which is connected with the last platinum or copper plate of the battery; and at the same time a mammillated deposit, which continually increases in length, is formed upon the charcoal on the negative wire in connection with
the zinc plate. Attempts have been made to apply this light
2488 to the purposes of illumination, and in particular cases, as for
the display of optical phenomena in the class-room, it is often of high value. Its application is, however, attended with great practical difficulties, of which the transfer of conducting material from one pole to the other is one of the most serious; and it is very doubtful if, even when the mechanical obstacles are removed, such a light can be economically or advantageously used for the general purposes of illumination. The light is too intense for the unprotected eye to endure for any length of time in its immediate vicinity, and the expense is so great, that unless the electricity can be obtained in the process of preparing some chemical compound in the battery itself which will defray the cost of production, its success as a mercantile speculation is very problematical.*

* The general appearance of the electric lamp of Duboscq is shown in Fig. 223, in which T. T. represent the charcoal points between which the voltaic arc is maintained. The object to be effected

is to preserve these points at a uniform distance from each other, and at the same height in the lantern, so that the source of light shall always be kept in the same position with respect to the lens.

The regulator by which this result is attained is shown at R.
Within this is an electro-magnet, and a clock movement, the
2489 principal parts of which are represented upon a larger scale
in Fig. 224. The clock movement is designed to bring the

FIG. 223.

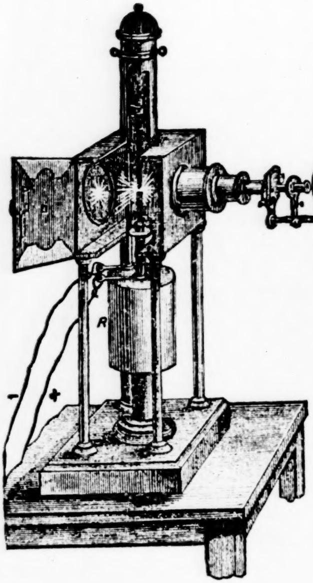
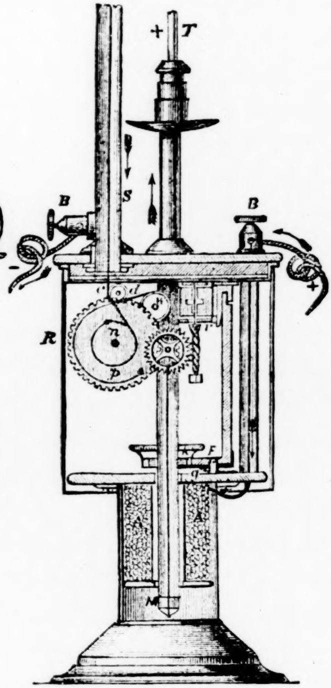


FIG. 224.



two points toward each other so as to compensate for the waste they experience in burning, and the electro-magnet is employed to check the clock action when no longer needed. When the battery is in use the negative point is always consumed in air more slowly than the positive one; and it becomes necessary to provide means for moving each point, at a rate proportioned to the rapidity of its consumption. This is effected by making the drums *n* and *p* of un-
equal dimensions; the chains *c* and *d* are employed to trans-
2490 mit the movements of the clock-work to the points T, T′.
The chain *c* attached to the upper or negative point T′, is coiled upon the smaller drum *n*, and passes up the tubular support *s*. This chain is wound in the opposite direction to that of the

chain *d*, which after passing over the pulley *d'*, is attached to the tube containing the lower or positive charcoal point T. Both drums are placed upon a common axis, and therefore both are moved by the clock in the same direction, so that whilst the chain *d* attached to the lower point is being wound up, the chain *c* connected with the negative point is being un*un*wound, though less rapidly than *d*, and the negative point is allowed to descend. The wires from the battery (about 40 pairs of Grove) are made fast to the binding screws B B', the positive wire B, being connected with one end of the coil A A of the electro-magnet M, while the other end of the coil is in electrical contact with the lower point T. The current is thus made to pass through the electro-magnet on its way to the charcoal points. When the electro-magnet is in full action it attracts the keeper *k* attached to the lower end of the bent lever working on the fulcrum F. The upper extremity of this lever, when the keeper is drawn home, locks into the ratchet wheel seen edgewise at *r*; thus arresting the clock movement, and rendering the charcoal points stationary. As soon as the distance between the points becomes too great, the current through the electro-magnet becomes reduced in power, and lets go the keeper *k*, which is forced away from the magnet by the releasing spring *q*. By this means the clock-work is immediately set free, and the points are thus made to approach each other, until the current recovers sufficient force again to attract the keeper, which once more locks into the ratchet wheel *r*. When the battery is in good action, these alternate motions of the keeper and of the clock-work recur with frequency and regularity; so that the points are maintained at a distance sufficiently uniform to prevent any sudden or material fluctuation in the amount of light.

2491 COMPLAINANT'S EXHIBIT CERTIFIED COPY OF DYER AND WILBER LETTER OF OCT. 4, 1880. W. T. F., Examiner. April 10, 1889.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the records of this office of a letter from Dyer and Wilber, dated October 4th, 1880, ordering copy of file-wrapper, contents and drawing in the matter of the application of Sawyer and Man, filed January 9th, 1880, for improvement in electric lights, and containing $5.25, cost of said copy.

Copy was furnished October 16th, 1880.

In testimony whereof I, C. E. Mitchell, Commissioner of Patents, have caused the seal of the Patent Office to be affixed this [SEAL.] 2nd day of April, in the year of our Lord one thousand eight hundred and eighty-nine, and of the Independence of the United States the one hundred and thirteenth.

C. E. MITCHELL,
Commissioner.

$5.25, certified. 12 photo.
198—286

Washington, D. C., *Oct. 4th*, 1880.

Hon. Commissioner of Patents:

Please furnish us with copies of the file and contents and dr'g, in the case of Sawyer and Man, electric lights, filed January 9, 1880, now in interference with Edison.

Enclosed therefor is the cost, $5.25.

DYER & WILBER,
Att'ys for Edison.

2492 Complainant's Exhibit Lichtenstadt U. S. Patent. April 22, 1889. W. T. F., S. E.

United States Patent Office.

Philipp Lichtenstadt, of New York, N. Y.

Improvement in Preparing Fibre from the Bamboo.

Specification forming part of Letters Patent No. 41627, dated February 16, 1864.

To all whom it may concern:

Be it known that I, Philipp Lichtenstadt, of the city, county, and State of New York, have invented or discovered a new and useful process for disintegrating the fiber of bamboo, so that it may be used in manufacturing cordage, cloth, mats, or pulp for paper; and I do hereby declare that the following is a full, clear, and exact description of the same.

My invention relates to a cheap and expeditious process for disintegrating or rendering into a fibrous or pulpy state for manufacturing purposes the tissues of the bamboo, (*Bambusa* and *Bambusa arundinacea*,) whereby I gain a greater amount of comminuted material from a given quantity of the crude material than by any other process hitherto practiced for the disintegrating of woody or vegetable substances of the character of bamboo.

To enable others skilled in the art to make and use my process I will proceed to describe the same.

In the reduction of vegetable substances to a fiber for manufacturing purposes a great object heretofore has been to destroy all the woody matter and only preserve the cellulose or cellular tissue. This process is expensive, and causes great loss in a fiber which may be utilized with great advantage and economy, so that while heretofore but from thirty to forty per cent. of the crude vegetable substance was saved in a fibrous or pulpy state fit for manufacturing
purposes I actually save by my process eighty-five per cent.,
2493 and sometimes more. I first take the bamboo and cut out
the joints thereof, and then split up the pieces or portions of the wood into slivers of, say, half an inch in width. The slivers or pieces are then put into a vat, say, capable of holding and treating one thousand pounds of the bamboo, where they are pickled in a solution of clear lime water, nitrate of soda, and oxalic acid. The

liquid content of the vat is about five hundred gallons, and the proportions of which the pickling liquid is made are about as follows: Of hot lime one hundred pounds: of nitrate of soda, four hundred pounds: of oxalic acid, forty pounds. The oxalic acid attacks the silica or outer coating of the bamboo plant and destroys it. It also acts, however, as a bleaching agent, and the quantity used may therefore be diminished if the fiber is not required to be bleached, as would be the case in cordage, coarse cloth, mats, and rough paper. The pickling liquid may be warmed, but not made hot enough to drive off the oxalic acid, and the material to be treated may remain in the pickle from twelve to twenty-four hours, after which it is removed and boiled in a solution of soda ash, using about two hundred pounds of soda ash to about one thousand of the material to be treated. This reduces the material to the con- — fiber half bleached. The material is then crushed between *dition of a* rolls and then "deviled," (combed, or carded, or heckled) and is then in condition to be spun into cordage, or other forms for manufacturing ropes, cloth, mats, &c., yarns. If, however, the fiber is to be used for paper-making, then it is taken to a pulping, beating, or grinding engine of any of the ordinary well-known kinds, where it is converted into a pulp and thence into paper. For the finer or whiter qualities of paper, the pulp may be bleached by any of the known processes.

Having thus fully described my process, what I claim therein as new is—

The process of separating and disintegrating the fibre contained
in bamboo by treating it with a solution of lime, nitrate of
2494 soda, and oxalic acid, and preparing the textile material for
manufacturing purposes, substantially as described.

PHILIP LICHTENSTADT.

Witnesses:
A. B. STOUGHTON.
H. H. PORTER.

Complainant's Exhibit Heaton U. S. Patent. April 22, 1889.
W. T. F., S. E.

United States Patent Office.

Charles Heaton, of New York, N. Y.

Letters Patent No. 68363, dated September 3, 1867.

Improvement in Preparing and Treating Vegetable Fibres.

The schedule referred to in these letters patent and making part of the same.

To all whom it may concern:

Be it known that I, Charles Heaton, of the city, county and State of New York, have invented a new and improved method of preparing and treating crude vegetable fibrous material, for the purpose of utilizing the fibre of the same to be used in the arts; and I do hereby declare that the following is a full, clear, and exact description of my method of proceeding and treatment.

Before describing my invention it is necessary, for the proper understanding of the subject, that I should make the following remarks:

2495 Bamboo, and other like large-jointed productions (which I prefer to treat by my process,) being found in hot climates, usually have to be carried from the place of their production to the place of consumption; and among other obstacles to their treatment and conversion into fibre, have the following disadvantages: When bamboo has been cut and stored away it is found to produce, in large quantities, an insect or bug of the beetle order, which seems to be taken up into the plant, in the egg form, during its growth. I have found this insect within the solid wood of bamboo, into which it has eaten long burrows, without being able to find any place where it had entered into the plant. I have also fermented bamboo, and have then found it to be full of insect life in the form of small white maggots, which may or may not be another form of the same insect brought into existence by the process of fermentation, but which certainly shows that insect life is taken up in the growth of the plant. This insect or bug is very destructive to the fibre, as well as to all wood-work adjoining the stored crude material, and also highly detrimental to the quality of paper made from bamboo, when paper is made from it. Another inherent disadvantage to bamboo as a fibre-producing material is its bulk. It is a very light and a very hard, unyielding material, and its shipment in the crude state is attended with great comparative expense. It is so light that after it has been split up and baled or pressed as much as practicable, a vessel of capacity to carry one hundred and sixty tons of ordinary freight can only carry forty-three tons of baled bamboo. Bamboo, as is well known, is a hollow structure, furnished at intervals with joints, like straw. At each of these joints there is a hard and tenacious diaphragm or partition, which prevents the material, in its crude state, from being baled solidly, unless each separate piece is put through rollers or otherwise crushed; and even after crushing it will be found to be so tenacious of its original form, and so elastic, as to go back to that form and be very hard to bale solidly. Should it be found worth while to arrange presses to bale it solidly, there is still the bug or insect before mentioned to be contended against.

2496 The object of my invention is to overcome each of these disadvantages, and to extract the fibre from such material without increasing the cost of such extraction; and to this end I place the crude material into a solution of caustic alkali of about the following proportions: To each ton of crude bamboo, dry, I propose to use and do use, two hundred pounds of hydrate of potassa (KO, HO,) of commerce, or its equivalent of soda ash, (N^aO, CO_2XHO,) which I make caustic by quicklime in the ordinary manner, and to which I add enough water to form a solution of the bulk necessary to cover the ton of bamboo to be softened. This

softening may be effected either in open tanks, and cold, or in closed vessels, and hot, the object being to soak the bamboo in the alkaline solution until it has become softened; but care should be taken, in using closed boilers and heat or pressure, not to carry the heat too high, or the material under treatment will be disintegrated and injured; as I will hereafter show. If I use closed vessels and heat, I find that in from two to three hours the bamboo has become quite soft, and that it offers no resistance to being baled. If I use an open tank instead of a closed vessel, and apply no heat, I find it takes two or three days to produce the same effect or soft condition of the material, but that in all other respects the condition is the same, namely, the crude material is reduced to a soft, yielding condition without having become disintegrated, and without having changed its conformation. In the course of from one to two days, depending on the climate, the soft material, on being taken out of the solution which softened it, becomes hard again, and with the exception of having become shrunk or shriveled up a little, and having also changed color, looks as it did before being subjected to treatment. Before this takes place, and while it is soft, I press it into bales, if I wish to transport it; and I find that with the same application of power and the same press used to bale the crude material I can easily press three times as much bamboo, which has been softened as I describe, into the space occupied by one-
2497 third the quantity of unsoftened or crude bamboo; thus enabling a vessel which would only carry forty-three tons of the crude material to carry one hundred and twenty-nine tons of prepared material, and therefore reducing the cost of transportation two-thirds. In addition to this saving in transportation, I find the insects or eggs before alluded to are all destroyed, so that the prepared material may be stored for any length of time without depreciating in its nature, and also that the absorption of oxygen, which goes on for a long time after softening, greatly facilitates the reduction to pulp or fibre, whenever it may be necessary to disintegrate it. The cost of chemical for softening cannot be taken as an offset to the saving in the cost of transportation, as the same chemical, or chemical of equal cost, would have to be used in any case to convert the crude material into fibre; the only difference being that by my method of proceeding I allow an indefinite time to elapse between the application of the chemical to soften, and the mechanical reduction of the softened material to pulp or fibre, which, in addition to enabling me to save in cost of transportation and destroy animal life, as before mentioned, also results in a great saving of chemical, because when material has been softened by an alkaline solution, it becomes greedy for oxygen, which it absorbs, so that while it is lying in store or awaiting disintegration, an action which costs nothing is going on, which renders the subsequent reduction or disintegration more easy, and also enables me to obtain a better product than I could do by any other process.

If it is required to make the material which has been softened and baled into brown paper, I simply untie the bale of prepared material and place it in a tank, tub, or other convenient vessel, and

cover it over with cold water, and allow it to remain in the same from six to twelve hours, when it swells up to its original size and becomes so soft and unresisting that it can be rubbed into fibre in the hands with ease. I now drain off the water, which has become of a dark, rich brown, or coffee color, and wash the material
2498 by causing hot or cold water to fall among it. When it is washed comparatively clean, so that the water which runs off is no longer highly colored, I transfer the material to the ordinary paper-maker's beating engine, (used in all paper mills, and sometimes called the rag engine,) and beat the fibres apart and reduce it to pulp in the same way that rags are reduced, and make it into paper in the ordinary manner.

For white paper, the material has to be treated differently, but such additional treatment forms no part of this specification.

By washing the softened material before disintegrating it, I find I avoid wasting the fibre, and get, as a consequence, a much greater yield of fibre from a giving quantity of material. I also find when paper is made, that it is better and stronger than would have been made from the same material by any other known process; and whatever may be the use made of bamboo thus softened, it will be found that the softening process to which it has been subjected will have improved its condition, and it will be found that notwithstanding the softened material becomes hard again, there is so much chemical stored up in it for future use to be made available at any time and put into energetic action by simply adding cold water. In the case of brown paper, as above shown, the material may be reduced to pulp and made into paper by mechanical action and simple cold water, without any additional chemical treatment whatever.

It is necessary for me to make some remarks, which I will make as brief as possible, in order to make quite clear what might otherwise be considered a very fine distinction but which in reality is a very broad one, and a new and novel method of proceeding.

Vegetable fibrous material had been made into paper for a long time prior to my invention, I am aware, and caustic alkaline solutions have been used for the purpose of reducing the crude material to pulp. In all cases where caustic alkali has been used, it
2499 has, I believe, always been the custom to boil such crude fibrous materials as are suitable for paper-making with caustic alkali, but such boiling has always been carried on for the express purpose of disintegrating and reducing the material treated to a pulpy mass in the boiler or vessel in which it has been boiled; and to accomplish this disintegration in whole or in part, it has been the custom to boil for very long periods, the express object being in all cases to reduce the material to a pulp, or as nearly so as possible, in the boiler, by dissolving its gums, and while the chemical which dissolves them is present. The mass of pulpy matter is then customarily transferred to the beating or rag engine, and there washed free from its dissolved gums and combined chemical solution, said engine being used as a washer and net for the purpose of reducing the material, which has always been more or less

reduced in the boiler. The object, I believe, has always been to disintegrate and separate the fibres one from the other and reduce the pulp by dissolving the gums. Patents have been taken for the combination of caustic alkali and certain high degrees of heat for the special object of reducing to pulp in the boiler and before washing the material, said washing being for the purpose of removing the dissolved gums and combined chemical from amongst the already disintegrated fibres. The ordinary beating or rag engine, which was originally designed for reducing rags, cloth, and other like fibrous substances (not crude fibre) to pulp and washing out dirt and coloring matter at the same time, being common in paper mills, has been and is used for washing such pulpy masses as are the result of boiling crude vegetable fibrous substances in caustic alkaline solutions combined with heat long applied for the purpose of disintegrating the same; and it is evident that in using the beating or rag engine for washing out dissolved gums and chemical from the disintegrated or partially disintegrated mass, the object has been to use the engine as a washer, and only as a beater or disintegrator when, from imperfection in the boiling process or from other causes, the material under treatment has not
2500 been uniformly disintegrated, as it was intended to be. My object and intention is exactly opposed to the boiling process, and I am particularly careful not to disintegrate in the boiler or while the chemical is present, as, if I did so, I should waste the fibre in washing out the chemical which reduced it, and also injure its quality by undermining its structure too much and thereby shortening its staple, as I find that where alkaline solutions are used with heat for the purpose of reducing vegetable fibre from the crude state directly to a pulpy mass, material so reduced is unfit for making into paper without the addition of some other long fibre, which has not been subjected to the same treatment, to enable the fibre to make a strong felt, a quality which alkalies and heat sufficient to disintegrate always must destroy. When I use heat I do so only as an accelerator to the softening process, for the purpose of causing the solution more quickly to permeate the pores of the material and soften it. All vegetable fibrous structures, so far as I have observed, are built up in the same order, and consist of fibres built up in series of structures. The first series, or the first natural division, consists of bunches of a second series, built up like and forming a duplicate of the plant of which it is a part. Each of these bunches is built up again of other still finer series of bunches, until, so far as I have been able to see, the very ultimate fibre, if there is such a thing, is an infinitely minute duplicate of the whole plant, and much too fine and minute to be washed by any known means without great loss in washing. All of the various substructures of which bamboo seems to be composed appear to be arranged in the same order of series below series, which are joined together by gum or gums which fill up all of the interstices without closing them. These gums are of a pithy and crystalline nature, and appear to be held together by the force of cohesion. This gum is of the same nature throughout the whole structure, which it

binds together, giving stiffness and inflexibility to the same. Cold caustic alkaline solutions readily permeate these several
2501 structures and soften the gum or gums, destroying the attraction of cohesion and rendering the whole mass soft and yielding, so that the fibres may be separated from each other and from their surrounding gums without any great exertion of mechanical force, and without injuring or breaking the fibre in the separation. But in order to dissolve these gums and separate the fibres by the chemical action and without the aid of mechanical force, heat and great heat is necessary in addition to caustic alkaline properties. But when the material is subjected to that chemical action which dissolves the gums, I find that if any, the whole of the gums is dissolved, and the material which should have been only partially disintegrated is reduced to its very ultimate fibre, its structure being so thoroughly undermined and broken up as to be unfit for anything requiring fibrous strength, and so finely disintegrated as to be lost in great proportion during the washing out of the dissolved gums. It is an axiom among paper-makers that no fibre will make good paper unless it is long enough to spin; and the reason that rags, though old and often rotton, make better paper than new fibrous vegetable matter, is because such matter is ruined by the harsh treatment to which it is subjected, and reduced so finely that it cannot be handled. Rags are not so reduced. The fibres of all rags are still perfect, undisintegrated structures or substructures, containing gums which have never been dissolved out, and therefore when they are put into the engine it is found that the action of the roll or beater disintegrates or draws out the fibres better than they can be separated by any chemical action. It is plain that if the gums among vegetable fibrous materials are of uniform nature, (and there is no reason to doubt but they are,) (and if the ultimate fibre is to- fine for manipulation or for making into paper except as a part substitute for rags, and this is generally known to be the case,) that when the necessary heat had chemical action are brought to bear, the material, if disintegrated at all, must be disintegrated to- much; that is, it is reduced to pulp too soon, because it
2502 has to be washed; and this is perhaps the reason that so far the making of paper from crude material has not been attended with perfect success. In addition to the waste of fibre which takes place when chemically disintegrated material is washed free of the spent chemical, a second great waste takes place, when white paper is made, in washing out the bleaching solution, which so decreases the yield of white pulp that it often costs much more than the rags would do which it is intended to substitute. In my method of separating crude fibrous material I do not dissolve the gums, nor do I disintegrate the material till after I have washed it. Then, if the object is to make white paper, I only partially disintegrate it preparatory to bleaching it, after which I wash out the bleach and reduce it to pulp in the beating or rag engine, using the engine as a disintegrator and not as a washer, by which means I avoid all waste and produce a better material at a less gross cost; that is to say, I treat a given quantity at a less expense and obtain a greater

quantity of fibre than by a chemically reducing process would be possible, as I do not reduce the material to pulp until all the manipulation is over, and when I have reduced it to pulp I convey it to the paper machine in the water in which it was beaten to pulp, while by all other methods of proceeding the material is boiled into pulp or sought to be so, then placed in the engine to wash it, not to disintegrate it, because it is already disintegrated too much.

I am aware that beating engines have been and are used for washing material which has been previously disintegrated or partially disintegrated by boiling. I am also aware the beating engines are and have been used for further disintegrating rags, cloth, hemp, tow, bagging, &c., which cannot be considered crude fibre, being already to a certain extent disintegrated. I do not claim the use of a beating engine for either of these purposes. But I am not aware that such engines are or ever have been used for
the purpose of separating the fibres of crude vegetable matter,
2503 as such fibres have always heretofore been disintegrated by
boiling and chemical action, so as to have entirely lost their conformation and characteristics before being placed into the beating engine. I am also aware that caustic alkaline solutions have been used for disintegrating and reducing crude vegetable fibrous productions to pulp or to a pulpy mass, in conjunction with heat. I do not claim the use of caustic alkalines for this purpose. But I am not aware that such solutions have ever been used for softening but not disintegrating crude material as a preparatory treatment to its mechanical disintegration. Nor am I aware that any chemical treatment has ever been applied to crude vegetable fibrous matter for the purpose of desicating, condensing, or curing such material, or for the purpose of reducing the cost of transportation of the same as a fibrous material, as I have described, prepared for shipment, storage, and future disintegration.

I do not limit myself to any particular vegetable fibrous production, as all crude fibrous matter may be advantageously treated as I have described. Nor do I limit myself to any particular means for mechanically disintegrating bamboo or other fibrous material which has been prepared for such integration by being softened as I describe. Nor do I limit myself to any particular time for such disintegration, whether before or after washing the softened matter, although I prefer to first wash it for the reasons set forth. Nor do I limit myself to any kind of chemical treatment for the purpose of preparing crude vegetable fibrous material to be baled compactly, when such treatment is for the purpose of destroying insect life or economizing bulk and lowering the cost of transportation, as it would be worth while, for this purpose, to use other chemical agents than alkalies, even though the cost of such chemical teatment was an additional cost to the ultimate product, but I prefer to use alkalies for the reason set forth.

I do not claim broadly the preparation of pulp or disinte-
2504 grated fibre from bamboo or other fibrous production; nor
do I claim the production of balls or bales of cane or bamboo fibre as an article of commerce, except when the same have

been disintegrated mechanically after softening the crude material, as I have described in this and my previous specifications.

I do not limit myself to any particular use for the fibre extracted by my process, as it is equally superior to fibre extracted by other processes for any purpose where fibre is or may be used, whether for paper-making or for the purpose of making soft-felted fabrics, either alone or mixed with other material, or for the purpose of string or rope making, or for textile fabrics. By my process fibres can be extracted from bamboo which can be mixed with linen or silk, or it can be spun and woven alone without admixture with other material.

What I claim as my invention and as new, and desire to secure by letters patent of the United States, is—

1. Subjecting crude vegetable fibrous material to any chemical treatment which softens and shrinks its bulk without disintegrating the same, for the purpose set forth and described, as a new article of commerce.

2. Preparing bamboo or other crude vegetable fibrous matter for transportation and for subsequent disintegration as a fibre-producing material, by means of an alkaline or caustic alkaline solution.

3. Softening and preparing bamboo or other crude vegetable fibrous matter by means of an alkaline solution, when so applied as not to disintegrate the material, but simply to prepare it for mechanical reduction, as fully set forth.

4. The process of disintegrating bamboo or other like crude vegetable fibrous matter, by means of the beating or rag engine or its mechanical equivalent, when such bamboo or other fibrous matter has not been reduced to a pulpy mass by chemical action, or when the material has not been previously subjected to a
2505 treatment which destroys its woody conformation, but has been prepared for mechanical disintegration by being softened in an alkaline solution.

CHAS. HEATON.

Witnesses:
ALEXANDER G. BLACK.
W. S. SWYMMER.

COMPLAINANT'S EXHIBIT RUSSELL AND HOWLAND UNITED STATES PATENT. April 22, 1889. W. T. F., S. E.

UNITED STATES PATENT OFFICE.

ROBERT W. RUSSELL, of Brooklyn, and THOMAS HOWLAND, of Stockport, New York.

Letters Patent No. 70474, dated November 5, 1867.

Preparation of Paper Pulp from Reeds, etc.

The schedule referred to in these letters patent and making part of the same.

To all whom it may concern:

Be it known that we, Robert W. Russell, of the city of Brooklyn, in the State of New York, and Thomas Howland, of Stockport, in Columbia county, in the State of New York, have discovered and invented a new and useful method and process for making paper pulp, papier-maché, and other materials from reeds, cane, bamboo, or hemp stalks, or other vegetable fibrous substances, and a new article of manufacture, that is to say, pulp suitable for the manufacture of paper, papier-maché, box-board, pasteboard, paper 2506 board, felted pulp, and other articles, made from reeds, cane, bamboo, or hemp stalks, or other fibrous vegetable substance, which has been subjected to Lyman's steam-blowing process, and then beaten into pulp, either with or without any treatment with chemicals; and we do hereby declare that the following is a full, clear and exact description thereof:

The cane, reeds, bamboo, or other vegetable fibrous substances, we cause to be first subjected to the steam-blowing process for which a patent was granted by the United States to Azel S. Lyman, on the 3d August, 1858.

We have discovered that the steam-blown material, after being beaten up in a rag engine, without any chemical or other preliminary treatment, will felt, and can be run off into paper, in the same way as paper is manufactured from pulp made from straw, wood, and other fibrous substances which have been boiled in alkaline solutions. This result is due to the fact that the steam-blowing process produces an effect similar to that of the rotting process upon flax straw, and similar to the process of maceration applied to manilla and various other vegetable fibrous substances.

By the steam-blowing process the fibrous substances are partially distintegrated. The heat of the steam changes the nature or condition of the gums or cementing matter holding the fibres together, so that such gums or cementing matter can be easily washed out or otherwise got rid of. The silex is dissolved or softened, and shattered and blown from the fibres, and the pith and other worthless matter is converted into dust, and the intercellular tissue of the vegetable fibrous substances which have been subjected to the steam-blowing process is, by the action of the rag engine, eliminated from the cellulose sufficiently to insure the felting of the fibres, from which the gums and other cementing matter have been washed out. By this simple process a material can be obtained which, on account of its cheapness, will be available for many new manufactures.

We have also discovered that when vegetable substances
2507 which have been subjected to the said steam-blowing process
are to be treated with caustic alkali or other chemicals, for the manufacture of a fine quality of paper or felt, such steam-blown material should be beaten, ground, crushed, or bruised, and washed, before the application of the chemicals.

The beating, grinding, crushing, or bruising, and washing of the steam-blown material may be done in a paper-maker's beating or rag engine, or by any other or well-known and suitable mode of beating, grinding, crushing, or bruising, and washing similar substances. It is convenient to beat, grind, crush, or bruise, and wash the said steam-blown material at one and the same time, but the washing may be done, wholly or partly, after the beating, grinding, crushing, or bruising as aforesaid.

The vegetable fibrous substances having been thus disintegrated and prepared for washing, and having been washed as aforesaid, and thereby deprived of a large part of the acid, gum, gluten, resinous, cementing, coloring, and other worthless and obnoxious matter, can be reduced to superior paper pulp, papier-maché, and other valuable materials, much quicker and more economically, and with the use of a smaller quantity of chemicals, and with a less degree of heat, than would be required if the steam-blown material had not been so prepared and cleansed as aforesaid. The quality of the product is also much better than it would be if the said fibrous substances after being steam-blown as aforesaid, were without such cleansing preparation subjected to a boiling in chemical solutions with such worthless and obnoxious matters, which neutralize a large portion of the chemicals used.

The material thus prepared may be boiled in any of the ordinary chemical solutions used in the boiling of straw, wood, and other vegetable fibrous substances, to convert the same into paper pulp and papier-maché, such as soda-ash made caustic with lime, or the caustic soda of commerce, or soda-ash, or sal-soda, or potash, or caus-
tic potash, or lime, lime water, or milk of lime, according to
2508 the quality of the material to be manufactured. After the
boiling in a chemical solution has been completed, the material is to be treated in the usual way, to be made into paper, papier-maché, and other products.

Prior to our said discovery and invention it was not known that the said steam-blown material could be made into paper without the use of chemicals, and the advantage of the said cleansing process, as a preliminary to the application of chemicals to the said steam-blown material, was not known. But the steam-blown material not having been subjected to the said cleansing process before the boiling in chemical solutions as aforesaid, a small portion only of the acid, gummy, resinous, and cementing matter has been got rid of before such boiling, and the greater part of such matter went into the tank or boiler on such boiling, and absorbed much of the chemicals used therein, besides causing the product to be inferior.

What we claim as our discovery and invention, and desire to secure by letters patent, is—

1. The above-mentioned process of making paper pulp, papier-maché, and other articles from vegetable fibrous substances, disintegrated as aforesaid by the said steam-blowing process, without maceration, boiling or chemicals.

2. The method of treating vegetable fibrous substances which have been subjected to the said steam-blowing process for the purposes aforesaid, by beating, grinding, crushing, or bruising, and washing the same, before the boiling of the same in any chemical solution, substantially as described.

3. The new articles of manufacture above described, that is to say, pulp of different kinds, suitable for the manufacture of paper and papier-maché, box-board, pasteboard, paper board, felted pulp, and other articles made either with or without the use of chemicals, substantially as above described.

Dated 13th August, 1867.

R. W. RUSSELL.
THOS. HOWLAND.

Witnesses:
E. C. HALLIDAY.
WM. P. ARNOLD.

2509 COMPLAINANT'S EXHIBIT ROBBINS & SOUTHMAYD UNITED STATES PATENT. April 22d, 1889. W. T. F., S. E.

UNITED STATES PATENT OFFICE.

LOUIS S. ROBBINS, of New York, N. Y., and JOHN A. SOUTHMAYD, of Elizabeth, New Jersey.

Letters Patent No. 87295, dated February 23, 1869.

Improvement in Preparing Fibre from Bamboo, &c.

The schedule referred to in these letters patent and making part of the same.

To all whom it may concern:

Be it known that we, Louis S. Robbins, of the city, county, and State of New York, and John A. Southmayd, of Elizabeth, in the county of Union, and State of New Jersey, have invented a new and useful improvement in preparing fibre from lignin of bamboo or cane, for the manufacture of textile fabrics; and we do hereby declare that the following is a full, clear, and exact description thereof, which will enable those skilled in the art to make and use the same.

Our invention relates to the development, disintegration, and preparation of the fibre of the bamboo for textile uses and purposes. We prefer the bamboo of the East and West Indies, and similar climates, having ascertained, by actual experiment, that the fibre thereof is stronger, and better adapted for said uses and purposes.

It is already understood that ligneous substances may be reduced to a fibrous pulp by a proper treatment with chemicals, as alkalies and acids, but no process has hitherto been discovered whereby the fibre of cane can be successfully applied to the manufacture of tex-
tile fabrics, as the treatment has not been so conducted as to
2510 obtain a fibre of sufficient length and strength, and otherwise
suitable for such a purpose.

In treating cane heretofore for the purpose of obtaining a pulp, or fibrous material, it has been subjected to the action of steam under pressure, or acids, and for such length of time as it required to soften the knotty joints and tougher portions that grow near the ground; besides no ad*a*quate mechanical means has been employed in connection with the treatment. The consequence has been that in subduing or softening the joints and harder portions of the cane by steam under pressure, or acids, the fibre of the lignin between the joints, which is the only portion that can be used for textile fabrics, has been destroyed for such purpose.

It is absolutely necessary to so commence and pursue the process that all the contained silicious and resenous matter shall be expelled, and that only such portion of the lignin shall be subjected to the process as shall afford the proper and desired fibre. Not only that, but the lignin, either before or after the disintegration of the fibre, should be saturated with oleaginous vapors.

In operating our present invention, we, in the first place removed the knots or joints, and then split the bamboo longitudinally in strips by means of sharp-edged instruments, arranged for the purpose.

After removing the knots or joints, and splitting the bamboo as aforesaid, the lower and tougher portions of the bamboo are separated from the remainder, since the hard and tenacious fibre that grows near the ground requires a treatment which for our present purpose, would be injurious to the upper and more tender parts.

The bamboo is then boiled in caustic alkali of about six degrees (6°) Baumé in an open kettle, until the silicious and gummy matter is softened. This operation requires from six to ten hours, according to the age and quality of the bamboo.

In this part of the process, the time occupied will de-
2511 pend upon the character of the lignin, the tougher and more
tenacious portions requiring the more vigorous treatment.

The next stage in the process is to press the bamboo, while hot, for the purpose of expelling the water, and so much of the silicious and resinous matter as may be held in solution, or combined with the bamboo; also, to prepare it for the subsequent boiling and cleansing processes.

We then again boil the bamboo in a weak solution of caustic soda for about three hours and afterwards for about two hours in soap and water, prepared for the purpose, which cleanses and softens the fibres without reducing it to a pulpy condition, or imparing its strength, which would be the result if longer boiled in caustic alkali.

The bamboo is then washed in hot water, until all the foreign substances are removed from the fibre, when it is prepared for carding, by passing it through a machine hackle constructed for the purpose. It is next subjected to strong and peculiarly constructed cards, which reduce the fibre to a proper condition for spinning.

It is necessary that the fibre be in a moist state during the operation of carding; but if water is employed for that purpose the fibre is weakened, and will be destroyed while passing through the cards. We therefore saturate the fibre with oleaginous vapors, which render it pliable, and lubricate it without imparing its strength. It can then be carded with facility, and a length of fibre retained, of sufficient length and strength to be applicable to and valuable for textile manufactures and purposes.

The fibre may be used either separately or in combination with other substances, for the purposes stated.

Having thus described our invention,

What we claim as new, and desire to secure by letters patent, is—

2512 The process herein described of preparing the lignin of bamboo for manufacturing textile fabrics, substantially as herein set forth.

LOUIS S. ROBBINS.
JOHN A. SOUTHMAYD.

Witnesses:
HIRAM HUSTON,
MARSHALL ROBBINS.

COMPLAINANT'S EXHIBIT SAWYER AND MAN HYDROCARBON TREATMENT PATENT. H. C. M., Special Examiner.

UNITED STATES PATENT OFFICE.

WILLIAM E. SAWYER, of New York, and ALBON MAN, of Brooklyn, N. Y.

Improvement in Carbons for Electric Lights.

Specification forming part of Letters Patent No. 211,262, dated January 7, 1879; application filed October 15, 1878.

To all whom it may concern:

Be it known that we, William Edward Sawyer, of the city, county, and State of New York, and Albon Man, of Brooklyn, county of Kings, and State aforesaid, have jointly invented certain improvements in carbons for electric lights; and we do hereby declare the following to be a description of the same, and of the manner and process of making, constructing, and using them, in such full, clear, concise, and exact terms as will enable any person skilled

in the arts or science to which it appertains, or with which
2513 it is most nearly connected, to make, construct, and use the
same, reference being had to certain letters patent of the United States heretofore granted to us for certain inventions hereunto appertaining, and to which especial reference will hereinafter be made.

Our invention is, first, of a novel process of preparing the illuminating part of an electric lamp, consisting of electrically heating the same while it is surrounded by a carbon liquid; secondly, of a new article of manufacture, consisting of an improved illuminating conductor for electric lamps, composed of consolidated carbon created by electric action; thirdly, of a novel process of preparing the illuminating part of an electric lamp, consisting of first heating the same by means of the electric current while immersed in a carbon liquid, and of subsequently, when the globe containing it is charged with nitrogen gas, and before the flow of such gas through the lamp has ceased, and before the lamp is finally sealed, heating its illuminating part by means of the electric current to drive out impurities or occluded gases.

In letters patent of the United States No. 205,144, granted to us, we have shown and described an electric lamp in which a pencil of carbon is heated to incandescence in a nitrogen or other carbon preservative atmosphere. One of the principal obstacles to successful electric lighting by incandescence is the dissociated character of nearly all obtainable carbon. In most of such carbon there is danger of fracture as well as of the establishment of the voltaic arc; and, furthermore, the carbon, unless specially prepared by our process, naturally occludes sufficient air or oxygen to render its consumption a mere question of time, since, as fully set forth in the letters patent referred to, the least quantity of oxygen in a sealed lamp is sufficient to combust an indefinite quantity of carbon.

As is well known, carbon suitable for electric lighting by the
voltaic arc is naturally produced in gas retorts; but generally
2514 the rods of carbon used in the "regulator-lamps," so called,
are molded from the powdered material. Neither the one nor the other quality of carbon is suitable for electric lighting by incandescence. In both there is a lack of homogeneity. The pencil is not sufficiently hard and dense, because in the first place the heat required to produce the proper character of carbon is as high as 7,000° Fahrenheit, and such a temperature is not obtainable in the retort, and in the second place the mechanical subdivisions of the material and the pressure necessary to produce the perfect article are practically unattainable. Carbons of the ordinary sort, when heated by the electric current, exhibit points and lines of unequal brilliancy. Carbons prepared by our process, when so heated, glow with a uniform brilliancy throughout.

We have found that a pencil of carbon immersed in a hydrocarbon liquid, and heated to an extremely high temperature by the voltaic current, is not itself attacked, but decomposes the surrounding matter, the carbon of which enters and fills up its pores to an extent impossible except with matter in a very attenuated state, and deposits a perfectly homogeneous layer, generally of a bright-gray color, upon the exterior surface. As the carbon increases in size more current is required to maintain its temperature, and if the current is gradually increased, in accordance with the demand for it, there is appearingly no limit to the increase in mass of the homogenous exterior deposit. Carbon pencils may be cut from this deposit, or the original pencil with its coating may be used in the lamps.

In this process it would seem that the carbon is never in contact with the liquid in which it is immersed, but surrounded by a carbonic gas of a very high temperature.

Naphtha, turpentine, beeswax, balsam, and most oils, if pure, operate satisfactorily. Almost any hydrocarbon, in fact, will answer.

We do not confine ourselves to the treatment of carbon
2515 alone, since it is obvious that many infusible substances non-
conductors of electricity may be heated in hydrecarbon liquids so as to render them conductors of electricity—as, for instance, a tube of lime inclosing a pencil of carbon, through which the electric current is caused to circulate.

In the letters patent hereinbefore referred to we have described a method of charging a sealed globe with pure nitrogen gas. We will suppose that the pencil of carbon, held between two carbon pieces of greater mass than that of the pencil, as shown in the said letters patent, is immersed in the hydrocarbon liquid and heated in the manner already described. Being then cleansed in alcohol, the pencil and its holders, without having been disturbed, are placed in the globe, in which they are to be hermetically sealed. The globe is charged with pure nitrogen, and then, while still allowing pure nitrogen to flow into and out of the globe, we heat the carbon to incandescence, thus driving out all impurities and occluded gases, which are carried out of the lamp by the current of nitrogen. With this operation the preparation of the carbon is completed, and the lamp now being hermetically sealed, as described in the letters patent referred to, is ready for use.

In concluding this description we will point out that the preparation and treatment of the carbon must take place in carbon liquid before it is put in the lamp, for if the carbon pencil be put in the globe of the lamp and hydrocarbon gas be present, part of the deposit resulting from its decomposition adheres to the globe of the lamp, making it black, and if the process be long continued the globe becomes so thickly coated as to obstruct the light absolutely; and that part of the carbon deposited upon the pencil-burner, or part of it, at least, instead of uniting with, consolidating, and purifying the pencil, collects in a sooty mass around its upper part, like a "thief" on the wick of a tallow candle, the effect of which is to
greatly impair the light and to practically destroy the lamp.
2516 The lamp becomes inoperative, also, for the additional reason
that the carbon gas being deposited leaves the hydrogen, in which the pencil is soon consumed; but the carbon prepared by our process before it is put in the lamp does not blacken the inner sur-

face of the globe of a lamp charged with nitrogen when heated by the current to drive out occult gases during the ingress and egress of the nitrogen, because in that case there is no carbon gas present, and, of course, no deposit; and we desire, also, to point out the fact that the consolidated homogeneous carbon of our invention may be produced by the electroplating process, as well as by the electrical heating of a conductor in a carbon gas or liquid. The cathode, composed either of solid carbon or of an infusible refactory substance, coated with plumbago or graphite, is immersed in a carbon liquid and connected with one pole of the battery. The other pole of the battery is connected with the anode, composed of solid carbon, also immersed in the liquid. The passage of the current decomposes the liquid, and deposits a homogeneous layer of carbon upon the cathode.

We do not intend to lay any claim to the treatment of a carbon burner after it is made and placed in the globe or illuminating chamber of the lamp, nor as a mere incident of the operation of the lamp as a part of the invention making the subject-matter of this application. We disclaim the treatment of the carbon in that way; but

What we do claim herein as new, and desire to secure by letters patent, is—

1. The method of preparing carbon to be used in the production of electric light, consisting of electrically heating it while surrounded or saturated with or by a carbon liquid.

2. The herein-described method of preparing the illuminating part of an electric lamp, consisting in first obtaining a solid deposit
of carbon by electric action before it is put in the lamp, as
2517 set forth, and subsequently, when the globe containing it is
charged with nitrogen gas, before the flow of the nitrogen through the lamp has ceased, and before the lamp is finally sealed, heating the illuminating part by means of the electric current, in order to expel impurities and occluded gases.

WILLIAM EDWARD SAWYER.
ALBON MAN.

Witnesses:
AMOS BROADNAX.
THOMAS SAULT.

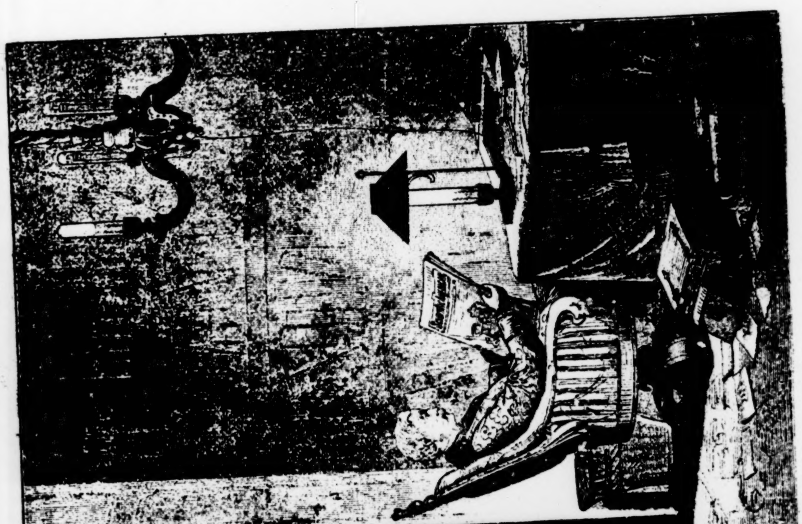
Complainant's Exhibit Scientific American Article.

Published in the Scientific American in New York on December 7, 1878.

The Sawyer-Man Electric Lamp.

The practical usefulness of the electric light for illuminating open spaces and wide areas has been amply demonstrated by the various devices for using the electric arc already widely employed. Hitherto, however, it has not been found economical, or even possible, as we understand it, to construct a lamp or candle, based on

No. 286.
C. E. Light Co. } p. 2518
v.
McK. Light Co.



THE SAWYER-MAN ELECTRIC LIGHT.

the electric arc, that would answer the requirements of ordinary domestic and industrial lighting, where a moderate amount of light, well distributed, easily manageable, and of perfect steadiness and softness, is needed. The electric arc seems, from its very nature, to present insuperable obstacles to the economical production of a large number of small lights in a circuit; in other words, such lights as we require in our dwellings, offices, factories, shops, and the like. And if there were no other means of obtaining light from electricity, the probability of the displacement of gas by it, for the purposes of general illumination, would hardly be worth considering.

(Here follows illustration marked p. 2518.)

2519 The production of light through the incandescence of a pencil of carbon or metal, forming part of an electric circuit and highly heated by its internal resistance to the passage of the electric current, offers an entirely different field for exploration; and though it has long been apparently closed by the failure of early attempts to obtain an electric light by such means, the achieved success of Messrs. Sawyer and Man, not to speak of the reported success of Mr. Edison, clearly indicates that this is the line along which the practical solution of the problem of household illumination by electricity is to come. The lamp, to be described further on, lacks only the practical demonstration of its economy by protracted use on a large scale, to compel acceptance as a successful solution of the problem.

So long ago as 1845, an American inventor, Mr. King, patented here and in England a lamp (said to have been invented by J. W. Starr) involving this principle. His light was produced in a vacuum, to prevent the oxidation of his incandescent carbon or metal, and was extremely promising for its beauty, brilliancy, and steadiness. But it failed to be permanent and economical from various defects and deficiencies, some of which have been removed by the increased power and economy of modern dynamo-electric machines, and by recent advances in the art of subdividing the electric current, but the most of them by the inventions and discoveries covered by Messrs. Sawyer and Man's patents.

The economical division of the current, or more correctly the light produced by a single current—popularly believed to be very difficult if not practically impossible—has been successfully worked out by several American investigators. As long ago as 1875, Mr. Moses G. Farmer, now electrical superintendent of the U. S. Naval torpedo station, at Newport, R. I., subdivided the electric current, produced by a small machine, into forty-two different branches, putting a light to each branch. Mr. Sawyer's system appears to be able to do the same indefinitely through the maintenance of
2520 a uniform resistance throughout the circuit and equal resistances in the several parts of the circuit, as will be shown further on.

The adaptability of this form of electric lighting to the needs of household illumination is indicated in Fig. 1. The light produced is pure, strong, and yet soft, like sunlight. It is, moreover, steady and cool. It is not influenced by air currents; and it does not vitiate the air by poisonous products of combustion, nor by withdrawing the vitalizing oxygen. The lamp takes up less room than the glass shade of a gas jet, and no more than the chimney of an oil lamp. To a limited extent, also, it is portable, and may be used as a drop light. The general appearance of the lamp is shown in Fig. 2 (page 354). The light is produced by the incandescence of the slender pencil of carbon placed as shown in the engraving. The light-giving apparatus is separated from the lower part of the lamp by three diaphragms, to shut off down-ard heat radiation. The copper standards lower down are so shaped as to have great radiating surface, so that the conduction of heat downward to the mechanism of the base is wholly prevented. The structure of the base, full-size, is shown in Fig. 3 (page 355). No detailed description of this portion will be required, further than to say that the electric current enters from below, follows the line of metallic conduction to the "burner," as shown by the arrows, thence downward, on the other side, connecting with the return circuit. The light-producing portion is, of course, completely insulated, and also sealed at the base, gas tight.

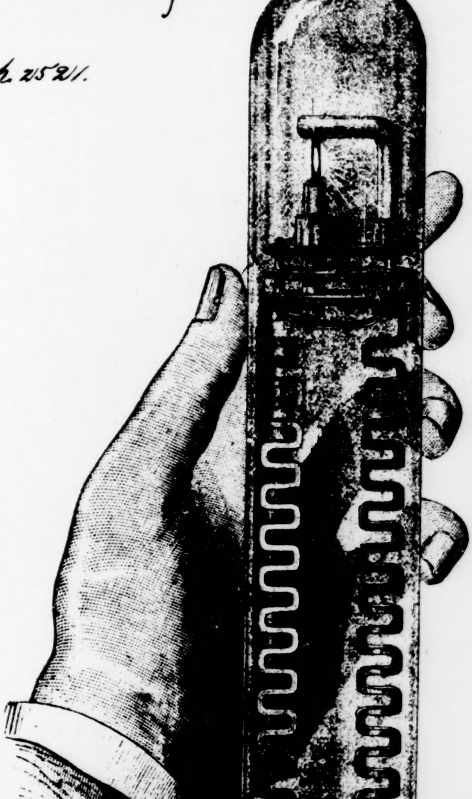
(Here follows illustration marked p. 2521.)

A fatal defect in all previous lamps depending on incandescent carbon has arisen from what has been called the "vaporizing" of the carbon. This Mr. Sawyer holds to be an absurdity, since the carbon is not even fused. The wastage of the carbon in mercurial vacuums, and in atmospheres of compound gas, is due, he holds, to chemical decomposition. Many gases, indifferent to carbon at ordinary temperatures, attack it destructively at temperatures obtained in the electric lamp; and the process is continuous, the carbon 2522 taken from the burner being redeposited on the glass case, and the gas left free to continue its depredation. Mr. Sawyer claims to have overcome this difficulty by his method of charging the lamps with pure nitrogen, and by providing for the fixing of any residual oxygen left in the lamp. In this way an unwasting carbon is secured. Another stumbling block on which other workers in this field have come to grief, has been the crumbling or disintegration of the carbon burner, due to sudden heating when the lamp is lighted. This is avoided in the Sawyer-Man lamp by an ingeniously devised switch, shown in Fig. 4. By this means it is impossible to turn the current on or off suddenly, to the disruption of the carbon. This, however, is not the only nor the chief advantage of the switch. It is, indeed, the key to the entire problem, the indispensable condition, Mr. Sawyer holds, of practical electrical distribution.

It is well known that an electric current will exactly and readily divide among circuits of equal resistance. Accordingly, if the resistance of a subcircuit be maintained constant, no matter what may be going on it, whether a lamp is not lighted at all, or

No. 286.
C. E. Light Co.
v.
McK. Light Co } p. 2521.

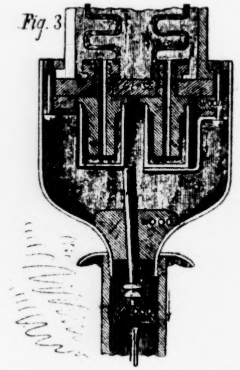
Fig. 2.



THE SAWYER-MAN ELECTRIC LAMP.

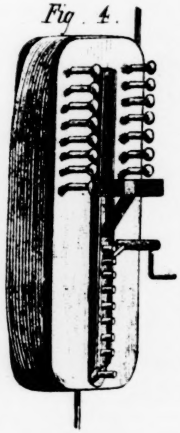
No. 286
C.E. Light Co. v. McK Light Co. } p. 2523

Fig. 3



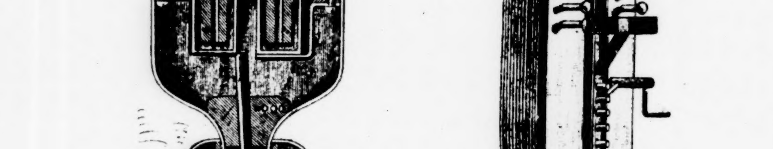
BASE OF SAWYER-MAN LAMP.

Fig. 4.



THE SWITCH.

Fig. 5.


SHUNT B
RESTNº .95 OF AN OHM
31 2/3
.63 1/3
.63 1/3
1.26 2/3
3.8
7.5
1
2
3
4
5
6
7
8
1/4
1/2
5/8
3/4
7/8
15/16
+
A
–
1.9
.38
.25 1/3
.18 2/21
.07 5/21
.06 1/3
LAMP
THE WHOLE CURRENT
REST .95 OHM

PRINCIPLE OF SWITCH.

lighted to a mere taper, or to any intermediate stage up to full brilliancy, it is obvious that no other lamp or lamps in that circuit will be affected. The operation of the switch, in securing such uniform resistance, is shown in the accompanying diagram, Fig. 5 (page 355).

(Here follows illustration marked p. 2523.)

The lamp has, let us say, a resistance of 0·95 of an ohm. Therefore if one lamp is out there should be a resistance of 0·95 of an ohm in its stead. This is the shunt resistance, B. The current enters at the "+" point, and leaves at the "—" point. The contact piece, A, bearing upon the two studs, 1, 1, all the current passes out by way of B. When A is moved to the studs, 2, 2, the current divides, ¼ going through the lamp, the other ¾ by way of B, and the resistance of the combined circuit is $0{\cdot}31\frac{2}{3} + 0{\cdot}95 = 1{\cdot}26\frac{2}{3}$ in the shunt; and $1{\cdot}9 + 0{\cdot}38 + 25\frac{1}{3} + 18\frac{2}{21} + 0{\cdot}07\frac{5}{12} + 0{\cdot}06\frac{1}{3}$ + (the lamp) $0{\cdot}95 = 3{\cdot}8$. The resistance of the circuit is, therefore, $\frac{1{\cdot}26\,2\text{-}3 \times 3{\cdot}8}{1{\cdot}26\,2\text{-}3 + 3{\cdot}8} = 0{\cdot}95$ of an ohm, and so on. In short, the resistance of the circuit is con-
2524 stant at 0·95, no matter what may be the change in the
proportion of the current given the lamp, as may be seen by making the required calculation for each pair of studs. The varying resistances required to give the best effect have been worked out by practical trial. The effect of ¼ the current through the lamp is to make the carbon a dull red. On studs 3, 3, one-half the current passes through, and the carbon become a bright red. On studs 4, 4, the lamp gets ⅝ of the current and becomes white hot. On 5, 5, the lamp gets ¾ of the current, and begins to assume the intense limpid incandescence of the sun; and the light increases rapidly with subsequent changes until the whole current goes through the lamp.

Thus it is seen that the greater part of the illumination is the product of a small part of the current. When the light is well on, a very slight increase in the current increases the light enormously. It is here that the great loss occasioned by dividing a fixed current among several lamps finds its explanation. A current that suffices in one lamp to produce a light, say of 100 candles, will, if divided between two lamps, give in each perhaps no more than 10 candles, or even 5, making a loss of 90 candles in the sum total. But if the current be doubled, each lamp will give a light of 100 candles, and the sum total will be 200 candles instead of 10. Having brought a candle or a system of candles up to the point of feeble incandescence, a (proportionally) small addition to the current will make them all brilliant. If at 6,000° Fah., a given carbon will produce a light of 3 candles, at 12,000° it will give 9 candles, and at 24,000° it will give 81 candles; the illuminating power increasing with vastly greater rapidity than the temperature.

The wires supplying the current may be run through existing gas pipes, each lamp being provided with a switch placed conveniently in the wall; and by simply turning a key the light is turned up or down, off or on. So long as the house is connected with the main it makes no difference to the producer whether all the lights are on or off, since the resistance of the entire 2525 (house) circuit must be overcome; though it will to the consumer, since a meter records the time that each lamp is on, and the charge is rated accordingly. If the Dynamo-Electric Light Company can supply the illuminating force so cheaply that the constant and brilliant illumination of all the rooms of a house can be secured at no greater cost than the partial and intermittent illumination now had from gas, it is obvious that the electric light will score an important point. The cost of lamps and switches, it is claimed, will not exceed that of gas fixtures.

The meter above referred to as shown in Fig. 6. It is a simple clock arrangement, with an attachment designed to throw the dial hands into connection when a light is on. From each switch a pair of conducting wires are run to opposite studs on the wooden disk shown at the top of the figure. When no current passes through the lamp the revolving spring shown in front of the stud-ed disk turns without making any record. When the current is on, one electric connection at each revolution is made through the pins assigned to the particular lamp, the armature of the magnet is moved, and the recording wheel is advanced one notch. This meter does not measure the quantity of electricity passing, but only the time a lamp is on. If two or any larger number of lamps are on, an equal number of connections are made at each revolution of the wheel, and the record wheel is advanced to correspond. This registration is, of course, a mere matter of business detail. In view of the well-founded popular dislike to gas meters, however, it would seem to be desirable to dispense with such devices entirely; and the nature of electric distribution appears to favor other and less objectionable modes and means of determining the financial relations of producers and consumers.

(Here follows illustration marked p. 2526.)

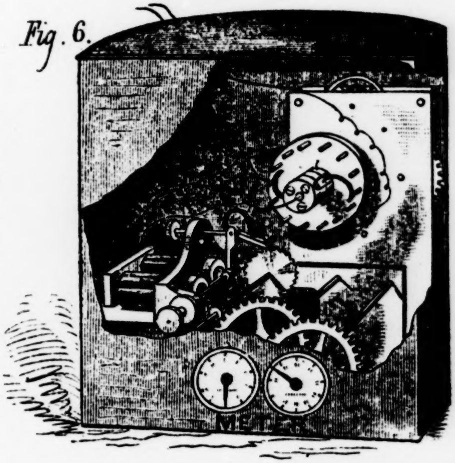
Figs. 7 and 8 indicate the method proposed for general distribution. Where the main is tapped for a subcircuit, a shunt is introduced so as to throw so much of the current as may be needed into the derived circuit. The resistance of say 100 added lamps 2527 will be about 100 ohms. By giving to the shunt a resistance of one ohm, $\frac{1}{100}$ of the current will be diverted, and the lamps supplied. When a large number of lamps are required in a circuit, a combination of the two plans indicated is employed.

The diversion of any portion of the electric supply into an added circuit, whether one house or a group of houses, necessarily increases the aggregate resistance of the electric district, and calls for more work from the generator. To meet such contingencies automatically, Messrs. Sawyer and Man have invented and patented a regulator, which responds instantly to any increase or diminution in the demand, thereby securing an absolutely uniform volume of current.

This regulator so controls the steam or other power actuating the generator of electricity, that the amount of power supplied is in-

No. 286.
C.E. Light Co.
v.
McK. Light Co. } p. 2526.

Fig. 6.



THE SAWYER-MAN METER.

Fig. 7

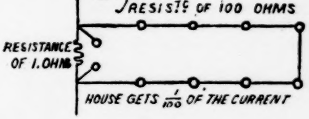

RESIST? OF 100 OHMS
RESISTANCE OF 1. OHM
HOUSE GETS $\frac{1}{100}$ OF THE CURRENT

Fig. 8.

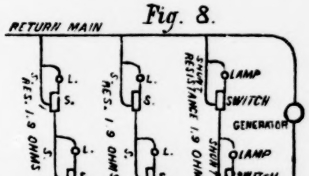

RETURN MAIN
S.
RES. 1.9 OHMS
L.
S.
S.
L.
S.
S.
RES. 1.9 OHMS
L.
S.
S.
L.
S.
SHUNT RESISTANCE 1.9 OHMS
LAMP
SWITCH
GENERATOR
SHUNT
LAMP
SWITCH
OUTWARD MAIN

Fig. 7.—DERIVED CIRCUIT. Fig. 8.—BRANCHED CIRCUIT.

creased or diminished in exact proportion to the demand, either by changing the volume of steam produced, or by coupling on or detaching different generators or parts of a single generator in circuit.

With regard to the cost of this mode of electric lighting no positive figures can be given. It is claimed to be entirely demonstrated that one horse power will give by the Sawyer-Man system of incandescence a light of 30 five-foot gas burners an hour. Where large powers are employed the cost of steam power, every item included, is commonly rated at one cent per horse power per hour. The cost of 150 feet of gas at New York rates is 41 cents, which would make the gas over forty-fold dearer than the Sawyer-Man light. Mr. Sawyer does not stand on this estimate, however, holding that even if the electric light should prove in practice on a large scale to be ten times as costly as calculation indicates, it will yet easily compete with gas, the light furnished being so much better and purer.

It is promised that facilities will soon be offered for the photometric test of a large number of lights, in a circuit, with dynamometric tests of the power employed in generating the electric
2528 supply. This, as already noted, is all that the system lacks to prove itself an accomplished economical fact.

Complainaint's Exhibit, Extract from Philosophical Magazine. C. E. D., Notary Public, May 6, 1889.

I have already shown elsewhere that the current from a small magneto-electric or electro-magnetic machine is sufficient to excite the great electro-magnet of the 10-inch machine; and it has been further found, by my friend Mr. G. C. Lowe, that the current from one small machine is sufficient to excite simultaneously the electro-magnets of several small machines. In a number of 3½-inch machines which have been constructed under my direction for Messrs. Elkington and Co., for the electro-deposition of copper on a large scale, the currents from two 3½-inch electro-magnetic machines are made to excite the electro-magnets of twenty similar-sized machines to a degree sufficient to bring out the maximum dynamic effect of each machine. The electro-magnets of the two 3½-inch exciting machines are charged by the current from a small 2½-inch magneto-electric machine; but I have found that nearly as good a result may be obtained from the twenty machines by dispensing with the small magneto-electric machine, and employing the residual magnetism of the two 3½-inch exciting machines in a manner similar to that described, almost simultaneously, by Mr. Farmer, Messrs. Varley, Mr. Siemens and Sir Charles Wheatstone.

So far I have adverted principally to the means by which a very serious defect in the practical working of the new induction machine was remedied, a defect which many of my friends, who were unacquainted with the efforts which have been made to overcome it, have considered to be fatal to the success of what seemed likely to be a useful invention. But while the
2529 difficulty arising from the heating was now obviated,

the subdivision of the materials of one large machine into a number of small ones gave rise to another defect which it was also found necessary to overcome; for although the armatures of several machines might be driven nominally at the same speed from the said driving shaft, by means of straps, yet when the combined direct current from several commutators was required, the want of perfect synchronism in the revolution of the a-matures operated to produce a diversion of the currents of some of them through the coils of others, which were at the neutral point of their revolution; and consequently the maximum useful effect of the combined currents could not be obtained.

As the high speed at which the machines were driven precluded the employment of toothed gearing, the only method which seemed at all feasible for producing the requisite synchronism of the armatures was to place a number of the machines in a straight line, and connect them together by means of a clutch fixed on the end of each armature spindle. The chief objection to the carrying out of this arrangement was the difficulty of providing the requisite means for preserving the synchronism of the system, when any of the intermediate machines were disabled by accident, or stopped for repairs; so that, practically, it would not have been found convenient to work more than two machines geared together in the manner described.

It was while experimenting with a pair of machines so geared together, that I first observed the phenomenon which forms the subject of this communication. These machines were arranged for producing the electric light, with a view to their application to light-house illumination. The armatures were 4 inches in diameter, and each of them was coiled with a copper-wire conductor, 280 feet long and $\frac{1}{8}$ of an inch in diameter. The currents were taken from the armatures by means of copper brushes rubbing against metal rings connected respectively with the ends of the armature coils, and were therefore in alternate directions. It has
2530 been found that alternating currents are much better
adapted for the production of a constant electric light at a fixed point in space than the current which has been rectified by means of a commutator.

The clutch, by which the armatures were connected, consisted of two iron discs about 4 inches in diameter, having, in the face of one, two iron pins which could be guided into two corresponding holes in the face of the other. These discs could be engaged or disengaged either when the machines were at rest or in motion. The relative positions of the pins and holes in the discs were such that the armatures might be engaged in reversed positions of half a revolution when required.

Each of these 4-inch machines, when making about 2,000 revolutions per minute, was of itself capable of producing a very efficient electric light; and when the two armatures were clutched together in such a position that the united positive currents from both machines proceeded from one polar terminal simultaneously with the united negative currents from the other polar terminal, the sum of the currents of the two machines was obtained. On the other hand, when the armatures were clutched together in the reverse position without any change being made in the armature connections, no current was produced outside the two machines.

These experiments, besides exhibiting the necessity of synchronous rotation, further showed that the armatures must also occupy the same relative position in the magnet cylinders in order that the combined current from the two machines might be obtained. It now occurred to me to see to what extent the want of synchronism in the armatures would affect the magnitude of the current. The armatures were therefore unclutched and allowed to revolve independently of each other, in the same manner as when the attempt was made to take the combined direct current from the commutators. After the alternating current had been transmitted
2531 through the electric lamp for some time, I was surprised to
find that there was no perceptible diminution in the amount of light produced from the carbon points, and that the current would melt very nearly the same quantity of iron wire as when the armatures were clutched together. On examining into the circumstances attending this unexpected phenomenon, I first observed that whenever the machines were stopped, the pins and holes in the respective discs were exactly opposite each other, and that, while the armatures were revolving, the two discs could at all times be engaged and disengaged with the greatest facility. Moreover, even when, before starting the machine, the discs were set a quarter or half a revolution out of the position in which the maximum amount of current was obtained, it was found that after the armatures had been revolving for a few moments, the discs resumed their normal position with respect to each other (as indicated by the action of the clutch), thereby exhibiting not only the synchronous rotation of the armatures, but also that the machines contained a principle of self-adjustment to the position in which the maximum effect of the combined current was obtained. It will, therefore, be evident that this property of the current, to maintain the synchronism of the armatures, renders it unnecessary to employ mechanical gearing of any kind for that purpose.

Proceeding further in this investigation, I found that, in order to produce a synchronous rotation, it was not at all essential that the circuit which conveyed the combined currents for producing the light should be completed, provided that the ends of the coils of each armature were connected respectively with the same metal plates which formed the polar terminals of the machines. In this case the armatures adjusted themselves to their normal positions even more readily than when the current was producing light.

2532 COMPLAINANT'S EXHIBIT EXTRACT FROM GANOT'S PHYSICS.

ELEMENTARY TREATISE ON PHYSICS.

Experimental and applied,
for the use of colleges and schools,

BY

PROFESSOR GANOT.

Translated and edited from the ninth edition.
with the author's sanction,

BY

E. ATKINSON, PH. D., F. C. S.,
Lecturer on chemistry and physics, Royal Military College, Sandhurst.

LONDON:
H. Bailliere, publisher, 219 Regent street. New York: Bailliere Brothers, 440 Broadway. Paris: J. B. Bailliere & Fils, Rue Hautefeuille. Melbourne (Australia): Ferdinand F. Bailliere. Madrid: Bailly Bailliere, Calle del Principe.
1863.

Sections 677–679, on pages 630–635.

677. Luminous effects.—In closing a voltaic battery a spark is obtained at the point of contact, which is frequently of great brilliance. A similar spark is also perceived on breaking contact. These luminous effects are obtained when the battery is sufficiently powerful, by bringing the two electrodes very nearly in contact; a succession of bright sparks springs sometimes across the interval, which follow each other with such rapidity as to produce a con-

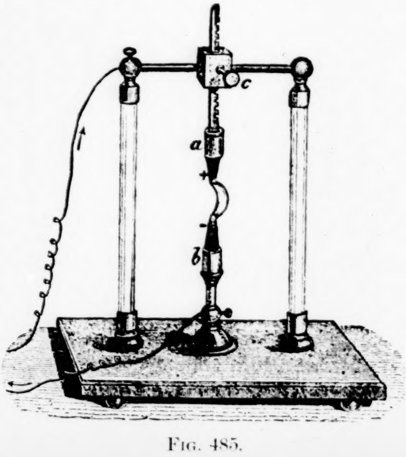


FIG. 485.

tinuous light. With eight or ten of Grove's elements brilliant luminous sparks are obtained by connecting one terminal of the battery with a file, and moving its point along the teeth of another file connected with the other terminal.

2533 The most beautiful effect of the electric light is obtained when with the terminals of the battery two pencils of charcoal are connected in the manner represented in Fig. 485. The charcoal *b* is fixed while the charcoal *a*, can be raised or lowered by means of a rack and pinion motion *c*. The two charcoals being placed in contact the current passes, and their ends soon become incandescent. If they are then removed to a distance of about the tenth of an inch, according to the intensity of the current, a luminous arc extends between the two points which has an exceeding brilliant lustre, and is called the voltaic arc.

The length of this arc varies with the force of the current. In air it may exceed 2 inches with a battery of 600 elements, arranged in six series of 100 each, provided the positive pole is uppermost, as represented in the figure, if it is undermost the arc is about one-third shorter. *In vacuo* the distance of the charcoal may be greater than in air; in fact, as the electricity meets with no resistance, it springs between the two charcoals, even before they are in contact. The voltaic arc can also be produced in liquids, but it is then much shorter and its brilliancy is greatly diminished.

2534 The voltaic arc has the property that it is attracted when a magnet is presented to it; a consequence of the action of magnets on currents.

Some physicists have considered the voltaic arc as formed of a very rapid succession of bright sparks. Its color and shape depend on the nature of the conductors between which it is formed, and hence it is probable that it is due to the incandescent particles of the conductor, which are volatilised and transported in the direction of the current, that is, from the positive to the negative pole. The more easily the electrodes are disintegrated by the current, the greater is the distance at which the electrodes can be placed. Charcoal, which is a very friable substance, is one of the bodies which gives the largest luminous arc.

Davy first made the experiment of the electric light, in 1801, by means of a battery of 2,000 plates, each 4 inches square. He used charcoal points made of light-wood charcoal which had been heated to redness, and immersed in a mercury bath; the mercury penetrating into the pores of the charcoal, increased its conductibility. When any substance was introduced into the voltaic arc produced by this battery, it became incandescent; platinum melted like wax in the flame of a candle, sapphire, magnesia, lime and most refractory substances were fused. Fragments of diamond, of charcoal and of graphite, rapidly disappeared without undergoing any previous fusion.

As charcoal rapidly burns in air, it was necessary to operate *in vacuo*, and hence, the experiment was for a long time made by fitting the two points in an electric egg, like that represented in Fig. 455. At present the electrodes are made of gas graphite, a modifi-

cation of charcoal deposited in gas retorts; this is hard and compact, and only burns slowly in air; hence it is unnecessary to operate *in vacuo.* When the experiment is made *in vacuo*, there is no combustion, but the charcoal wears away at the positive pole, while it is somewhat increased on the negative pole, indicating
2535 that there is a transport of solid matter from the positive to the negative pole.

678. Foucault's experiment.—This consists in projecting on a screen the image of the charcoal points produced in the camera obscura at the moment at which the electric light is formed (Fig. 486). By means of this experiment, which is made with the photo-electric microscope, already described (Fig. 344, page 442), the two charcoals can be readily distinguished, and the positive charcoal is seen to become somewhat hollow and diminish, while the other increases. The globules represented on the two charcoals arise from the fusion of a small quantity of silica contained in the charcoal. When the current begins to pass, the negative charcoal first becomes luminous, but the light of the positive charcoal is the brightest; as it also wears away the most rapidly, it ought to be rather the larger.

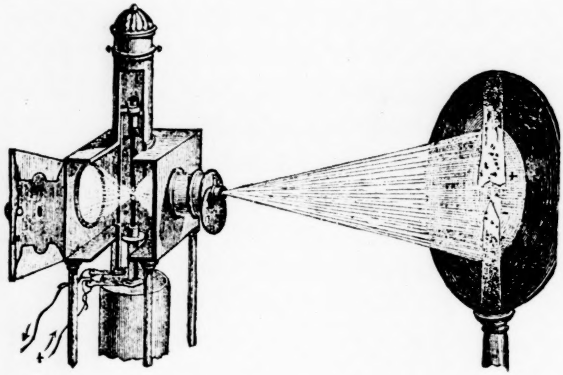


Fig. 486.

679. Regulator of the electric light.—When the electric light is to be used for illumination, it must be as continuous as other modes of lighting. For this purpose, not only must the current be constant, but the distance of the charcoals must not alter, which
2536 necessitates the use of some arrangement for bringing them nearer together in proportion as they wear away. One of the best modes of effecting this is by an apparatus invented by M. Duboscq.

In this regulator the two charcoals are movable, but with unequal velocities, which are virtually proportioned to their waste. The motion is transmitted by a drum placed on the axis, x y (Fig. 487). This turns in the direction of the arrows two wheels, a and b, the

diameters of which are as 1 : 2, and which transmit their
2537 motion to two rack-works, C and C′. The first lowers the
positive charcoal, *p*, by means of a rod sliding in the tube,

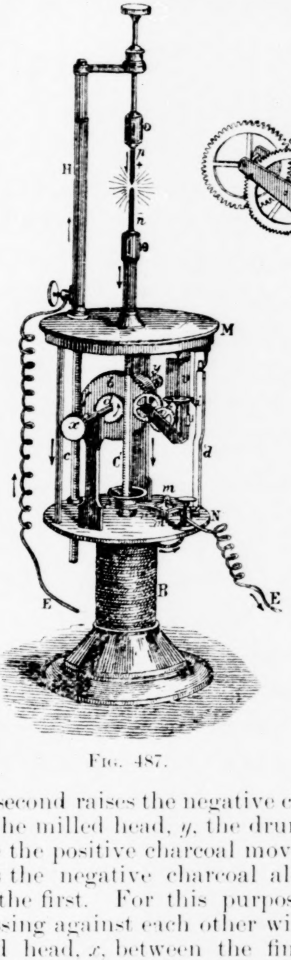


FIG. 487.

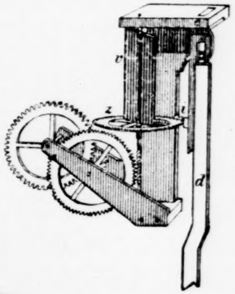


FIG. 488.

H, while the second raises the negative charcoal, *n*, twice as rapidly. By means of the milled head, *y*, the drum can be wound up, and at the same time the positive charcoal moved by the hand; the milled head *x*, moves the negative charcoal also by the hand, and independently of the first. For this purpose the axis, *x y*, consists of two parts pressing against each other with some force, so that holding the milled head, *x*, between the fingers, the other, *y*, may be moved, and by holding the latter the former can be moved. But the friction is sufficient when the drum works to move the two wheels *a* and *b* and the two rack-works.

The two charcoals being placed in contact, the current of a powerful battery of 40 to 50 elements reaches the apparatus by means of the wires E and E′. The current rising in H, descends by the positive charcoal, then by the negative charcoal, and reaches the apparatus, but without passing into the rack-work, C, or into the part on the right of the plate, N; these pieces being insulated by ivory discs placed at their lower part. The current ultimately reaches the bobbin B, which forms the foot of the regulator, and passes into the wire E′. Inside the bobbin is a bar of soft iron, which is magnetized as long as the current passes in the bobbin, and demagnetized when it does not pass, and this temporary magnet is the regulator. For this purpose it acts attractively on an armature of soft iron, A, open in the centre so as to allow the rack-work C′ to pass, and fixed at the end of a lever, which works on two points, *m m*, and transmits a slight oscillation to a rod, *d*, which, by means of a catch, *i*, siezes the wheel, *z*, as is seen on a larger scale in the figure 488. By an endless screw, and a series of toothed wheels, the stop is transmitted to the drum, and the rack-work being fixed, the same is the case with the rack-work. This is what takes place so long as the magnetisation in the bobbin is strong enough to keep down the armature, A; but in proportion as the car- 2538 bons wear away, the current becomes feebler, though the voltaic arc continues, so that ultimately the attraction of the magnet is no longer equivalent to a spring, *r*, which continually tends to raise the armature. It then ascends, the piece *d* disingages the stop *i*, the drum works, and the charcoals come nearer; they do not, however, touch, because the intensity of the current gains the upper hand, the armature A is attracted, and the charcoals remain fixed. As their distance only varies within very narrow limits, a regular and continuous light is obtained with this apparatus until the charcoals are quite used.

By means of this regulator, M. Duboscq illuminates the photogenic apparatus represented — Fig. 344, by which all the optical experiments may be performed for which solar light was formerly necessary.

Complainant's Exhibit Muspratt's Chemistry Extract. April 22, 1889 W. T. F., S. E.

Chemistry, Theoretical, Practical, &c., by Dr. Sheridan Muspratt, published at London, Glasgow, and New York, vol. 2, page 642.

Very little information can now be obtained of the invention and early progress of the art of paper-making. The earliest accounts do not agree, either in regard to date or place; but all point to the East as the seat of the discovery, leaving almost no doubt that the principle of the modern art of reducing vegetable fibre to a liquid state is a Chinese invention. * * *

The paper produced resembles what is commonly termed flimsey, but takes a finer and more delicate impression from copper plates, and is known by the name of India proofs. A small quantity of it is used in this country for the finest engravings. It is generally made of the inner bark of the bamboo and cotton tree.

2539 In the United States Patent Office.

Edison vs. Maxim vs. Swan. } Interference. Electric Lamps.

In pursuance of the annexed notices the parties to the above interference attended before me on the day herein named by attorney as follows: Joseph Wilson Swan by H. A. Seymour, L. L. Leggett, L. W. Serrell, and W. M. C. Witter, counsel. Thomas A. Edison by Richard N. Dyer, counsel.

WM. H. MEADOWCROFT,
Notary Public, N. Y. Co.

Thomas A. Edison, a witness produced in his own behalf, being duly sworn testifies as follows, in answer to questions proposed to him by Richard N. Dyer, counsel for Edison:

1 Q. What are your name, age, residence and occupation?
A. Thomas A. Edison, residence New York, occupation inventor, age thirty-six.
2 Q. The first issue in this interference is "A carbon formed from a straight strip of card-board, paper, or parchment paper, bent to the form of an arch, hoop or loop and carbonized by heat while in a bent condition substantially as set forth." When did you conceive the invention set forth in this issue?
A. About August, 1877.
2540 3 Q. What did you then do? What trial, if any, did you then make of this invention?

Objected to as leading.

A. I made a lamp in August, 1877, containing a strip of carbon in the form of a horseshoe which had been previously cut straight from card-board paper bent in the form of a horseshoe or arch and carbonized while in that condition. This arch of carbon was placed in clamps and put under the bell-receiver of an air pump and the air exhausted therefrom and the carbon brought up to incandescence by the passage of the electric current through the same.
4 Q. Are you sure this was in 1877?
A. Yes.
5 Q. When next did you use this invention?

Objected to as leading.

A. About November, 1878.
6 Q. Please state what you did then.
A. We tried experiments over again with various materials.
7 Q. State the next definite use of this invention.

Objected to as leading.

A. We continued these experiments at different times up to

October, 1879, when they were successful, the conditions being attained necessary to render the incandescent conductor suitable and of commercial value.

8 Q. Please state more fully the nature of the success attained in October, 1879.

A. At that time we had conducted the experiments by means of a Sprengel pump, instead of the old hand air pump, and used a vessel made entirely of glass, through which the wires passed connecting the terminals of the filament of carbon, instead of the ground joints and cemented joints previously used upon the old air pump. Under the new conditions a very high *vacuo* was obtained which was on account of the chamber being entirely of glass, permanent. With the old air pump and ground joint a vacuum could not be made high enough to prevent the destruction of the 2541 carbon, and it could not be maintained after obtaining a partial vacuum.

9 Q. Did the lamps made in October, 1879, answer in all particulars the first issue of this interference?

Objected to as leading, the witness not having as yet stated that he made any lamps in 1879, and further objected to on the ground that the witness will state the facts and the office will determine whether or not those facts embrace the issue.

A. A number of lamps were made in October, 1879, and in November, 1879, which contained a carbon formed from a strip of cardboard, paper, and parchment paper bent to the form of an arch or loop or horseshoe and carbonized by heat while in a bent condition.

10 Q. Have you any records of the manufacture of such lamps embodying the first issue of this interference, and if so, please state what they are.

A. I have here exhibits which have been photographed from my laboratory note book. These exhibits are photographs from pages 131, 133 and 135. No. 32 was a lamp made from a strip of paper $\frac{1}{32}$ of an inch wide and three inches long, bent to the form of a loop and carbonized. No. 33 was made from card-board paper, .043 wide, .010 thick, 3.312 long bent in the form of a loop and carbonized. No. 37 consisted of a strip of card-board paper, three inches long, and one-sixteenth of an inch wide, bent in the form of a loop and carbonized. No. 41, the same. On page 135 there are two dates—one, November 10th at top of the page, and in the middle of the page, November 11th. Under the latter date is shown a piece of paper ready to be carbonized which had been cut out of a piece of card-board and not cut out as a straight piece of paper and bent over to form a loop. The sketches on pages 131 and 133, although not dated, I am sure were made within one or two days of the sketches on page 135 which are dated.

2542 Attorney for Swan objects to the last answer and also objects to the photograph exhibits referred to, on the ground that these exhibits are not the best evidence, and demands that if the witness intends to establish a fact by his original note book, that book must be placed in evidence that the office may be enabled to determine its value and the genuineness of the matter now referred to and claimed to be found on certain pages of this record. It is insisted that it is bad enough to be obliged to run the gauntlet of Mr. Edison's voluminous library but to be concluded by photographs claimed to represent certain pages of some certain book, Swan's attorney enters his earnest protest and will object to any such exhibits or any testimony thereon.

11 Q. What is the number of this note book and of what set of books does it form a part?

Objected to because the note book is not in evidence.

A. The number of the book is 52. It is one of a series of laboratory note books kept by me and my assistants, and this book contains a large number of notes relating to experiments not related to this case.

12 Q. By whom was this particular note book kept, more particularly?

Objected to for reason last stated.

A. Almost entirely by one of my assistants named Charles Batchelor. The exhibits marked 131, 132, 133 and 135 are in his handwriting.

(The photographs referred to are put in evidence and marked "Edison's Exhibit First Issue A," "B," and "C," respectively.)

13 Q. Please look at the paper now handed you and marked "Edison's Exhibit First Issue, A," and state what it is?

2543 A. It is a photograph of page 131 of my note book No. 52.

14 Q. Have you compared this exhibit with the original page of your note book of which you say it is a photograph, and if so, state whether it is a correct copy of the said page and of all of it?

A. I have so compared and it is a correct copy of said page and of all of it.

15 Q. Please look at the paper now handed you and marked "Edison's Exhibit First Issue, B," and state what it is.

A. It is a photograph of page 133 of my note book No. 52, and is a correct copy of that page and all of it.

16 Q. Please look at the paper now handed you and marked "Edison's Exhibit First Issue, C," and state what it is.

A. It is a photograph of page 135 of my note book No. 52 and is a correct copy of such page and all of it.

(It is here stated by counsel for Edison that, since the note book referred to is a book of original notes and contains memoranda of many matters not bearing upon the issues in this interference and of great importance to Mr. Edison, it is not desired to relinquish the custody of the original book itself; but such book is hereby tendered to counsel for Swan, for the purpose of making an examination of the pages referred to, bearing upon the subject-matter of

this interference, and for such other examination as they may desire to make to satisfy themselves of its authenticity. But it is now stipulated by and between the parties in the interference that the photographs referred to and marked "Edison's Exhibits First Issue, A," "B," and "C," respectively be received in evidence in lieu of the pages of the original note book, of which they are photographic
copies, with the understanding that such original note book
2544 be produced at all the hearings in the case, and also be subject to the examination of counsel for Swan for the purpose of cross-examination.)

17 Q. How do these pages of which Exhibits A, B and C are photographs occur in the original note book?

A. They have alternate numbers on them, there being nothing on the back of pages 133 and 135, and only some figuring on the back of page 131. The back of 131 is No. 132, the back of page 133 is 134, and the back of page 135 is 136.

18 Q. What do the numbers 32 to 41 inclusive on these pages indicate?

A. The number of the carbon filament, of proposed lamp, or lamp.

19 Q. Please state what your method of numbering was?

A. Our method was to number the filaments and if they were successfully carbonized and placed in a lamp the number became the number of the lamp.

20 Q. Please state whether or not you recollect if any carbons and clamps corresponding to the sketches in exhibits referred to were embodied in working lamps?

A. We made lamps with all the different kinds of clamps shown in the exhibits.

21 Q. Please explain the construction of carbons shown at the foot of Exhibit C, and in what respect it differs from those shown above in the same exhibit and in the preceding exhibit?

A. This form of filament was cut by means of knives in a steel mould of the shape of the filaments. Previously we had marked straight stripes by means of a pencil and cut them out with scissors and knives and bent them in the form of arches and carbonized the same, but in the filaments shown at the bottom of Exhibit C, the filament was not bent after being cut straight but was cut as shown direct from the paper.

2545 22 Q. About how many working lamps do you think you made in October and November, 1879, as stated by you embodying the first issue of this interference?

A. I think as many as twenty.

(Objected to on the ground that the witness should state the facts and the office will determine whether those facts come within the issue.

Notice is hereby given by counsel for Edison that motion will be made to amend the preliminary statement so far as it relates to the first issue to correspond with evidence already given by Mr. Edison.

placing the date of use of the invention set out in the first issue back to August, 1877.

Counsel for Swan gives notice that he shall object to any testimony tending to antedate the date set up by Mr. Edison in his preliminary statement, and further that he shall object to the amending of such statement on the ground of undue delay in making the application.)

23 Q. The second issue of this interference is "A carbon for an electric lamp made of carbonized parchment paper." When did you conceive this invention?

A. August, 1877. Carbonized parchment paper was used in an incandescent electric lamp under the same conditions as the lamp before testified to in the first count of the interference.

(Objected to as contradicting and tending to antedate the facts set up in the preliminary statement.)

24 Q. What was the nature of this lamp and where is it now?

(Objected to as the witness has not yet testified with reference to any particular lamp as embodying the second issue.)

A. There were two kinds of lamps, one of which consisted of an
air pump, its base and a bell-jar cover; through the base of the air-
pump two wires or connections were passed from the ter-
2546 minals, over which the bell jar was placed and the air ex-
hausted. Between these terminals strips of straight and bent
strips of carbonized card-board paper and parchmentized paper were secured and through which the current passed to bring them to incandescence. One of the apparatus used at that time is, I believe, used as an exhibit in the case of Sawyer and Man *vs.* Edison, and is now in the Patent Office. This exhibit consisted of a spherical chamber of glass with metallic ends which formed a part of the terminals and having a base with a stop-cock so arranged as to be placed over inlet tube of an exhaust pump with the air exhausted from the globe.

25 Q. Have you made further use of carbonized parchment paper for the carbons of electric lamps; if so, please describe such use.

(Objected to as leading and not warranted by the testimony of the witness as thus far given.)

A. In 1878, about November or December, I again used parchmentized paper for forming carbons for electric lights, and in October and November, 1879 made lamps containing flexible filaments of carbon made of parchmentized paper.

(Objected to as not being warranted by the preliminary statement, no statement having been made therein that the witness made any use of this invention prior to the filing of Swan's application, except a single alleged use in August, 1877.)

26 Q. Look at the paper now handed you and marked Edison's Exhibit Second Issue, D, and state what it is.

A. It is a photograph of page 107 of my laboratory note book No. 52.

27 Q. Please compare this exhibit with the original page of your note book which you say it is a photograph of and state whether it is a correct copy of the said page and all of it.

2547 A. I have compared the photograph of page 107 with the original in the book and find it to be the same, and contains all of the original. I will mention that I find the following "D. N. C., M'ch 23, '83," which I suppose is the mark of the photographer, both on the original and photograph.

28 Q. Please look at the paper now handed you and marked "Edison's Exhibit Second Issue, E," and state what it is.

A. It is a photograph of page 117 of my laboratory note book No. 52. I have compared the photograph with the original and find that it is an exact copy and contains all there is in the original and the photographer's mark.

29 Q. Please look at the paper now handed you and marked "Edison's Exhibit Second Issue, F," and make the same statement about it.

A. It is a photograph of page 169 of my laboratory note book No. 52. I have compared the same with the original page and find it is an exact copy of the same, and contains all that is on the original and has the photographer's mark.

These photographs are put in evidence and marked as described, and the same stipulation is entered into with respect to these exhibits as with regard to Exhibits A, B and C.

30 Q. What bearing does Exhibit D have upon the second issue of the interference?

A. I find that in Exhibit D there is mentioned that a lamp was made of vulcanized fibre which is paper parchmentized by means of chloride of zinc; I may mention that while all these exhibits were written by Mr. Batchelor they were done so under my instructions, he merely carrying out my instructions in trying the experiments; I refer to the Exhibits F, second issue, E, second issue, D, second issue, C, first issue, B, first issue, and A, first issue.

Objected to as not warranted by preliminary statement.

2548 31 Q. At what date was this lamp of vulcanized fibre made?

Objected to as not warranted by the preliminary statement.

A. About October 21st, or it might have been the 20th, 1879.

32 Q. I refer to the lamp described in Exhibit D; state why you give a different date for the making of such lamp from the date of the exhibit.

Objected to as Exhibit D does not describe a lamp of any kind.

A. For the reason that we could not have made all of these exhibits in one day, and from a strong impression gained from the exhibit that the lamps were made within one or two days of the date of the exhibit.

33 Q. Please describe the construction of the lamps made from the various materials stated in Exhibit D.

A. The lamps consisted of a globe of glass through which the platinum wires were sealed, upon the ends of which were secured the filaments of carbon, the globe being exhausted by means of a Sprengel pump to high *vacuo*, the carbon being heated to incandescence while being exhausted and afterwards sealed by fusion of the glass practically the same as the present lamp.

34 Q. Please state what bearing Exhibit E has upon the second issue of this interference.

A. This exhibit shows different materials which were carbonized under certain conditions, to investigate the phenomena of carbonization, among which is vulcanized fibre, being paper parchmentized by chloride of zinc. This was an investigation only.

35 Q. On what date about was this investigation made?

A. Either on the same day or the day previous to the date contained in the exhibit, October 27th, 1879. I may mention
2549 that all the experiments recorded in these exhibits were made
always within one or two days of the date contained thereon.

35 Q. Please state what bearing Exhibit F has upon the second issue of the interference?

A. Exhibit F shows the record of lamps made with their various numbers and what the carbons were made from. For instance, lamps Nos. 79 and 80 were made from Crane's parchment paper No. 56, lamps Nos. 81, 82 and 83 were made from Crane's parchment paper No. 44. Sample books of parchmentized paper made by the manufacturer Crane were obtained, and from the different samples in the book filaments were cut and carbonized. These lamps were good and commercial lamps.

(Objected to as embracing matter not warranted by the preliminary statement.)

36 Q. What was the construction of the lamps described in Exhibit F?

A. The construction was substantially the same, in fact was exactly the same, as in my patent No. 223,839 of January 7th, 1880, filed November 4th, 1879, except the filament was in the form of a horseshoe and clamped in platinum clamps.

(A copy of the patent referred to in the answer is put in evidence and marked "Edison Exhibit Second Issue, G." It is now stipulated that copies of patents may be used in evidence by either side the same as regular certified copies.)

37 Q. Have you preserved any of the parchment paper like that used by you in 1879?

A. Yes, sir.

38 Q. I call your attention to a piece of paper marked "Edison's Exhibit Second Issue, H;" please state what this is?

A. It is a piece of parchment paper with the blanks marked
2550 on it which were to be cut out by a knife or scissors, the
blanks being placed between the steel molds the shape of the filaments required, and cut, and then afterwards carbonized and placed in lamps. This mold, I think, was used in December, 1879. Possibly it might have been used in January, 1880. I do not think we used this mold after January, 1880. But my assistants, who will testify in this case, will probably be able to remember better than I. A number of filaments cut from carbonized paper, and from this form, were made and placed in electric lamps and worked; the lamps were good lamps.

39 Q. Where was Exhibit H found?

A. It was found by my assistant, Martin Force, in the case at my laboratory containing old apparatus used in the early stages of electric lighting.

Objected to.

40 Q. Where is Charles Batchelor in whose handwriting Exhibits A to F are written?

A. He has been residing at Paris, France, since July or August, 1881.

A copy of caveat No. 93 of Thomas A. Edison entitled "Improvement in electric lighting," dated December 17th, 1879, filed December 22d, 1879, is put in evidence and marked "Edison's Exhibit Second Issue I," it being stipulated that said copy shall be received in evidence with the understanding that the original or a certified copy thereof be produced at the hearing.

41 Q. I call your attention to your caveat 93 filed December 22d, 1879, a copy of which I hand you. What bearing has this caveat on the second issue of the interference?

A. On page 8 of a copy of this caveat it is stated that vulcanized paper which is paper may be used. Vulcanized fibre is paper parchmentized by means of saturated solution of chloride of zinc
which performs the same operation as sulphuric acid. Lamps
2551 were made in October, November and December of parchment paper parchmentized both by sulphuric acid and chloride of zinc and these lamps worked very perfectly and were good practical lamps and nearly as good as we make them now, the only improvement made since that time being in the refinements of manipulation.

Objection is made to that part of above answer which relates to the manufacturing of lamps as not warranted by the preliminary statement and contradicting it in effect.

By consent the direct examination of the witness is postponed.

Continued on page —.

Pursuant to adjournment, the taking of testimony on behalf of Edison is continued this 24th day of May, 1883, at 10.45 a. m.

Present: W. C. Witter and H. A. Seymour for Swan, and Richard N. Dyer for Edison.

Direct examination of THOMAS A. EDISON resumed:

42 Q. Have you, since 1879, made and used electric lamps provided with carbons formed from straight strips of card-board, paper, or parchment paper, bent to the form of an arch, hoop, or loop, and carbonized by heat while in a bent condition, and, if yea, to what extent has such manufacture and use been continued?

A. I have at various times, since 1879, made lamps of which the filament of carbon was formed of paper, parchment paper, wood, and other materials, cut straight, and bent in the form of a loop, and carbonized while so bent. I think I made, in the latter end of 1880, as many as 300 such filaments of vulcanized fibre or parchment paper (question here repeated) which were cut straight
2552 and bent in the form of a loop and carbonized and these carbons were used in electric lamps. I have, at various times, made a dozen or so lamps containing filaments cut straight, bent in the form of a loop, and carbonized. In fact, all our lamps, that is to say, the principal portion of all our lamps, contain filaments cut straight, bent in the form of a loop and carbonized.

43 Q. Were any carbons made in this way by you between 1879 and the latter end of 1880, that is, by cutting straight strips of card-board, paper, or parchment paper, bending in the form of a loop, and then carbonizing, as stated in my previous question?

A. Yes, sir; my assistants made lamps containing strips cut straight and bent in the form of a loop, and carbonized while so bent, at various time in 1880.

44 Q. To what extent has this practice been continued since 1880?

A. We have made at least 250,000 lamps containing filaments cut straight, bent in the form of a loop, and carbonized while so bent.

45 Q. Have you, since 1879, made and used electric lamps provided with carbons made of carbonized parchment paper, and, if yea, to what extent has such manufacture and use been continued?

A. At various times since 1879 I have made lamps formed of a filament of parchmentized paper. In the latter part of 1880, we started to make a large number of lamps containing a filament of carbon made from parchmentized paper, and obtained specially prepared parchmentized paper from a company called the Vulcanized Fibre Company, which has its works, I believe, at Wilmington, Delaware. Previous to this, at different times, we had used vulcanized fibre, which is parchmentized paper parchmentized by chloride of zinc, but the lamps did not have as long a life as those made from bamboo, on account of the impurities which were in the paper. In the latter end of 1880, we prevailed upon the Vulcanized Fibre Company to make a number of very thin sheets of parch-
2553 mentized paper, with as much of the impurities washed out as was possible by their process. We cut a large number of filaments from this stock, carbonized them, and made lamps, but the life of such lamps was not equal to those of bamboo. In 1882,

about July, I started to produce paper parchmentized by various chemicals, with a view of obtaining a quality superior to that salable in the market, with a view of using the same instead of bamboo, which is variable in its nature and quite costly. I made a great number of samples of such paper, and carbonized the same, but it was not equal to the bamboo. I have been engaged in parchmentizing paper, and other forms of cellulose, for the last six months, with a view of obtaining raw stock from which to cut the filaments of carbon, which would be superior to bamboo, the material we now use.

46 Q. To what extent had you made and used incandescent electric lamps prior to the 20th day of July, 1880?

A. I had made as many as five or six hundred. In January, 1880, I made an exhibition in Menlo Park to the public, wherein I lighted my laboratory, machine shops and two or three houses, one of which was my own house, about one thousand feet from the laboratory, and had ten or fifteen street lights containing incandescent electric lamps containing filaments of carbon. We continued to make them as fast as we had facilities from January, 1880, and before that time and since.

Cross-examination by W. C. Witter, counsel for Swan:

47 X Q. About how many patents on subjects other than the issue of this interference did you take out between October, 1879, and May 27th, 1881, and how many applications for patents did you make between those dates, patents for which were not issued prior to May 27th, 1881, or are still pending. And how many caveats during the same period. In making this answer you are at liberty to refer to any documents which you desire to refer to, and to aid you in the matter, I had you a pamphlet, entitled "Sixth 2554 Bulletin of the Edison Electric Light Company," on the sixth page of which I find the following language: "The following is a list of the first eighty-one patents for electric lighting issued to Mr. Edison in the United States with the number, date and title of each."

Objected to as incompetent, immaterial and irrelevant.

A. Perhaps as many as five or six patents and applications, perhaps two caveats. It would take some time to ascertain the exact number.

48 X Q. I find in the list given on page six of the pamphlet, handed you, twenty-three patents were issued to you between those dates. Will you look at the pamphlet, and see if you are not satisfied that twenty-three patents were issued between those dates?

A. I understand your question to mean the number of patents applied for and obtained between the dates you named If you mean the number of patents issued to me between those dates, I find in the list, which you have handed me, twenty-three patents were issued between the dates named.

49 X Q. You believe that to be a correct statement, do you not?

A. Yes, sir.

50 X Q. Will you now state how many applications for patents you made between those dates exclusive of the applications for patents which are enumerated in the list handed you in the pamphlet.

A. I will look at my books if counsel desires, but will state that there might have been six or there might have been twenty; I cannot say positively without referring to my books.

51 X Q. I should like to have you look at your books and answer the question pretty closely.

A. I find by reference to my list that one hundred and seven patents and applications and ten caveats were made between those dates, but I think some of the applications were allowed and are included in the twenty-three patents which we have just spoken of.

2555 52 X Q. Does the number which you have now given, include your foreign applications?

A. No, sir; American applications.

53 X Q. Was it your practice to apply for foreign patents in all cases where you applied for American patents?

A. No, sir.

54 X Q. In what proportion of the cases did you apply for foreign patents between the dates named. Please answer approximately?

A. I should say eighty-five per cent.

55 X Q. You applied for an English patent on or about November 20th, 1879, patent for which was issued and numbered 4576 did you not?

A. Yes, sir.

A printed copy of same is here offered in evidence marked "Swan's Exhibits Edison's English Patent 4576."

56 X Q. You also applied for an English patent on or about December 15th, 1879, patent for which was issued and numbered 5127, did you not?

A. Yes, sir.

A printed copy of the above patent is put in evidence and marked Swan's Exhibit Edison's English Patent 5127.

57 X Q. On or about December 11th, 1879, you made an application for a patent in the United States did you not, in which you described the mode of manufacturing carbons by cutting them with dies in the shape in which they were to be carbonized and then carbonized them?

A. Yes, sir; I believe I did.

58 X Q. That application contains the following language, does it not. "I make use of paper of the desired thickness as free as possible from foreign substances or adulterations, and for this purpose I prefer and use 'bristol-board.' With suitable instruments, such as a punch and die, I cut out a narrow strip of this paper, pref-

erably in the form of an elliptical bow or an arc of a circle,
2556 the ends of the strip being by preference wider than the other
portions. A number of these pieces of paper are laid flatwise in the bottom of a mould, preferably of wrought iron, and there is laid on them a light weight in the form of a flat piece of gas-retort carbon or other device that will not be distorted by the heat. If several of these are laid one on the other in the mould, a piece of tissue paper is interposed between each one and the next. A cover is used to close the mould and the mould is raised very gradually to a temperature of about 600 degrees Fahr. This allows the volatile portions of the paper to pass away and at the same time the mould retains the paper in its proper shape and the paper is prevented from curling up or becoming distorted as it would be likely to do if the heat was applied suddenly, or the light weight dispensed with. The mould is now placed in a furnace and heated almost to a white heat and then removed and allowed to cool gradually. Figure 5 is the paper blank before it is carbonized. The blank *a* is cut out of paper material such as 'bristol-board,' in the proper shape, the form shown in figure 5 is preferred, the same is laid in the metal mould *b*, and when several are laid one on the other, pieces of this paper are introduced between. The weight *d* is laid on these; it is to be heavy enough to prevent the paper curling up under the action of the heat, but it allows the paper to contract as the volatile matters are expelled by the heat. This weight *d* is of gas-retort carbon. The cover *e* is placed on the mould and secured, and the mould is heated as before described."

This question and all previous questions relating to this application are objected to by counsel for Edison, as incompetent, immaterial and irrelevant.

A. Yes, sir; if the paper I read from is correct.

59 X Q. Have you any reason to think it is not correct?

A. No, sir.

2557 60 X Q. Corresponding language is found in the English
patent No. 5127, copy of which is just put in evidence, is it
not?

A. It is the same.

61 X Q. Figure 5, referred to in the United States application, was the same as figure 5 of the English specification, was it not?

A. Yes, sir.

62 X Q. At the time of applying for an English patent in November, 1879, copy of which is put in evidence as number 4576, you also applied for a United States patent covering substantially the same ground, did you not?

A. Yes, sir.

63 X Q. With the exception of these two applications, did you make any other application for any kind of a paper carbon till you filed the present application in May, 1881?

A. Yes, sir; patent 239,372 refers to paper carbons; also an application filed October 30, 1880; also patent No. 239,151, filed November 24th, 1880; also an application December 15th, 1880.

64 X Q. State briefly what the applications of October 30 and December 15th, 1880, were about?

Objected to as incompetent, immaterial and irrelevant, and the witness is instructed that he need not answer the question.

A. Electric lamps.

64½ X Q. Have they anything to do with the issues of this interference? If so, what?

A. Nothing more than that when I made an application for a patent for an incandescent conductor made of paper, I did not suppose it was necessary to file an application for every variety of paper, red, blue, green, parchmentized, manilla, bamboo or other kinds of paper. These applications speak of an incandescent conductor of paper, and in that respect do not exactly meet the count in this interference.

2558 65 X Q. In what other countries was it your habit to make applications for patents for inventions, patents for which were applied for in the United States?

Objected to as incompetent and immaterial.

A. Most all countries that have patent laws.

66 X Q. What is the number of the present application for a patent in this interference, and what does that number signify?

A. It is number 311. It signifies that it is the number of applications up to that date taken by me in the last ten years.

67 X Q. I see that the caveat, copy of which was put in evidence by you, called Caveat I, second issue, March 26th, 1883, is No. 93. What does that number signify?

A. It signifies the number of caveats that have been applied for by me within the last ten years, on different inventions.

68 X Q. In what countries were patents applied for or taken by you for the inventions forming the subject-matter of the English letters patent 5127?

Objected to as incompetent and immaterial.

A. I do not know, but think most of the countries having patent laws.

69 X Q. Same question as to English patent No. 4576?

Objected to as incompetent and immaterial.

A. I do not know, but think most of the countries having patent laws.

Counsel for Swan asks the commissioner to mark the sixth bulletin as follows: "Swan's Exhibit Edison's Bulletin;" and he offers in evidence that part of the pamphlet commencing with "Edison's patents," at the bottom of page 5, through the pamphlet.

2559 Objected to as incompetent, immaterial and irrelevant.

70 X Q. (The twelfth bulletin of the Edison Electric Light Com-

pany, under date of July 27th, 1882, is handed the witness.) By whom was this bulletin, as well as the sixth bulletin, issued?

A. By the Edison Electric Light Company.

71 X Q. With your knowledge?

A. I did not see it until it was printed.

72 X Q. You knew of their issue at or about the times of their dates, did you not?

A. I knew after they were issued.

73 X Q. How soon after?

A. A day or two.

74 X Q. On page 13 of the twelfth bulletin the following language is used, is it not: "Mr. Joseph Wilson Swan, of England, after whom the 'Swan lamp' is named, has only two patents in the United States relating to incandescent electric lamps. The first, No. 233,445, was applied for April 12th, 1880, and granted October 19th, 1880; the second, No. 234,345, was applied for June 16th, 1880, and granted November 9th, 1880. These are the only patents on the 'Swan lamp' in the United States;" and on page 15 the following: "The second claim in Mr. Swan's first patent is for a straight strip of paper bent into a loop or horseshoe. This was the form first used by Edison, and probably by every other experimenter on lamps. But Edison improved upon it. His improvement consists of cutting the paper into shape, instead of bending it, it being evident to any one that by cutting paper into exact shape greater uniformity of result can be obtained than by bending, and no special care or work is needed in ensuring that all loops shall be uniform.

"The third point in Swan's first patent, and the first point of
his second patent, is parchmentization prior to carbon-
2560 ization. Edison tested this as early as 1878 and he
soon after mentioned it in a caveat, but he found no
gain in this additional step of parchmentization. Besides, it cost money and increased the cost of production of the finished lamp." And on page 16 the following: "It thus appears that Mr. Swan's so-called improvements on parts of the incandescent lamp are, commercially speaking, of little value. Every point claimed by Swan is something discarded by Edison in his march towards simplification, which means the best result, and the best service for the least money." And on pages 19 and 20 the following: "3d. All that Mr. Swan claims are only some minor features of the alleged improvements, but it is doubtful if they really are improvements, all of them having been tried and discarded by Edison, for simpler and more economical means equally or more efficient for the ends sought, long before Mr. Swan's patents were issued."

Objected to as incompetent and immaterial.

A. Yes, sir.

75 X Q. How extensively were these little printed bulletins circulated?

A. I believe they were circulated only to our stockholders, and later to some others.

76 X Q. There is a notice to that effect, is there not, at the head

of the bulletin reading as follows: "These bulletins, originally issued as a convenient way of answering the inquiries of distant agents, are now, in response to numerous requests, sent also to all stockholders, to give them information of the progress of the company and of other matters of greater or less interest connected with electric lighting. Agents are particularly requested to communicate to the vice-president whatever practical points of general interest may be developed by their experience in installing or operating our lights."

A. Yes, sir.

2561 The twelfth bulletin is marked "Swan's Exhibit Twelfth Bulletin," and the parts above quoted by Swan's counsel are put in evidence. Exhibit objected to as incompetent, immaterial and irrelevant.

Recess here taken for an hour.

77 X Q. You knew of the preparation of an article which appears on page 531 and following pages of Scribner's Monthly for February, 1880, entitled "Edison's Electric Light," did you not?

A. I saw some of the manuscript while being prepared.

78 X Q. You furnished the editor of that magazine with a letter headed as follows, did you not?

"Editor Scribner's Monthly.

Dear Sir: I have read the paper by Mr. Francis Upton, and it is the first correct and authoritative account of my invention of the electric light.

Yours truly, THOMAS A. EDISON.

Menlo Park, N. J."

A. I furnished such a letter after reading a portion of this communication which was written in a popular manner and not in an accurate and scientific manner for scientific persons. It deals very generally with the details.

79 X Q. About when did you write that letter?

A. I should say a month or two before the magazine appeared.
Mr. Upton was called upon by the proprietors of that magazine to
write a popular article on electric lighting, and I gave him permission
to write such an article, and the proprietors of the paper, desiring
to make it perhaps more striking, obtained a letter from me
to the effect that it was authoritative and accurately described; but
I desire it understood that this article is not written for a sci-
2562 entific journal, but for a public who know nothing about the
scientific part of the subject, and therefore it does not give
details, but only generalities. A large portion of the article written
by Mr. Upton I never saw until the magazine appeared, but relied
entirely upon his statements that it would be satisfactory, and no
misstatements would be made.

79½ X Q. You find the following in that article do you not: "A long time was spent, with a fair degree of success, in seeking to make a spiral of lamp-black tar in the form of a wire. To hold this together he used a bit of ordinary sewing cotton, which was covered with lamp-black and succeeded in producing from an inch and a half of this simple thread, bent into an inch, a light equal to an ordinary gas jet. The lamp-black, however, contained air, which greatly interfered with the success of the method. He then used a simple thread, which he found to answer the purpose, though it presented the objection of being fragile, uneven in texture, and unmanag-able. This difficulty suggested the use of charred paper, cut into a thread-like form. The difficulties apparently so insuperable melted away. The electric lamp was completed. A piece of charred paper cut into horseshoe shape, so delicate that it looked like a fine wire, firmly clamped to the two ends of the conducting and discharging wires so as to form part of the electric circuit, proved to be the long-sought combination. From this a light equal in power to twelve gas jets may be obtained. Fig. 8.

"The process by which the paper is rendered serviceable is also extremely simple and inexpensive. The horseshoe loops are cut from card-boards, and placed in layers within an iron box, with tissue paper between; the box is hermetically sealed, and then raised to a red heat. Nothing remains but the carbon loops and the carbonized tissue paper. All other forms of carbon previously used had presented the difficulty of containing air or gas?"

A. I do; but the statement is not absolutely correct, but quite sufficient in an article of that character.

2563 80 X Q. Name all the different kinds of paper you experimented with in the latter part of 1879 in making carbons for electric lamps.

Objected to as incompetent and immaterial.

A. I have used bristol-board in various colors, paper made from manilla, bamboo paper, paper of which the United States currency is printed upon, parchmentized paper, linen paper, tissue paper, straw paper, and others that I do not remember.

81 X Q. Have you tried blotting paper, bibulous paper?

A. Yes, sir. I tried uncalendered bristol paper so that I could select the proper thickness, but this paper was pressed under a press to make it hard before use.

82 X Q. Did you try bank-note paper?

A. Yes, sir.

83 X Q. Bond paper?

A. Yes, sir.

84 X Q. In the case of carbons made by you consisting of a foundation of paper thread or other substance, and having a coating of carbonized tar or lamp-black, what was the source of light?

A. The filaments.

85 X Q. What part of the filament?

A. The outside.

86 X Q. Consisting of what?

A. Carbon.

87 X Q. Produced from what?

A. From the carbonization of the volatile matters of the cellulose and the tar.

88 X Q. Did the cellulose and the tar form a homogeneous structure?

A. Not perfectly homogeneous, although the tarry products of the cellulose mixing with the tarry products of the tar, coalesced to form a carbon, which, although not perfectly homogeneous, was partially so.

2564 89 X Q. You think that a portion of the light was furnished by the carbon, which was the result of the interior filament, do you?

A. If, as was the case, a very little tar was put on the material, the portions of the filament would be exposed and radiate light directly, but as a matter of fact the surface of paper, bamboo and other forms of cellulose, when carbonized, give off tarry matter, which, running out upon the surface, becomes carbonized, and generally the surface thus formed by the carbonization of the tarry matters produced by the decomposition of the cellulose is the carbon that radiates light. There is a large amount of tarry products in the decomposition of cellulose.

90 X Q. In the production of carbons cut out in moulds of the shape of horseshoe or of circular shape and carbonized in moulds, what was the object of the tissue paper that was placed between the blanks?

A. If I remember right the object was to prevent the tar which resulted upon the decomposition of the cellulose and paper from running and sticking the carbon to the mould. Also to permit the the loop to contract upon the surface of the tissue paper.

91 X Q. Why was not tissue paper used in connection with the carbons that were cut straight and bent round the little blocks of carbon that had been produced in evidence?

A. Because the weight was not applied to all of the filaments, but each single filament was separate and was kept straight by its pulling a weight; but with the several filaments, one upon the other, cut from blanks, one weight was used, hence something must be placed between the filaments, so that they could contract independent of each other.

92 X Q. Was the use of tissue paper in connection with experiment seventy-one, on page 163 of Note Book Fifty-two, such as you have just described tissue paper to be used for, and will you compare the note on page 153, reading as follows: "All that we have made like forty-three are cut crossways out of the card" with
2565 the language applied to seventy-one on page 163, as follows:
"The card cut lengthways so that grain (as it were) lays that way," and explain a little more fully what you mean by cutting crossways and cutting lengthways?

A. We used various kinds of tissue paper. The meaning of cutting lengthways and crossways of the bristol-card was that in the making of the paper the fibres generally lay more in one direction than another, owing to the action of the machinery, and therefore cutting one way or the other did not make a difference in the numbers of the fibres that laid parallel. I think what is meant by carbonizing with white tissue paper is that the tissue paper was used to separate the blanks in the mold.

93 X Q. Did it require a different cutter to cut them with the grain lengthways as mentioned with reference to 71, from cutting them crossways as mentioned with reference to 43, or was it only a different application of the same horseshoe or loop shaped cutter?

A. I do not think it required any different cutter. I do not see why it should.

94 X Q. Then I suppose 71 differed from 43, in that 71 was cut lengthways with the grain and 43 crossways with the grain, being otherwise the same?

A. So the exhibit states.

95 X Q. In carbonizing the loops that were bent round the bits of carbon, how were they secured to the carbon?

A. In various ways.

96 X Q. Please tell how?

A. The ends of the filaments were sometimes secured by wedges of carbon, and by tying them round a piece of carbon. Sometimes one end was secured and the other end tied to a piece of carbon. Sometimes the weight placed in between the loop was held fast, and the block of carbon to which the ends of the filament were tied moved. Sometimes that was stationary and the piece of carbon between the loop moved. Sometimes a groove in a block of
2566 carbon the shape of the filament was made and the filament placed therein and allowed to contract in the groove without securing the end.

97 X Q. Over what period were books like Record Book 52 kept?

A. I think they were kept up from the fall of 1878 until some time in 1881. They are not very full, and very few of the pages are dated, for the reason that we were under great strain, the place was crowded with people; I had thirty or forty assistants, and I sadly neglected my usual care in dating exhibits and recording all experiments, as I had previously done accurately with regard to the telephone. I really had not time. Had I thought at the time that my application for an incandescent lamp wherein paper was used did not cover all kinds of paper I certainly should have made a very voluminous record of experiments with parchmentized and other kinds of paper.

Last part of the answer beginning with the words "had I thought," and continued down to the end is objected to as irresponsive, and the witness is requested to answer questions simply and not endeavor to excuse himself at this late day for what he now seems to consider an oversight.

A. I have not endeavored to excuse myself as there is quite sufficient records to meet this case.

98 X Q. On page- 137 and 139 immediately following a drawing on page 136, which was stated in the testimony to represent a blank cut from paper in its present shape, I find the following language:

"November 12th, 1879. In order to bring the cards out of carbonizing chamber perfectly straight we found the only way was to put sheets of tissue paper in between the loops (instead of cards as we had been using), and after six alternate layers of loops and tissue sheets to put a small piece of carbon to act as a light weight on top, then close the whole up in a chamber and heat very slowly, taking care not to get too great on it until after all the volatile matter has gone off which will be known after it has given over smok-
2567 ing, then put in furnace and bring to a yellow heat." This reference to tissue paper and method of carbonizing is what you have heretofore referred to as having been accomplished in the molds, is it not?

A. I have heretofore referred to the fact that I have used tissue paper between the loops for permitting them to contract. This also speaks of the use of tissue paper between the loops to permit them to contract.

99 X Q. The drawing on page 145 opposite 43 in pencil represents the new model from which the paper blanks numbered 43 and 44 were cut, does it not?

A. I believe it does.

100 X Q. This drawing shows that the blanks were cut from paper in the form of a horseshoe, does it not?

A. Yes, sir.

101 X Q. Look at page 207, Record Book 52, and state if you can what kind of paper was used in making carbons 141, 142 and 143?

A. I think they were punched-out carbons in horseshoe shape.

102 X Q. Is there anything there that tells you what kind of paper they were punched from?

A. No, sir.

103 X Q. What was the object of the weight of 126 grains Troy of carbon which appears from that entry to have been used?

A. I believe it refers to the size of the weight of carbon which was placed on top of filaments while being carbonized.

104 X Q. Do you understand that the three horseshoe blanks referred to there, to wit: 141, 142 and 143, were laid one on top of the other, and a weight on top of the whole, and the three then carbonized.

A. Yes, sir; I think that it is the way it was done.

105 X Q. Please examine the pages of this Record Book, No. 52, from page 137 to 280, the last page of the book, and refer to the numbers of the lamps therein referred to, and of which a
2568 separate record is made running from number 43 to 260,
and state if the record shows that each of the carbons for them were cut from paper in the form of a horseshoe blank and then carbonized.

A. As far as I have been able to discover they do except numbers 53 and 54, which were models for Patent Office. What these were I cannot remember.

105½ X Q. Numbers 53 and 54 occur on page 151, do they not, and also on the page occurs the date November 23, 1879, does it not, and on the preceding page, namely, 149, occurs the date November 20th, 1879, and the whole entry with reference to 53 and 54 is as follows, is it not?

"53 }
54 } made as models for Patent Office."

A. Yes, sir.

106 X Q. On page 135 I find the following entry: November 11th, 1879. Made chamber for carbonizing, and cut out piece so and carbonized number in between the cards. They came out excellent." In the margin is a drawing representing a carbon cut out in horseshoe form. Will you examine this Record Book 52, and see if you can find therein, prior to this citation, any commendatory word relating to a carbon filament, and if you do, quote it?

A. I find no commendations previous to November 11th, 1879, in this particular book, but I believe there are commendations of a filament of carbon in another book now in evidence. I think the results of the lamps are entered in some other book, where perhaps the commendations might be found if there were any to commend it.

107 X Q. You find a good many remarks that are the contrary to commendatory of carbon filaments, in this book prior to page 135, do you not?

A. No, sir; I do not find one. I find that we had difficulties in carbonizing them. We were very fresh in the business, and they were more difficult to manipulate than those cut out of paper, because with those cut flat it was very much easier to get the proper pressure on them and strain, so as to make them even; and besides a great number could be put in a mold, while with the straight carbons each carbon had to have its own little rigging. The *re*remarks, "bursted in carbonization" has nothing to do with the commendation or non-commendation of the filament of carbon, or that the glass bursted or the inside bursted. These are not derogatory to the filament of carbon. As soon as we became more expert in the business, we went back to the early method, and cut out filaments straight, bent them, and carbonized them while so bent, and have continued this use ever since, having made over a quarter of a million in this manner. 2569

Last part of the answer about continuing to use, and number of lamps made, is objected to as irresponsive.

108 X Q. In this D. B. E. in regard to the quarter of a million that you say were made and put in the market, you include the bamboo filament of your present manufacture, do you not?

A. Yes, sir.

Counsel for Swan requests of counsel for Edison the privilege of putting Record Book 52 in evidence bodily, being willing to stipulate that the book may remain in possession of counsel for Edison, except for such at hearings and examinations as may be required.

Counsel for Edison requests counsel for Swan to state how the portions of the Note Book 52, photographs of which are not in evidence, are material.

Counsel for Swan will undertake to show that on hearing. Counsel for Swan would add that the record book in question contains an unbroken record of a continuous line of experiments with carbons for electric lamps, numbered consecutively from 1 to
2570 260, and such being the fact, the proper bearing and importance of the parts put in evidence by counsel for Edison can only be shown by an inspection of the whole record.

Counsel for Edison states that even assuming that the record book in question contains records of a continuous line of experiments with carbons for electric lamps, that does not show the materiality of other portions of the record book than such as relate to the issues in this interference, and that as those portions of the record book relating to such issues have been put in evidence, the rest of the book is immaterial and has no proper place in the record. Counsel for Edison is unwilling to permit any further use of the record book in question than is provided for and stipulated in the stipulation contained in folios 20 to 22 of the printed record.

109 X Q. At the top of page 171 I find the following: "Tests of papers and card-boards for ash." What does that mean?

A. It means that the manufacturers loaded their paper with clay and other materials and we desired to ascertain what amount of these adulterations were used in different samples of paper.

109 X Q. How many different samples were tried for ash, as appears by this record?

Objected to as immaterial and incompetent.

A. About 40.

100 X Q. Is parchment paper or parchmentized paper mentioned in that list as having been tried?

A. No; for the reason that manufacturers do not put adulterations in parchmentized paper.

111 X Q. Will you produce the record book immediately succeeding Record Book No. 52, and containing a continuation of the numbers of carbons from 260 onward?

A. No, sir; I have produced sufficient records to meet the counts in this interference.

2571 112 X Q. Look at the printed copy of evidence in case of Sawyer-Man *vs.* Edison, now handed you, and state whether you testified as recorded in that volume from page 2 to page 88, and page 134 to page 141, inclusive.

A. Yes, sir; I believe I did.

Counsel for Swan offers the same in evidence as marked, "Sawyer-Man *vs.* Edison, Swan's Exhibit Edison's Deposition."

Objected to on the ground that the same is incompetent and immaterial unless offered for the purpose of contradicting or impeaching the witness, in which case the witness's attention should be called to the specific statements upon which such contradiction is sought to be based.

113 X Q. How was the material which you got from the Vulcanized Fibre Company, Wilmington, made?

A. It is made, I understand, by treating the paper with a strong solution of chloride of zinc, which parchmentizes the fibres so they all coalesce to form a non-fibrous mass.

114 X Q. You have stated that, in the latter part of 1880, you made a number of lamps with carbons made of vulcanized fibre. Give the names of the assistants employed in making such carbons.

A. I think the man who made the carbons was named Bradley. I think Mr. Batchelor made a lot at first. Afterwards Mr. Bradley made a few. After that we got some of the paper stock from the Wilmington company, when a large number were cut out. Mr. Bradley also had two or three assistants whose names I cannot remember. I think one of these men cut a large number for me.

115 X Q. Was the provisional specification of English patent No. 5127 cabled ab*oard*?

A. No, sir; but the Philadelphia correspondent of the London Times four or five days after I made my exhibition at Menlo Park, or started to make the exhibition, and about six days after 2572 the New York Herald published a full account of my lamps, which was December 24th, 1879, telegraphed to the London Times a full and complete description of the lamp sufficient to permit one skilled in the art to make the same and it was published in the London Times I think either the 29th of December, 1879, or the first or second of January, 1880, from which description Mr. Swan in about fifteen days afterwards filed a patent application in the British patent office, containing almost a similar lamp as that described in the cable to the London Times.

All after the word "no, sir;" is objected to as irresponsive, not called for by the question and volunteered by the witness.

Adjourned to Friday, May 25th, at 10 o'clock a. m.

Met pursuant to adjournment.

Present: W. C. Witter and H. A. Seymour for Swan; S. A. Duncan for Maxim and Richard N. Dyer and E. H. Lewis for Edison.

Counsel for Edison here offers in evidence copy of an article from the London Times of December 23d, 1879, entitled "Mr. Edison and the Electric Light," and also a copy of an article from the London Times of December 29th, 1879, upon the same subject, and requests that these copies be marked Edison's Exhibits R and S respectively.

Counsel for Swan here gives notice that he will introduce in evidence printed copies of such patents as he has referred to in his cross-examination and of which no special notice of an intention to introduce has heretofore been made.

116 X Q. Will you please produce to be put in evidence in this case the original agreement dated November 15th, 1878, between the Edison Electric Light Company and Thomas A. 2573 Edison, or a correct copy thereof to have the same effect as the original?

A. No, sir.

117 X Q. In default of the best evidence counsel for Swan produce a document and asks the witness whether that is a correct copy of the instrument called for.

A. I cannot say, for I have not the original for comparison.

Counsel for Swan calls upon the counsel for Edison to produce the original in order that it may be compared with the copy here presented.

Counsel for Edison here refuses to produce the original agreement called for on the ground that it is wholly immaterial and irrelevant.

The copy presented is here put in evidence and marked "Swan's Exhibit Agreement of November 15th, 1878."

The exhibit is objected to as incompetent, immaterial and irrelevant, and also as not being the best evidence, no sufficient foundation for the introduction of the same having been made, and no identification of the same as a copy having been made.

Counsel for Swan reads to the witness Edison the copy agreement produced, as follows:

This agreement, made the fifteenth day of November, in the year one thousand eight hundred and seventy-eight, between Thomas A. Edison, of Menlo Park, New Jersey, party of the first part, and the Edison Electric Light Company, a corporation created and existing under the laws of the State of New York, and hereafter called "the company," party of the second part,

Witnesseth:

Whereas, the company has been organized with the view of becoming the owner of, and of making, using and vending, and licensing others to make, use and vend within the United States and other countries or colonies hereinafter mentioned, all the inventions, dis-
coveries, improvements and devices of said Edison, made or
2574 to be made, in or pertaining to electric lighting, or relating
in any way to the use of electricity for the purposes of power,
or of illuminating or heating, or relating to improvements in electric engines, or to the developing of electric currents by machines or otherwise, for any use or purpose, except electric telegraphy;

And whereas, the said Edison is willing and desirous, in order to obtain the means to continue his investigations in the subjects above named, to transfer, upon the terms heretofore agreed upon, and hereinafter fully set forth, all the right, title and interest in his said inventions, made or to be made, as herein provided, and the exclusive use thereof in the countries above named, together with all letters patent of the United States or Canada, and all letters patent, special grants, concessions or privileges of any other state or country of North or South America, excepting the possessions of Spain, which may be granted for any of said inventions, discoveries, devices or improvements.

Now therefore, in accordance with said terms, and in consideration of the mutual agreements of the parties hereto, as herein set forth, they respectfully agree with each other as follows:

First. The said Edison hereby sells and assigns to the company

the entire right, title and interest in and to all inventions, discoveries, devices and improvements which he has hitherto made pertaining to electric lighting or to the use of electricity for the purposes of power, or of illumination or heating, or to improvements in electric engines, or to the developing of electric currents by machines or otherwise for the uses or purposes above mentioned, or any of them; and especially all inventions, discoveries, devices and improvements which are described in the following applications and caveats for patents of the United States, namely, an application in case No. 156, dated October 5th, 1878, filed October 14th, 1878; applications in case No. 162 and No. 163, prepared by L. W. Serrell & Son, but not yet signed; in caveats numbered 82, dated October 7th, 1878; 83, dated October 25, 1878; 84, dated October 12, 1878;
and 85, dated October 25, 1878; and also those which are
2575 described in a certain application, and the papers thereto per-
taining to letters patent of the Dominion of Canada, dated October 25th, 1878; and does also agree that all other inventions, discoveries, devices and improvements of the character above described, and all improvements which he may make within the period of seventeen years from the date of this instrument shall be deemed to have been made for and shall belong to the company; and that he will take all such steps as are provided in the third article hereof to secure to the company letters patent of the United States and Canada, and such letters patent or other special grants or concessions of any other State or country of North or South America, except the possessions of Spain, as can be secured from them, or any of them. It being specially understood and provided, however, that this agreement is not intended to convey or give any interest to the company in any invention designed, or to give any right of use for electric telegraphy, or capable solely of being used in electric telegraphy of any invention which may be applicable to that as well as to any of the other purposes which are the subject, as above named, of this agreement, but the right of use of any invention, discovery, apparatus or device contemplated by this agreement for electric telegraphy remains in said Edison, and the company agrees to grant, under any letters patent belonging to it, such licenses for his benefit as he may request for the business of electric telegraphy.

Second. All inventions or discoveries of the character described in the first article hereof which may be made by said Edison within the first five years of the period above named, and all improvements which he may make during the same period upon any of such inventions, devices or improvements shall belong to the company without further consideration; but compensation shall be due for all inventions or improvements made after the expiration of said
five years; and immediately upon the issue of any letters
2576 patent, grants, concessions or privileges for inventions, discov-
eries, devices or improvements made after the expiration of said five years, if the company desires to hold such inventions and patents, such compensation shall be due and payable, and if the parties are unable to agree within three months from the date of

such letters patent, grant or concession, upon the amount and the time, conditions and manner of payment of such compensation, the same shall, upon the written demand of either party, be submitted to arbitration of two indifferent and disinterested persons, one to be chosen by each party, with power to choose a third, and the decision of such arbitrators, or a majority of them, shall be final and binding upon both parties.

Third. The said Edison agrees that, in respect to all the inventions and improvements herein provided for, he will promptly file, in the proper offices of the United States and Canada, such caveats as may be necessary, in the judgment of the company, to protect the same, and will also promptly thereafter file his applications in the same offices for letters patent therefor, with requests that such letters patent may be issued to the company, as sole owners thereof, whenever the law allows, and will, simultaneously with the filing of such caveats or applications, also deliver to the company special assignments to it of all the right, title and interest in and to such inventions and improvements.

And said Edison also agrees to prepare or cause to be prepared such drawings, models and specifications of the inventions and improvements provided for by this agreement, as may be necessary, in the judgment of the company, or as may be required by it, to describe and illustrate them fully, and to deliver the same, with all sketches or memoranda pertaining to them, to the company, and at all times, upon the request of the company, to make, execute and deliver to it all amended specifications, models, drawings or applications that it may reasonably require; and all new or other assignments that may be necessary to secure to the company the exclusive ownership of all the inventions, discoveries, devices
2577 and improvements intended by this agreement in their most perfected form, together with all papers required to secure reissues, renewals or extensions of letters patent, grants or concessions for any of them.

And said Edison agrees, from time to time as requested by the company, to take all such other measures as may be necessary to procure letters patent or other grants or concessions, protecting his inventions, in such other States or countries of North or South America, except the possessions of Spain, and to assign to the company, immediately upon receipt of them, all such letters patents, grants, concessions or privileges, which may be issued in the first instance directly to him; but the expense of all things done in accordance with the provisions of this agreement, except as otherwise specially provided in the fifth article hereof, are to be borne by the company.

Fourth. The said Edison agrees on behalf of and for the benefit of the company, to prosecute with his utmost skill and diligence, further necessary investigations and experiments upon the use of electricity for the purposes described in the first article, and to endeavor to discover and devise the best and most economical means, modes and apparatus for applying electricity to the purposes above named, and for rendering the means, modes or apparatus which he may have discovered or devised, more useful, economical and convenient: and to perfect and complete all his inventions and improvements described in the first and second articles, and all such as may result from the further investigations and experiments herein provided for, as far and as fast as may be in his power.

Fifth. The company hereby agrees to issue to said Edison two hundred and fifty thousand dollars of its capital stock of three hundred thousand dollars and to pay him, upon the execution of this agreement, the sum of thirty thousand dollars in cash—of which sum said Edison agrees to expend twenty-five thousand dollars, or so much thereof as may be necessary, in procuring and paying 2578 for the means and material required for the most effective prosecution of the investigations and experiments provided for in the fourth article hereof, and in defraying all other charges attendant upon such investigations and experiments, as well as the legal or other expenses attendant upon the organization of the company, and the preparation and taking out of patents in the United States and Canada for his inventions already made and described in the caveats and applications above referred to.

Sixth. The company further agrees, out of its first net earnings, remaining after reserving fifty thousand dollars, or so much thereof as may be required to repay the sums paid in cash by the subscribers to its capital stock, to pay to the said Edison the further sum of one hundred thousand dollars in cash; and thereafter to pay him an annual royalty upon every light licensed or used with its consent under any of the patents of said Edison, of five (5) cents per light; and guarantees to pay in each year royalties to an amount not less than fifteen thousand dollars a year, if it has net income to that amount in that year from any source; provided, however, that the company shall have the option, by notice given on the first day of January in any year, to pay thereafter a yearly commutation of thirty thousand dollars in lieu of all royalties derived under patents of the United States and Canada; and the like option, upon similar notice, to pay thereafter annually the sum of twenty thousand dollars in lieu of all royalties or income derived under patents, grants, concessions or other rights secured to it in the other States or countries above named.

Seventh. The company hereby covenants with the said Edison that it will, in so far as the same may be practicable and economical, seek with diligence and good faith to introduce, as extensively as possible in all the countries named in this agreement, the electric light produced by means and apparatus invented by said Edison, as well as to bring all such means and apparatus into like use for all the other purposes contemplated by this agreement.

2579 Eighth. The said Edison agrees, at the request of the company and at its expense, to execute and deliver, from time to time, such writings of further assurance, such separate instruments making special assignments of the interest of any portion thereof conveyed hereby, or such special powers or authorities as for its convenience or interest it may desire to have separate from the general body of stipulations herein contained.

Ninth. The several agreements and covenants of the parties hereto shall bind and shall enure to the benefit of, respectively, the executors, administrators, and assigns of Edison and the successors of the company.

In witness whereof, the party of the first part has hereto set his hand and seal, and the party of the second part has hereto caused its corporate seal to be affixed, and its corporate name to be subscribed the day and year first above written.

THE EDISON ELECTRIC LIGHT COMPANY.
By NORVIN GREEN, *President.* [L. S.]
THOMAS A. EDISON. [L. S.]

Signed, sealed and delivered in the presence of—
[SEAL.] FRANCIS R. UPTON.
CHARLES ROTH.

Attest: C. GODDARD, *Sec'y.*

STATE OF NEW YORK, } ss:
City and County of New York, }

On this fifteenth day of November, one thousand eight hundred and seventy-eight, before me personally came Norvin Green and Calvin Goddard, to me known to be respectively the persons 2580 described in and who executed the foregoing instruments as the president and secretary respectively of the Edison Electric Light Company, the corporation described in and in whose behalf the same instrument was by them executed, and they severally acknowledged to me that they executed the same as the free act and deed of said company for the uses and purposes therein mentioned, and thereupon the said Norvin Green being by me duly sworn, said that he resided in the city of New York; that he was the president of the said Edison Electric Light Company, and that he signed the name of the said The Edison Electric Light Company and his own name as president thereof, by order of the board of directors of said company; and the said Calvin Goddard, being by me duly sworn said that he resided in the city of New York; that he was the secretary of the said The Edison Electric Light Company; that he knew the corporate seal of said company; that the seal affixed to the foregoing instrument was such corporate seal and was affixed by him by order of the board of directors of said company, and by the like order he signed his own name to said instrument as secretary of said company.

And on the same day before me personally came Thomas A. Edison, to me known to be the individual described in and who executed the foregoing instrument and acknowledged to me that he executed the same for the uses and purposes therein mentioned.

In witness whereof, I have hereunto subscribed my name and affixed my official seal the day and year first above written.

CHARLES ROTH,
[L. S.] (67) *Notary Public, N. Y. Co.*

118 X Q. Did you not, on or about November 15th, 1878, make with the Edison Company an agreement substantially to the effect of the above?

2581 Counsel for Edison objects to the question on the ground that if such an agreement was made, and is in writing, the document is itself the best evidence of the nature and substance of the agreement. On the further ground that the question is immaterial, irrelevant and incompetent, and the witness is instructed that he need not answer same.

A. I am instructed by my counsel not to answer the question.

119 X Q. Did you not make, about November 15th, 1878, with the Edison Company, an agreement that you would promptly file, in the proper office in the United States and Canada, caveats and applications for letters patent for all inventions and discoveries made by you pertaining to electric lighting, or the use of electricity for the purpose of power or of illumination or heating, or improvements in electric engines, or for the development of electric currents, by machines or otherwise, for the uses or purposes above named, for the benefit of the Edison Electric Light Company?

Question objected to as incompetent, immaterial and irrelevant, it appearing that counsel is reading from a paper purporting to be an agreement or a copy of an agreement. The question is improper because it is not the best evidence of the nature or substance of the agreement in question and is objected to by counsel for Edison on that ground as well as the general grounds above mentioned. The witness is instructed not to answer.

Cross-examined by S. A. DUNCAN, Esq., counsel for Maxim:

120 X Q. Is it a fact that your notes and records of experiments relating to the telephone were much fuller and more accurate than those relating to the electric light?

A. Yes, sir.

121 X Q. Why was this so?

A. Because I only had two or three assistants. We had more time, and I did a great portion of the work myself, whereas 2582 with the electric light I had 20 or 30 assistants and things were going on with a great rush, and I could not make all the records myself.

122 X Q. Did you make your own records in the case of the telephone?

A. Most of the records were made by myself in the case of the telephone.

123 X Q. In the case of the electric light the records of experiments were made largely by your assistants, were they not?

A. Yes, sir; I detailed different men for different work, with instructions to keep records.

124 X Q. When did your records of experiments on the electric light begin?

A. In the fall of 1878.

125 X Q. When did this great rush of which you have spoken of begin?

A. About the same time. I put on a great force of men, being furnished with funds by the company which was organized to take over what inventions I might make.

126 X Q. Did that company also have the right to control what inventions you had previously made relating to the electric light?

Objected to as incompetent and immaterial.

A. I forget now the wording of the contract.

127 X Q. I did not ask for the wording of the contract, but the substance of it in this one particular.

Same objection.

A. I cannot give the substance, nor cannot remember whether they did or did not have the right.

128 X Q. When did you first begin experimenting on the electric light?

A. I have experimented more or less since 1864 with the electric light.

129 X Q. When did you first experiment with incandescent carbons for electric lamps?

A. In 1869, is the first that I now remember.

2583 130 X Q. Was it your instructions to your assistants to make a record of all important experiments relating to the electric light?

A. Yes, sir; they were told to put down what the result of their experiments was.

131 X Q. So far as you know is there anything of importance to be found in your record books bearing upon the subject-matter of the present interference which has not already been produced in evidence, or which does not constitute a part of Record Book No. 52?

A. I do not know. I find the books now in evidence contain sufficient data in my mind for the purpose of this interference. There may be other things in other books relating to the subject-matter of this interference.

132 X Q. Did you examine this book, No. 52, in order to ascertain its bearing upon this interference?

A. After it was produced I did.

133 X Q. Have you examined any other of your record books for the same purpose?

A. I do not remember of having examined any of them.

134 X Q. In your answer to cross-questions, propounded by counsel for Mr. Swan, you made some reference to your application for a patent on paper carbon; I suppose you regard that as an important application, do you not?

Objected to as immaterial.

A. In some senses I do, and in other senses I do not.

135 X Q. In what sense not?

A. That it — not so good material for incandescent lamps as other materials which I have used.

136 X Q. Still you deemed it very important, did you not, to control by means of a patent the use of paper carbons for incandescent lamps, and in that respect did you not consider that application a very important one?

Objected to as immaterial.

2584 A. I considered it important in respect to not permitting others to use the fact of having beaten Edison for the purpose of a trade advertisement.

137 X Q. And otherwise important?

Objected to as immaterial.

A. Do you refer to the mere use of a paper?

138 X Q. I refer to the application which related to paper carbons which formed the subject of one of your answers on the cross-examination in behalf of Mr. Swan.

A. I also considered it important that having first used paper carbons that others should not be permitted to use the same to my detriment. Although I have a better material, still a paper-carbon lamp in the hands of unscrupulous persons might be used to my detriment.

139 X Q. Would it not be a great advantage to you and your associates in business to be able by means of a patent for the paper carbon to stop other people from using it even though you did not wish to use it yourself?

Objected to as immaterial.

A. I have patents which would prevent them from using paper carbon even if they had a right to do so. Therefore, this question is rather a broad one.

140 X Q Do you know whether your record books contain all your important experiments in relation to the paper carbon for electric light?

A. No, sir; I do not.

141 X Q. Have you reason to suppose that the books are not full in this respect?

A. Yes, sir; they are not full; they were very poorly kept, and some of the books even have been lost.

142 X Q. You regarded the paper carbon as an important thing at the time you were experimenting with it in 1878, 1879 and 1880, did you not?

A. I regarded the use of the filament of carbon in 1878 and 1880 as a very important invention, but regarded the particular 2585 material of smaller importance to the broad patent for a filament of carbon for an incandescent conductor.

143 X Q. What do you mean by "filament" of carbon?

A. I want a copy of Webster's Dictionary to aid me in a proper definition of the question.

Counsel for Maxim says that he is not asking the witness what the proper definition of the term filament is, or what Webster's definition of the term is, but is asking the witness for his definition of the term as used in his last answer.

Question withdrawn.

144 X Q. Are you able to give a definition of the term "filament" as you used it in your last answer?

A. I could give a definition of a filament of carbon but, as my impression is that this definition will be used in future cases, I desire the aid of a dictionary that I might more fully define it.

145 X Q. What is your own idea in regard to the meaning of that term as you used it in the last answer but one.

A. A thin flexible piece of carbon like a hair, which may be bent, in contradistinction to a stick of carbon.

146 X Q. I find among the questions and answers in the cross-examination conducted by counsel for Swan, the following: "Q. You find a good many remarks that are the contrary to commendatory of carbon filaments in this book (Edison Note Book 52) prior to page 135, do you not? A. No, sir; I do not find one. I find that we had difficulties in carbonizing them. We were very fresh in the business and they were more difficult to manipulate than those cut out of paper, because with those cut flat it was very much easier to get the proper pressure on them, &c." What do you mean by that answer to that question?

A. I mean what I stated.

146½ X Q. In other words you meant, did you, that it was much easier to manipulate flat carbon blanks cut out of paper than to manipulate carbon filaments?

2586 A. No, sir; I do not mean that. I mean that it was much easier to manipulate carbon filaments cut out flat from paper than carbon filaments cut straight from paper and bent in the form of a loop.

147 X Q. Is that what you said?

A. Yes, that is what is meant and said.

148 X Q. Please examine that portion of Note Book No. 52 which precedes page 135, and state whether you find described in that portion carbons made otherwise than from paper?

Objected to as incompetent and immaterial.

A. Yes, sir; I find that it has been made of various substances as is shown on page 117, a photograph of which is in evidence.

149 X Q. Does not the earlier portion of this book (prior to page 135) contain various sketches of carbon filaments in spiral form, and otherwise made of other material than paper?

A. Yes; it shows them made out of thread, and thread with tar rubbed on.

150 X Q. You have stated heretofore how vulcanized fibre is made. What personal knowledge have you of the mode of making this article?

A. I believe I have read the patent containing a description of the process for making vulcanized fibre from parchmentized paper by means of a strong solution of zinc. I have made parchmentized paper myself by this means.

151 X Q. The vulcanized fibre which you used in 1879 for electric light carbons was procured from the Vulcanized Fibre Company, Wilmington, Delaware, was it not?

A. It was made at Wilmington, Delaware, I believe.

152 X Q. Did you procure it direct from the manufacturer?

A. I think we did. We used a great deal of vulcanized fibre for insulating work.

153 X Q. In what shape did you buy that material at that time?

2587 A. We shaved off thin pieces and cut them straight, and bent them in the form of a loop, and carbonized them while so bent.

154 X Q. You mean that you shaved off pieces from slabs of fibre?

A. Yes, sir.

155 X Q. Those slabs were about how thick?

A. I cannot remember the thickness of the particular slab, but we had slabs from a sixteenth of an inch to three-quarters of an inch thick.

156 X Q. Could you produce at the present time any specimen of that vulcanized fibre?

A. It is sold in open market now and can be procured by any one.

157 X Q. Personally, you do not know that the vulcanized fibre which you bought and used in 1879, was made under the patent to which you have referred, do you?

A. No, sir; but I know that we made an analysis of some samples at the time and found zinc in it.

158 X Q. Can you produce the memorandum of that analysis?

A. I could not tell without looking.

159 X Q. Who made the analysis?

A. I cannot remember.

160 X Q. At what date was it made?

A. I think about November, 1879.

161 X Q. Can you state more accurately than that?

A. No, sir. I know that we found it had a great deal of ash, and we had a curiosity to know what were the impurities in it, and some one about the laboratory made a test and found it heavily loaded with oxide of iron and zinc.

162 X Q. In your Note Book No. 52, under date of November 27th, there appears a record of some forty or fifty tests for ash on various kinds of materials. Can you state whether any of those tests related to vulcanized fibre?

A. No, sir; I am sure the test on vulcanized fibre was made previous to that test.

2588 163 X Q. Ought not that test to have been recorded in this book?

A. No, I do not think so. Isolated experiments were not always put down in the book.

164 X Q. Are you sure that that was an isolated experiment?

A. Yes, I feel convinced of it.

165 X Q. How so?

A. I think I made it myself. I burned some of the vulcanized fibre, and then found it had a very large amount of ash.

166 X Q. What refreshes your recollection so that now you can state that you made the test, when a few minutes ago you were unable to state who made it?

A. Because you have called my attention more particularly to that fact, and I have now, since being examined, had called to my memory the fact. I have a pretty vivid recollection of that now.

167 X Q. How can you determine that it was before November 27th, and not after?

A. Because I can remember that we made a vulcanized fibre lamp just a day, I think, after we made a thread lamp, and I remember the circumstances of making the lamp and testing the same, and about the same time we decided to procure all kinds of materials and make lamps of them. And I believe we did procure all kinds of paper, and having an idea that ash was a detriment, that is to say, an adulteration, we made a test, a regular test, to determine which kind of paper had more or less of these adulterations.

168 X Q. When did you make that thread lamp that you have just spoken of?

A. The one that I refer to I think was made on the 20th or 21st day of October, 1879.

169 X Q. You made a great many thread lamps, did you not, along about that time?

A. Yes, sir.

170 X Q. How do you single out that particular lamp as
2589 the one which was directly connected with the vulcanized
fibre?

A. I single it out because the lamp had no tar on it. It was purely made of thread.

171 X Q. How do you connect in your mind the vulcanized-fibre lamp with the lamp made of thread without tar?

A. For the reason that the next lamp made I am quite certain was the vulcanized-fibre lamp after the lamp made of thread without tar.

172 X Q. Was there anything in that lamp made of thread without tar that led you to think of vulcanized fibre?

A. Yes, sir.

173 X Q. What suggested vulcanized fibre?

A. There were spots formed by arcs between the fibres of the thread, which, although I am not sure, I think caused me to get out a more solid filament, and vulcanized fibre being more solid than thread I made a lamp of this, but it being so heavily loaded with zinc it did not give the results I desired.

174 X Q. Can you produce any record showing an experiment made by you of a carbon of vulcanized fibre introduced into an exhausted glass receiver so as to form an incandescent lamp?

A. Yes, sir. On page 117 it states that we had carbonized vulcanized fibre with other things, and on page 169 lamps were made from vulcanized fibre, Nos. 79, 80, 81, 82 and 83.

175 X Q. What is the entry on page 169 to which you referred in your last answer?

A. "79 and 80 made from Crane's parchment No. 56. 81, 82 and 83 made from Crane's parchment No. 44."

176 X Q. You understand then, do you, that this entry is an entry relating to vulcanized fibre?

2590 A. Yes, sir. Parchmentized paper is vulcanized paper. The particular process for parchmentizing the paper used at Wilmington has been called vulcanizing. Parchmentization and vulcanization are the same, both being done by chemical agents which act in the same manner upon cullulose. When I speak of vulcanized fibre in one sense I mean that procured at Wilmington. When I say that Crane's parchment is vulcanized fibre I mean that it is a product the same as that at Wilmington and can be with truth called parchmentized or vulcanized fibre.

117 X Q. What does your Note Book 52 mean when it uses the term vulcanized fibre?

A. It means parchmentized paper made at Wilmington and called vulcanized fibre.

178 X Q. Can you produce from your Note Book No. 52 or any other note book a record of any experiments made with an incandescent lamp having a carbon of vulcanized fibre in the last sense of the term?

A. You mean vulcanized fibre made at Wilmington?

179 X Q. Yes. That is, I mean vulcanized fibre in the sense in which you used the term on page 117 of your Note Book No. 52, which I understand you to say means the material made at Wilmington?

A. I do not find in the note book any record of a lamp being made containing vulcanized fibre made at Wilmington but only the same kind of material called Crane's parchment in lamps 79 and 80 and the others on page 169.

The last part of the answer objected to as uncalled for by the question and volunteered.

180 X Q. Have you any record of the experiments made with the lamps containing carbons constructed from Crane's parchment paper?

A. I desire to amend the previous answer by stating that I have looked over the book and find that on page 107 we made a lamp of vulcanized fibre.

2591 181 X Q. Now produce, if you can, your record of the experiment or test which you made with that lamp?

A. This book appears to be a record of lamps made, and another book, which is in evidence, of the results of the experiments in working the lamps. My counsel states that no record of the results obtained from the vulcanized-fibre lamp mentioned on page 107 is contained in the book.

182 X Q. So far as you know, do your record books contain an

account of any test made of a vulcanized-fibre lamp, meaning by that material such as you procured from Wilmington and subsequently vulcanized?

A. No, sir; I do not know.

183 X Q. What record do you find in your note books in regard to experiments or tests with lamps containing carbons made from Crane's parchment paper?

A. I find a record of lamps 79, 81 and 82, of which photographs are in evidence.

184 X Q. Will you explain the entry in relation to lamp 79, of which entry Edison's Exhibit N is a copy?

A. It seems that the filament of carbon before the current was passed through it, and while the globe was exhausted of air, measured 350 ohms. After the current had passed through the filament, it was found to have a resistance of 138 ohms. After burning for some time, it was reduced to 135 ohms. When sealed off of the pump, it measured 142 ohms. It means that it had a good vacuum—that is to say, the globe was in high vacuum.

185 X Q. Does it anywhere appear that any tests were made with that lamp after it was sealed off from the exhausting pump?

A. It is not in these two books; but I distinctly remember that these lamps, when they came off the pumps, were put up to the proper candle power and burned to be able to get their lasting time. That was our practice.

186 X Q. Does not your records give an account of the lasting time of some of your lamps?

2592 A. Possibly they do in some other book.

187 X Q. But, so far as you know, there is no record of the durability of this particular lamp 79?

A. I have not looked over the records. Possibly if I looked over them, I could find a record.

188 X Q. According to the entry in your record book in regard to lamp No. 81, of which entry the photograph Edison's Exhibit O is a copy, how high was the carbon heated measured by the color of the light?

A. From the record I should judge that the carbon was bright red, and while bright red a measurement of its resistance was taken, which is recorded as being of 320 ohms. It does not state what its resistance would be at any other incandescence.

189 X Q. Have you any record in regard to the tests made with lamp 80?

A. Yes, sir.

190 X Q. What is that?

A. I find, on page 238 of my book, the following record of lamp 80: "When cold before heating it was 1,100 ohms; after heating a moment it was reduced to 340; when I put the current suddenly it bursted at one of the ends."

191 X Q. Do you know how Crane makes the paper which is sold as Crane's parchment paper?

A. Not to my knowledge.

192 X Q. On page 15 of the twelfth bulletin of the Edison Elec-

tric Light Company, is contained the following: "The third point in Swan's first patent, and the first point of his second patent, is parchmentization prior to carbonization; Edison tested this as early as 1878, and he soon after mentioned it in a caveat, but he found no gain in this additional step of parchmentization; besides, it costs money and increases the cost of production of the finished lamp." What, if you know, is meant in that extract by the statement that Edison found no gain in this additional step parchmentization?

Objected to as incompetent and immaterial.

2593 A. That is an opinion of Major Wilber, counsel for the electric light company.

193 X Q. It professes to be the opinion of the Edison Electric Light Company, does it not?

A. I do not know; I understand it is the opinion of Major Wilber, given to the Edison Electric Light Company.

194 X Q. Did not the Edison Electric Light Company adopt that opinion before embodying it in this circular?

A. I do not know.

195 X Q. The bulletin was issued by the company and not by Major Wilber?

A. Yes, sir.

196 X Q. And does not profess to give the views of Major Wilber, but those of the company?

A. I do not know; the document itself is the best evidence what it purports to do or not.

198 X Q. What officer of the company prepares those bulletins?

A. That bulletin, I believe, was prepared by the vice-president.

199 X Q. You mean by Major Eaton?

A. Yes, sir.

200 X Q. How do you know it was prepared by Major Eaton?

A. Only from the fact that he prepares the bulletins; they all emanate from him.

201 X Q. Does he ever advise with you about the contents of them?

A. Sometimes he does.

202 X Q. You remember how it was with reference to this bulletin number twelve?

A. No, sir; I do not.

203 X Q. Is it true, in point of fact, that you have not gained anything by this additional step of parchmentization or is this a misstatement which the Edison Electric Light Company have sent out to its stockholders? 2594

A. As a matter of fact, I have obtained better results from the use of bamboo than from the use of parchmentized paper.

Objected to as not responsive, and question repeated.

A. As I have stated that bamboo gave me better results than parchmentized paper, and I think that is an answer.

204 X Q. That paragraph of the bulletin, now under discussion, assumes to compare Swan's carbons when made from paper which

was parchmentized prior to carbonization with carbons made from paper which was not parchmentized prior to carbonization, and the statement is that Mr. Edison found no gain in this additional step of parchmentization; meaning, of course, that he found that parchmentization was of no value in the preparation of carbons from paper. Please state whether, in point of fact, that is true, or is this declaration contained in the bulletin of the electric light company a misstatement?

Question is objected to by counsel for Edison as incompetent and immaterial, and as containing a statement of what can best be determined by reference to the paper itself.

A. It is true that there does not appear to be any advantage gained over unparchmentized paper by parchmentized paper.

205 X Q. Do your experiments with the two classes of paper demonstrate that?

A. It demonstrates that no apparent gain is obtained by parchmentizing the paper. But I believe there may be a gain if perfectly parchmentized material could be obtained.

2595 206 X Q. Does this appear from the record which you have made in your note books of your various experiments with the two kinds of paper carbons?

A. No, sir. We used all kinds of papers, both parchmentized and otherwise, and as the records show several were made with parchmentized paper, and had they been as good as the ones made with other forms of paper, we should undoubtedly have continued to use parchment paper in place of those other kinds of paper. Whether the material used was properly parchmentized or not might have been the reason why it did not give as good results as other forms of paper.

207 X Q. You parchmentized some of it yourself, did you not?

A. I tried to parchmentize some.

208 X Q. Did you fail or succeed in that attempt?

A. I parchmentized, but not so successfully as that which I purchased.

209 X Q. Have you seen this Exhibit H?

A. Yes, sir.

210 X Q. Did you parchmentize that?

A. No, sir.

211 X Q. Who did, if you know?

A. That would be hard to say who parchmentized that particular piece of paper, after a lapse of two or three years.

212 X Q. Is it some of Crane's paper?

A. My impression is that it is.

213 X Q. During the last of 1879, and the first of 1880, how many note books were in use in your laboratory at any one time?

A. I cannot say. There were a pile of them laying round the laboratory.

214 X Q. Was it your practice to leave blank places in your note books to be subsequently filled up either by yourself or your assistants at your leisure?

A. No, sir. We picked up the book and turned to the first blank page and entered what was desired on the page and dated it.

2596 215 X Q. Does the date show the date on which the entry was made or the date on which the experiment which is recorded was made?

A. Yes, sir.

216 X Q. Which one?

A. It was always our practice to put the date down on which the entry was made.

217 X Q. Did you never owing to pressure of business or otherwise omit to make an entry on a day when some experiment was performed, but leave blanks which you could subsequently fill up under that date?

A. No, sir; I do not think so. I think the books themselves will show the way the records were made.

218 X Q. How do the books show?

A. By the dates.

219 X Q. But if you were to leave blank pages and fill them up subsequently in consecutive order it would do, would it not?

A. We never followed that practice. Where a large number of experiments follow after each other the date is on the first page generally and no dates are on the other pages.

220 X Q. And that always means, does it not, that the record was made on the date which is given and has no necessary relation to the time when the experiments were made?

A. It means that where the date is put the entry was made on that date, but where no date was put it does not follow that the entry was made on the date of the first part of the experiment. Wherever there is a date it means that all of the records under that date on that page were made at the time on that day.

221 X Q. What does it show as to the date at which the experiment was made, before the thing was constructed, which is described in the entry?

A. It means that the experiment or thing was made on that date or finished on that date generally.

2597 221 X Q. Was the testimony which you gave in the interference between yourself on the one hand and Sawyer and Man on the other, a copy of which deposition is in evidence in this case, true?

Recess here taken for an hour.

A. The evidence which I gave in the Sawyer-Man interference with myself was true.

222 X Q. How many paper carbons for electric lamps, roughly stated, have you ever made or caused to be made?

A. Several thousand.

223 X Q. How many such have you ever sold or has the Edison Company sold?

A. I cannot state. I do not keep their books.

224 X Q. Of the several thousand paper carbons made, how many were made of parchmentized paper?

A. There might have been a dozen or so made in 1879 and I think as many as 100 in the latter part of 1880.

225 X Q. How many of these carbons made from parchmentized paper were sold?

A. I do not know. The lamp factory keep the accounts and they probably know how many lamps of these kinds of lamps were sent out with others.

226 X Q. Do you know that any of them were sold?

A. No, sir; I do not. We were making a large number of lamps, and whether these were mixed in with the others or not, I cannot tell.

227 X Q. Of the several thousand lamps with paper carbons, how many had carbons that were straight in the blank and then bent in the loop form before carbonization?

A. I did not state that there were several thousand lamps made. I said in answer to your question that there were several thousand carbons. Of the number of lamps made I think 75 to 100 and perhaps more were made from straight strips or filaments cut straight and bent in the form of a loop, and carbonized while so bent.

228 X Q. How many of these were sold?

A. I do not know.

2598 229 X Q. Do you know that any were?

A. I cannot tell whether they were mixed with the regular lot or not.

230 X Q. What do you mean by the regular lot?

A. We were making a large number of lamps every day from bamboo. These were the regular lamps.

231 X Q. Between what dates were these 75 or 100 lamps made? I mean lamps containing paper carbons that were cut straight and then bent before carbonization.

A. It was either in December, 1880, or in January, 1881, that the lot I spoke of were made.

232 X Q. How many lamps having paper carbons of all kinds have you ever made or caused to be made?

A. I cannot at this date tell how many, but I should judge that we made as many as 1,500, possibly 2,000.

233 X Q. When were those made mostly?

A. In the latter part of 1879 and the early part of 1880. Also I think a number were made in the early part of 1881.

234 X Q. Which did you find to be the best lamp, the one in which the paper carbon was cut out in horseshoe form or the one in which the paper was cut out straight and then bent in horseshoe form before carbonization?

A. It was not a question of the particular form of the paper. It was a question of the facility of manufacturing and carbonizing the paper in the different forms. It was a very difficult matter to cut the paper straight and then properly carbonize it when we first started, and the reason why we changed over to the other form was because it was easier to make them and carbonize them in this form.

235 X Q. And cheaper?

A. At that time it was not a question of cheapness.

235 X Q. Which is the cheaper, in fact?

A. Punching the blanks would be cheaper than cutting them out straight. But it is difficult to punch a long filament—that is to say, it is more difficult, I understand, than if in the horseshoe form.

2599 236 X Q. Which method of manufacturing gave you the better product, cutting straight and then bending and carbonizing, or cutting in loop or horseshoe form and carbonizing?

A. Owing to the difficulty of cutting in straight form, we only made a few lamps at first and adopted the other form. Therefore the comparisons at that time could not be made that would be correct. Besides, we did not know as much when we cut them straight as we did a few days afterwards, when we cut them the other way, and lamps made at one time would not be so good as they would be several days afterwards. But since that, while not the cheapest, the best way and most accurate method of cutting is in the straight form. It is the form we adopt in cutting out bamboo. But the mechanism is one of exceeding difficulty to make, even now, a single cutting mold costing from $100 to $250.

237 X Q. Is the reason for cutting the bamboo straight different from that which would lead you to cut the paper straight?

A. We could not cut the bamboo in the form of a horseshoe at all. We could have cut the parchmentized paper or vulcanized fibre in 1880 by punching in horseshoe form, but we preferred to cut it straight.

238 X Q. Why?

A. Because you can do it more accurately.

239 X Q. You found great difficulty in manipulating the blank after it was cut, did you not?

A. No, sir, because we had worked up to perfect means and methods, whereby it could be properly carbonized and brought out straight. It was only in the early days that we had the difficulty.

240 X Q. Which would be the most expensive process of preparing paper carbons to-day, to cut the blank in the loop form and carbonize it, or to cut it straight and then bend it and carbonize?

A. Cutting it straight would be the cheapest, although
2600 it might be punched in the form of a horseshoe, but punching is not the best way.

241 X Q. When I said cutting I meant to use the term in a sense broad enough to include punching as one form of cutting.

A. Both kinds might be punched. Then they would be equally as cheap.

252 X Q. Would there not be a special manipulation in the one case that would not be necessary in the other, and would not that add to the expense?

A. Both could be punched by punch and die. The punching straight might be more difficult than punching in the form of a horseshoe, by reason of the great length of the die, although when the die was made I could have punched with equal cheapness.

253 X Q. After you had punched out the blank you would have to use special appliances for bending and confining the blank in

form before carbonizing in the one case, that would not be necessary in the other, would you not?

A. Yes, sir.

254 X Q. Would that add anything to the expense?

A. Yes, sir.

255 X Q. Would it make that process more expensive than the other?

A. Yes, sir.

256 X Q. Then in reality it would cost more to make a paper carbon for an incandescent lamp by the process of cutting straight, then bending and carbonizing, than by the process of cutting or punching in loop form and carbonizing? Is that correct?

A. As far as the carbon itself is concerned it would, but as far as the manufacturing of lamps is concerned it would not, because the paper carbon cut straight is a better carbon than when punched in the horseshoe form, and less lamps would be lost in the process of manufacture. Hence the straight-cut carbon lamp would be less expensive, although the carbon filament itself might cost more.

2601 257 X Q. You mean to say, do you, that carbons prepared from the blank, cut straight and then bent, will be more durable than the other form of carbon?

A. I mean to say if it is cut straight.

258 X Q. You mean cut rather than punched?

A. Yes, sir.

259 X Q. Please compare two paper carbons which are made by punching out the blanks in the one case straight to be subsequently bent and carbonized and in the other case in horseshoe form, and tell me first, which of those would cost the most, and in the second place, which would be the best?

A. I should say the filaments in both cases could be made with equal cheapness. In carbonizing, the straight filament would probably cost the most. As to their quality, it would depend upon how both were carbonized.

260 X Q. When I asked you for the relative cost, I meant the cost of the carbon as finished and ready to be used in a lamp. Which one would cost the most?

A. If both were punched, I think the straight carbon would cost the most.

261 X Q. And which one would be the best?

A. I think the straight carbon would be the best.

262 X Q. Why?

A. Because the application of the strain and pressure to get them all alike can be better applied than if they were punched out in the horseshoe form.

263 X Q. What do you mean by the strain and pressure to get them all alike?

A. If filaments are carbonized without anything to retain them in shape or restrain them, they will curl in all kinds of shapes.

264 X Q. In carbonizing a blank horseshoe form would you not

adopt some means to prevent its curling and warping in every direction?

A. Yes, sir.

2602 265 X Q. Could not this be done as well with a blank cut in horseshoe form, as a blank cut straight and thent bent?

A. It possibly could be done.

266 X Q. If you were going to make a thousand incandescent lamps with paper carbons for exhibition to-day, would you prepare the carbons by making them in horseshoe form, or would you make them straight and then bend them?

A. I would make them straight and bend them.

267 X Q. Why?

A. First place, filaments cut and not punched are better, and it is easier to cut a filament straight than it is to cut it in the form of a horseshoe; and second, because we have means which experience has given us for restraining the carbon so as to prevent its warping, and producing them all of the same length.

268 X Q. You mean restraining a paper blank during process of carbonization?

A. Yes, sir.

269 X Q. When did you discover those means of thus restraining the paper blank when cut straight?

A. If you mean strips cut straight and carbonized straight, I discovered it in 1876.

270 X Q. No, I mean cutting straight then bending, and then carbonizing?

A. Some time in September or October, 1879.

271 X Q. Then you knew, did you, in September or *or* October, 1879, that you could make a better carbon out of paper by cutting the blank straight, and then bending it in a loop form and carbonizing?

A. No, sir; I did not.

272 X Q. When did you get this knowledge first?

A. I had no knowledge as between one or the other methods at that time. I simply adopted the horseshoe form on account of the case as against the other process at that time of making it.

2603 273 X Q. When did you first learn that it was easier to cut the blanks straight and bend them before carbonizing?

A. That is self-evident that it is easier to cut a straight blank than it is to cut a carbon blank like a horseshoe.

274 X Q. I will put the question in this form: When did you first discover that it was easier to make electric carbons out of paper by cutting the blanks out straight and then bending and carbonizing, rather than by cutting in loop form and carbonizing? You will please remember that this question includes the whole process of making the carbons, and not simply the first step of cutting out the blank.

A. We knew at the time that it was easier to cut these carbons straight than it was to cut them round a grooved form. But the straight carbon filaments presented difficulties in carbonizing. The others in horseshoe form did not present these difficulties in carbonizing. We were in a hurry to get some lamps and could not wait to work up all the details necessary to successfully carbonize as we wanted straight filaments.

275 X Q. Have you discovered since 1879 that it is easier, everything considered, to make paper carbons by cutting the blank out straight and then bending and carbonizing, than it is to cut the blanks out in loop form and carbonize them?

A. Yes, sir; besides, that is self-evident. When I say self-evident, I refer in all cases to carbons cut by a knife in contradistinction to carbons punched.

276 X Q. Which makes the best carbon, one produced from a blank which has been cut out of a sheet of paper with a knife, or one made from a blank cut from a sheet of paper with a punch?

A. The one cut by a knife, as a sharper and cleaner cut can be made, and it does not leave a burr or ragged edge.

277 X Q. When did you first discover that a paper carbon
2604 produced by making a blank straight, then bending and
carbonizing it was better than a paper carbon produced by
making the blank in a loop form and carbonizing it?

A. Do you mean both being cut by the knife?

278 X Q. Both being shaped by the same class of cutting instrument whether knife or punch?

A. If you will state whether by knife or punch, I will answer the question.

279 X Q. You may answer the question assuming it relates to the use of a punch.

A. I cannot give you the date of any discovery, but I can state that if both the horseshoe and the straight carbon were punched and then carbonized, and then put in a lamp, I think the lamps made with a straight carbon would be better lamps for the reason, as I have already stated, that the strains on the carbon can be better placed, and the carbons brought out more alike than in the case where they are punched out, laid in moulds one above the other with one weight common to all.

280 X Q. The same reason would apply if the blanks were formed by cutting with a knife?

A. Yes, sir, except that where the horseshoe is punched the burr or edge thrown up somewhat interferes with their proper application of the weight and their contraction as against the same kind of a loop having no burr but the weight applied equally over the whole surface of the filament.

282 X Q. How many paper carbons have you ever made where you cut out the blank in horseshoe form, using a knife for that purpose?

A. Several thousand.

283 X Q. Have most of your blanks been cut with a knife rather than a punch?

A. The horseshoes have.

284 X Q. How about the paper carbons where the blanks were made straight and subsequently bent? Were those cut out with knife or punch jointly?

A. They were cut out with a knife.

2605 285 X Q. Never with a punch?

A. No, sir; I do not remember of any.

286 X Q. If I understand you right, you have testified that you have made or caused to be made at least 1,500 or 2,000 incandescent lamps with paper carbons. Is that correct?

A. Yes, sir.

287 X Q. And of this number, if I understand you aright, some 75 or 100, more or less, had carbons which were made by cutting the blank straight and then bending and subsequently carbonizing it. Is that correct?

A. I think I have made as many as 150 lamps in the latter manner.

288 X Q. Most of these 150 lamps last referred to were made, if I understand you, in the latter part of 1880, or early in 1881. Is that correct?

A. Yes, sir.

289 X Q. And at that time you knew, did you not, that it was easier to make the carbons in that way, namely, by cutting the blank out straight and then bending and carbonizing it, than by making it in horseshoe form and carbonizing it? And you also knew, did you not, that it would make a better carbon by cutting the blank out straight, then bending and carbonizing, than to make it in horseshoe form and carbonize it?

A. I knew at that time that it would be cheaper to cut it out straight than it would be to cut it out by a knife in a grooved form like a horseshoe. And I also knew that with my approved appliances it would be a better carbon.

290 X Q. And yet you adopted for your lamps generally a more expensive mode of manufacturing the carbon and a mode which gave you an inferior product. Is that correct?

A. No, sir; I have stated the opposite.

291 X Q. Which of the two modes of making these carbons do you now say gave you the best product?

2606 A. The best way would be to cut them straight, bend them in the form of a horseshoe or loop, and carbonize them.

292 X Q. That is because it gives you the best product?

A. Yes, sir.

293 X Q. And it would be the easiest way?

A. With my present appliances it would be the easiest way.

294 X Q. And you knew in 1879 that it was the easiest way, did you not?

A. I knew in 1879 that it was the easiest way to cut, but not the easiest way to carbonize them.

295 X Q. When did you learn that it was the easiest way to carbonize them?

A. I knew at the time, by working up the details, it would be as easy to carbonize them, although it might be more expensive on account of the molds and things necessary.

296 X Q. Is it not a fact demonstrated by the entries in your various note books, that the paper carbons which you have made

from the blanks cut out in horseshoe form, have behaved better in lamps than those which you made by cutting the blanks out straight and then bending and carbonizing them?

A. They behave better for the reason that I have already stated about ten times, that the trouble was in carbonizing those cut straight and as I had not time to go ahead and experiment on devices whereby I could eliminate this defect in carbonization I adopted the more ready plan of cutting them out in horseshoe form for the ease with which they could be carbonized.

297 X Q. What experiments have you made since 1879 which justify you in saying that a carbon made from cutting a paper blank out straight and then bending and carbonizing is superior to those made by cutting the blank out in horseshoe form and then carbonizing?

Objected to as incompetent and immaterial.

2607 A. I remember that when in the early part of 1880 we got a straight cutting mold, and had worked up devices whereby straight carbons could be carbonized in a proper manner, that the lamps made with these straight carbons bent in the form of a loop and carbonized gave better results and lasted longer than the ones previously made by cutting it in horseshoe form.

298 X Q. Will you please produce your records of the experiments to which you have made reference in your last answer?

The question is objected to as incompetent and immaterial, and the witness is instructed that he need not produce records of inventions not bearing upon this controversy which have not already been patented.

A. I suppose I could find records if I should look through my books. They are not here.

299 X Q. Where are the books to which you refer?

A. I think some are at my house; perhaps some of them are in the possession of the electric light company.

300 X Q. That is in this building, is it not?

A. Yes, sir.

301 X Q. Do you know if there are any records in your note books that would bear out your statement as to those experiments made early in 1880?

A. I do not know, but I think there might be. As I cannot tell what any examination will lead to, I cannot tell what matter to introduce beforehand.

302 X Q. Will you, before the close of the testimony in this interference, produce such records as you may have of those experiments made in the year 1880 which lead you, as you state, to the conclusion that a paper carbon made by cutting the blanks straight and then bending and carbonizing was better than one made by cutting the blank in horseshoe form and carbonizing?

A. If my counsel will permit me I will look over the records, and if I find anything bearing on that subject, if they will permit, I will introduce it.

2608 303 X Q. If we hear nothing from you in that regard, may we conclude that you have found nothing?

A. No, sir.

304 X Q. Would not that be a logical conclusion; you agree to produce the records if you find them; now would it not be fair to assume that if we do not hear from you, you have not found any such record?

A. If my counsel instructs me that I need not produce anything, I shall certainly not take the time to go over a vast amount of records to find the matter in question, as it is not an easy job.

Counsel for Maxim states that inasmuch as the witness has testified in substance that probably such records exist, it will be assumed that inasmuch as the witness has said that if he should find records to that effect he will produce them, it will be assumed at the hearing of this interference, if such records have not been introduced that they do not exist.

Counsel for Edison replies that counsel for Maxim has misstated the substance of the witness's testimony, in this that the witness really stated that he would examine his records and produce them if permitted to do so by counsel. Therefore his inability to do so does not in any sense imply that such records do not exist. Counsel for Edison further states that inasmuch as the records of experiments called for bear simply upon the witness's judgment as to the comparative cheapness and utility of the two classes of carbons, they are immaterial upon the issues of this controversy, and the witness will be instructed not to produce them.

305 X Q. How many lamps with paper carbons did you make, or cause to be made, during the year 1881; state approximately if you can?

A. I have already stated that I think 75 or 100 lamps having paper carbons were made either in December, 1880, or January, 1881. I do not now remember any other in 1881.

306 X Q. Why did you make those at that time?

2609 A. Because I wanted to make a comparison between the life of the lamp made with bamboo and with paper, vulcanized fibre or parchment paper.

307 X Q. How many lamps with carbon paper did you make in 1882? State approximately.

A. I did not make any myself; whether any were made at the lamp factory I cannot state.

308 X Q. Then almost all the lamps with paper carbons which you have made were made in 1880, were they?

A. In 1879 and 1880.

309 X Q. You have testified about certain lamps having paper carbons made in 1877; will you state more explicitly what those were?

A. Have I so testified in this interference?

Question withdrawn.

310 X Q. Did you make any lamps having paper carbons in 1877?

A. Yes, sir.

311 X Q. How many?

A. One lamp that I now remember of.

312 X Q. How many carbons did you try in that lamp?

A. Several.

313 X Q. How were those carbons made?

A. Made by carbonizing paper.

314 X Q. Explain fully the process of making them as to shape, manipulation and other details.

A. It is a long while ago and I have not refreshed my memory on the subject, but I will try and remember as near as possible. Strips of paper were cut out and placed in an iron mold with a weight on top of the paper strips, and put into a stove and carbonized. The strip was then taken out, put into a lamp, and clamped, the base of the lamp put over a hand pump, the air exhausted as far as possible and the current passed through the carbon.
2610 An experiment on the pump under the bell glass, was made with a loop of carbon carbonized in charcoal by means of heat from paper. The carbon being mounted in clamps and the bell jar put over the whole, the air exhausted from the bell jar and the loop heated by the passage of a current. Also straight strips of carbon were put in between clamps, and bowed out initially so that any contraction would not break the carbon.

315 X Q. Is that all you recollect about those experiments?

A. It is, sir, at the present moment. I should have to refresh my memory.

316 X Q. How would you do that? By any memorandum that you have?

A. Yes, sir.

317 X Q. Have you a memorandum of those experiments?

A. I think I have.

318 X Q. Where is that?

A. I do not know where they are now. Perhaps in the building.

318½ X Q. When was the memorandum made?

A. I cannot remember.

319 X Q. Made at the time of the experiments?

A. I cannot remember.

320 X Q. But you are confident you have such a memorandum?

A. I think I have.

321 X Q. In what shape is it? In one of your regular memorandum books?

A. No, sir; I think not.

322 X Q. In what shape is it?

A. On a piece of paper.

323 X Q. It is probable that you made it at the time of the experiment, is it not?

A. Yes, sir; it is probable.

324 X Q. Yet you would not swear to it?

A. No, sir; I have not refreshed my memory on it at
2611 all. It is so long ago and so many things have passed
through my mind since.

325 X Q. How lately have you seen that memorandum?

A. I do not think I have looked at anything relating to that subject for over a year. I am sure I have not.

326 X Q. Do you think you saw that memorandum a year ago, or at any time within two years?

A. I cannot remember.

327 X Q. Who assisted you, if anybody, in making those experiments in 1877?

A. I think Charles Batchelor and James Adams.

328 X Q. Anybody else?

A. Perhaps John Kreusi; I am not certain.

329 X Q. What kind of paper was used in making carbons used in those experiments?

A. I cannot remember without refreshing my memory.

330 X Q. Did you not use parchment paper then?

A. Very possibly.

331 X Q. Why do you say very possibly?

A. Because my laboratory is well stocked with every kind of material.

332 X Q. Was it at that time?

A. I think we had a pretty good supply of different materials.

333 X Q. Do you think you did use parchment paper?

A. I cannot tell without refreshing my memory.

334 X Q. Did you not testify in the interference case between yourself and Sawyer-Man referred to in your present deposition that you thought those carbons with which you experimented in 1877 were made of bristol-board?

A. I do not remember. I have not read my evidence in the Sawyer-Man case since it was taken.

335 X Q. If you did so testify in that case, is it probable that those carbons you made were of bristol-board?

A. If at the latter end of my testimony in that case,
2612 after having my memory refreshed by being some time on
the stand, I did not state that I used parchment, it is probable that we did not use parchment paper.

336 X Q. Do you now say that you think you used parchment paper in 1877 or bristol-board?

A. I said that we might have used it.

337 X Q. But you have no present recollection as to what in fact you did use?

A. Not without refreshing my memory.

338 X Q. Had you refreshed your memory upon this point when you gave your direct testimony in the present interference?

A. No, sir; I do not cram for a case. I have not time.

339 X Q. Have you not testified in the present interference that you did use parchment paper in those experiments in 1877?

A. I do not remember of having so testified. I remember, I think, of testifying in the Sawyer-Man case that I used parchment paper, but I think this referred to 1879. In the present interference I may have testified that we used parchment paper, but I do not remember it now. Since testifying I paid no attention to the matter whatever.

340 X Q. Can you now remember about how many paper carbons you experimented with in 1877?

A. There might have been six or eight—possibly twelve.

341 X Q. And some of them were in loop form, were they not?

A. Yes, sir.

342 X Q. Do you recollect what you testified in the Sawyer-Man interference as to the shape of those carbons?

A. No, sir.

343 X Q. Did you not testify that they were straight?

A. Some were straight. As a matter of fact they were not exactly staight, as they had to have an initial bowing to prevent them
2613 being broken or contracted after the current had been put
on. I do not think the question in interference with Sawyer-Man related to what particular shape the carbons were in.

344 X Q. How large light did you get from those carbons in 1877?

A. I think they oxidized immediately, and possibly we *we* got three or four candles; very difficult to judge.

345 X Q. Why difficult to judge?

A. Because even now an expert cannot tell whether a gas jet is giving ten or twenty-five candles by looking at it.

346 X Q. He can measure it, can he not?

A. Yes, sir; but we had not reached the photometer at that time.

347 X Q. Then you simply guessed at the candle power of those carbons in 1877?

A. Entirely a guess.

348 X Q. And you estimated about three or four candles?

A. At this present moment I estimate that they might have given two to eight candles; possibly more, possibly less. Very difficult matter to judge it.

349 X Q. Do you think any one of them gave as much as two candles light?

A. It is a very difficult matter to state the candle power. Some of the experiments were tried in the daytime, they did not last long enough to judge much about it.

350 X Q. How long did they last?

A. Well, perhaps a minute or two minutes. Some of them went out almost immediately.

351 X Q. Do you think that any one of them lasted two minutes?

A. Without refreshing my recollection I do not think they did last two minutes, any one of them.

352 X Q. Perhaps not as much as two minutes?

A. Yes, perhaps not as much as two minutes.

353 X Q. Would you be willing to swear that any one of them lasted one minute?

2614 A. No.

354 X Q. Those experiments of 1877 took place in August?

A. July, August or September.

355 X Q. After that, when next did you make any lamps having paper carbons?

A. In the winter of 1878.

356 X Q. How many lamps did you make then?

A. I cannot now remember without refreshing my memory; I think we made a number of carbons out of rolled-up paper. I think we only tried experiments with the carbons.

357 X Q. That is, without putting them into lamps?

A. We made a kind of a contact lamp, in which we used these paper carbons where the light was given out by bad contact between a piece of metal and the carbon.

358 X Q. Have you any record of those experiments made in the winter of 1878?

A. Yes, sir; I think I have. I think they were included in the Sawyer-Man interference.

359 X Q. Do you know how many carbons you made at that time?

A. They were made, I think, by a man named Martin Force; also by Mr. Batchelor; I do not know *know* exactly how many they made; perhaps as many as twenty or thirty.

360 X Q. And perhaps a less number?

A. No, I think they made as many as twenty

361 X Q. Your note books would show?

A. I do not know whether they would show the number; I think I have testified as to the number in the Sawyer-Man interference.

362 X Q. Is it not a fact that your experiments with carbon paper in 1877 made so little impression upon your mind that when you prepared your preliminary statement in the Sawyer-Man interference you omit all mention of those experiments?

2615 A. The main thing that was in my mind was a lamp made of a filament of carbon independent of the particular quality of material or cellulose used, and as the experiments of 1877 as to electric lamps were failures they did not impress me one way or the other; certainly not as to material.

363 X Q. You made no mention of those experiments of 1877 in that preliminary statement?

A. I do not remember whether I did or not; I think I had my attention called to the fact afterwards by other parties.

364 X Q. Did not the Sawyer-Man interference relate to a paper carbon, and was not the question involved there one of priority between yourself and Sawyer and Man as to the alleged invention of the paper carbon?

A. Yes, sir; but at the time the preliminary statement was made I had given the subject very little attention, and my mind was full of the fact that they were endeavoring to deprive me of the use of a filament of carbon, and paper in my mind then was a secondary consideration. When I make a preliminary statement I generally put into it what I remember at the time, without looking up my notes and memoranda, because I seldom have time; but afterwards, in collecting all the data, and talking with other people, I then have my memory refreshed about things which I had forgotten; to remember all the experiments made by me in the last eight*h* years would require a very prodigious memory.

365 X Q. Did you not say in your testimony in the Sawyer-Man interference that in making your preliminary statement in that case you had forgotten about the experiments of 1877 because "the results were probably not sufficiently satisfactory to impress it on your mind"?

A. I probably did say so.

366 X Q. Was that statement then made by you true?

A. Yes, sir.

2616 *8*67 X Q. You say that you had in that year 1877 one lamp in which you used paper carbons; how was that one lamp constructed?

A. We had a lamp spiral removable from the pump, which is called a Gassiot cascade, which could be exhausted by placing it over the mouth of the pump.

368 X Q. Where was this so-called lamp at the time you passed the current through the carbon; was it on the air pump or elsewhere?

A. I think we tried two or three carbons in the lamp. The carbon was lighted while the lamp was on the air pump, it might have been taken off and set on something as it had a cock whereby we could cut off the connection between the globe and the pump, and disconnect the lamp from the same and set it in any position we desired from the pump.

369 X Q. Why did you stop your experiments with paper carbons in 1877, in August or September, and not renew them again till the winter of 1878?

A. Because we had such hard work in getting a vacuum whereby the carbons would remain stable. We renewed them in 1878 because we were going to use the carbon in a condition where it did not require a vacuum. Although I think we also tried them in a vacuum

370 X Q. Did you not testify in the Sawyer-Man interference that the carbons with which you experimented in 1878 in the so-called lamp which you then had were straight?

A. I remember that the carbons were rolled up and therefore were bent, but the whole formed a straight piece of carbon. But the paper itself was bent.

371 X Q. Please explain a little more fully your meaning?

A. The paper was rolled up like a tube and then carbonized. The tube was straight.

372 X Q. Then you do not wish to be understood as saying that these 1877 paper carbons were brought into the loop form?

2617 A. Some of them were loops. The ones which I have testified as straight had a loop in them for the purpose which I have before stated. The others were in the form of a loop and secured to a rigging on the pump over which a bell jar was placed.

373 X Q. When was the carbon brought into the loop form?

A. The ones that were straight, as I have stated, were bent before they were carbonized, while the other ones in the form of a loop were carbonized while in a bent condition in charcoal.

374 X Q. Were those carbons which you say were in loop form made by rolling up a strip of paper and then bending it?

A. No, sir.

375 X Q. How were they made?

A. Small strips of paper bent round in the form of an arch and placed in charcoal and carbonized.

376 X Q. And those were used in the Gassiot cascade?

A. No, sir. They were used on a rigging on the face of an air pump, over which the bell jar was placed.

377 X Q. Will you produce the memorandum of your experiments with paper carbons in 1877. Also the memorandum of your experiments with paper carbons made in 1878?

A. I will try and produce them.

Adjourned until Saturday, May 26th, at 10 a. m.

NEW YORK, *May 26th*, 1883.

Met pursuant to adjournment.

Parties present as before.

THOMAS A. EDISON resumes the stand and cross-examination continued:

2618 By Mr. DUNCAN, counsel for Maxim:

378 X Q. Have you made search for, and can you now produce the memoranda or any of them called for by the last question?

A. No, sir; I have not had time.

379 X Q. Have you made search for, and can you now produce any of the other memoranda or records called for during this cross-examination?

A. I have not made any search for exhibits at all.

Counsel for Maxim calls upon the counsel for Edison to produce for inspection such memoranda as have been called for in the course of the cross-examination of this witness.

Redirect examination by Mr. R. N. DYER, counsel for Edison:

380 R. D. Q. What has been your practice in regard to applying for patents upon modification in details of principles upon which you have been working, that you have successfully and practically used?

A. I do not think I understand the question exactly.

381 R. D. Q. Did you hear the question?

A. Yes.

382 R. D. Q. Has it been your practice to apply for patents upon all the modifications in the matter of detail upon principles that you have been working upon?

A. No, sir.

383 R. D. Q. Did you or not make many successful experiments

and embody the principles experimented upon in practical working apparatus, before the end of 1879, upon which no applications for patents were filed up to May 27th, 1881, and, if yea, give some general idea of the number?

Counsel for Maxim objects to the question as immaterial.

A. Yes; perhaps a dozen.

2619 384 R. D. Q. Did you or not use any kind of paper for the carbon filaments of electric lamps, and produce practical and operative lamps therefrom, before the end of 1879, upon which no applications for patents were filed up to May 27th, 1881, and if yea, state as nearly as you can the number, and name such specifically as you can now remember?

A. I will, without referring to books, answer from memory. I think a great many lamps were made containing different kinds of paper, on which no patents were applied for up to May, 1881; for instance, we made good operative lamps of manilla paper, United States currency paper, bond paper, parchment paper, bamboo paper, linen paper, bibulous paper, bibulous paper soaked in carbonizible compounds, straw paper, wood paper.

385 R. D. Q. Was the article in "Scribner's Monthly" in evidence intended to include, and did it as a matter of fact include, all the materials that you had used and made successful and operative lamps from up to the time of its preparation for publication?

Counsel for Maxim objects to the question unless the witness should admit that he was responsible for said article.

A. No; it was not a scientific article, but an article intended to give a general idea. It would be entirely out of place to describe all the experiments in an article of such a character. It does not include a fraction of the experiments tried, or the articles used in making incandescent lamps.

386 R. D. Q. I now call your attention to the twelfth bulletin of the Edison Electric Light Company in evidence, and to the second paragraph contained on the fifteenth page of the same as follows: "The second claim in Mr. Swan's first patent is for a straight strip of paper bent into a loop or horseshoe. This was the form first used by Edison, and probably by every other experimenter on lamps, but Edison improved upon it. His improvement consists in cutting the paper into shape instead of bending it, it being evident to any one that by cutting paper into exact shape greater uniformity 2620 of result can be obtained than by bending, and no special care about work is needed in insuring that all loops shall be uniform." Please state if the foregoing statement is true as a matter of fact, and that you authorized the same; or if your attention was specially called to the language used before or after the publication of the bulletin?

A. It is not true. My attention was not called to it; I did not authorize its being made. When properly qualified it might be true.

387 R. D. Q. You may make any explanation in regard to this bulletin and the special statement referred to, as you may desire.

A. I have nothing much to say about this bulletin except that it is published by the Edison Electric Light Company, and I have no authority over what goes into it, and I do not read it half the time. I know nothing of their opinion. I do not remember of ever reading it before being brought into this case. I stated that the paragraph in question might be true if qualified. If we consider the great difficulty of getting good carbons by proper devices for carbonizing them in a bent form, as against the simpler method of cutting them out, and carbonizing a number under pressure without these devices necessary with a bent carbon, then the statement would be true. It states that, "It is evident that by cutting paper in exact shape, greater uniformity can be obtained than by bending." This is not correct, because the filament can be cut straight with greater uniformity than if cut in a horseshoe shape; and the fact that at the time this bulletin was printed, and for a long time previous to that, all our lamps were made by cutting straight and bending, shows that the statement here is not correct when not qualified; so that our practice a long time previous, and at the time that the bulletin appeared, refutes the statement in the bulletin.

388 R. D. Q. Is there any other statement in the article on the Swan patent in that bulletin about which you wish to make an explanation—I call your attention to the last page of the article?

2621 A. In the third article it states that all the things claimed by Swan have been tried and discarded by Edison. That is to say, discarded for simpler and more economical means or more efficient means. I desire to state that the word "discarded" if meant abandoned, is not correct. The reason why the specific things are not used is because we have better things. If any person desires to give an order for any of those things we are ready to make them.

389 R. D. Q. Are you able now to make and furnish upon order, by the use of the methods pursued by you in 1879, commercial incandescent lamps provided with filaments of carbon made by cutting paper into straight strips and bending into the form of loops and carbonizing, and also commercial lamps made by the use of parchmentized paper?

A. Yes, sir.

390 R. D. Q. What proportion, if any, of the carbon filaments made by you before 1881, by cutting straight strips from paper or card-board and bending them into the form of loops, and then carbonizing, were either soaked with tar or lamp-black, or both?

A. I do not remember that any were coated with tar or lamp-black; I think several carbons were coated in tar. That is all.

391 R. D. Q. Please answer this question with regard to lamps provided with filaments of carbon made of parchmentized paper before 1881?

A. I am certain we did not soak or coat any parchmentized paper filaments with tar or lamp-black.

392 R. D. Q. Does the fact of the use of tissue paper in carbonizing between flat cut blanks signify in any way that the blanks were coated with tar or lamp-black, or both?

A. No, sir.

393 R. D. Q. Could you now, by the use of the blanks of 2622 carbon, the carbon placed with grooves, and the other devices that you have testified you used in 1879, make successful lamps with filaments cut straight from paper and bent into the form of loops before carbonization?

A. Yes, sir; we made them at the time and can do so now with the devices used at that time; but as I have already testified it was more difficult than with the flat carbons at that time. Not so great a percentage of good carbons could be obtained as by the other process.

394 R. D. Q. In addition to the statements made in your direct examination, and in your cross-examination by counsel for Swan and Maxim, have you now any further statement to make in regard to the use of parchmentized paper for carbons for electric lamps in 1877?

A. Yes, sir; I have been thinking the matter over last night, and I now know that I used parchmentized paper in 1877 for electric lamps.

395 R. D. Q. Have you examined the commercial Swan lamp of to-day?

A. Yes, sir; I have examined lamps made by Swan in England and imported into this country.

396 R. D. Q. What is the form or shape of the filament of carbon used in the Swan lamp?

Objected to as immaterial by Mr. Witter.

A. It is in the form of a spiral.

397 R. D. Q. Do you know the material of which that spiral is constructed?

Same objection.

A. I have received samples of material from England which is said to be that used for making his lamps, with the statement that it is parchmentized thread. From investigation with his lamp I find that he does not use the parchmentized thread to give light, but his carbon is coated with a deposit of hard carbon which radiates the light. This method is used by most all the makers of my lamp to cover up and render useful the filaments of car- 2623 bon which they do not seem to have learned how to make in a proper manner without the use of this coating of hard carbon.

398 R. D. Q. Do you find it necessary to employ this coating yourself?

A. No, sir.

Recross-examination by Mr. DUNCAN:

399 R. X Q. What do you understand to be the real object of this coating of hard carbon in such lamps as the Swan, and others referred to in your last answer but one?

A. They seem to have defects in the carbon which they state that this deposit of hard carbon eliminates and makes the lamp better.

400 R. X Q. The light as you understand it, is given off by the coating of hard carbon?

A. Yes, sir; when the hard carbon is deposited from the gas, the filament is very perfectly coated, so that the surface of the original filament is covered entirely by a coating of hard carbon which radiates light.

401 R. X Q. In that case what function does the parchmentized thread play in such a lamp as the Swan lamp?

A. It is used as a blank to effect its coating.

402 R. X Q. What other lamps did you refer to in the answer in which you have described the construction of the Swan lamp, when you spoke of most of the existing lamps as having blanks coated with hard carbon?

A. I referred to Lane-Fox, the Maxim, and other lamps on the continent of which I have had samples, but do not now remember the names of.

403 R. X Q. Is it your understanding that in all of these lamps which you have named, the light is given off by the coating of hard carbon, and that the original blank serves simply as the filament upon which to deposit that hard carbon?

2624 A. It is a combination filament, the original filament being a blank upon which the hard carbon is deposited, and if entirely coated, the hard carbon gives off the light, although the original filament acts as a conductor to the current as well as the outside coating of carbon, the whole forming a compound filament of carbon of two different qualities.

404 R. X Q. How have you refreshed your memory since yesterday as to the nature of the experiments which you made in 1877, particularly as to the character of the paper which you then used?

A. By thinking over the subject. I have already testified in some interference, that owing to the very poor character of the results obtained at this time, that it had not impressed itself upon my memory.

405 R. X Q. Did you use any parchmentized paper in making electric carbons in 1878?

A. Yes, sir.

406 R. X Q. Of whose manufacture?

A. I don't know.

407 R. X Q. How many carbons did you make in that year from such paper?

A. Mr. Batchelor, I think, made the carbons. I don't know how many he made with parchment paper. He made some.

408 R. X Q. It is a fact, is it not, that in 1879 you found it more difficult, with the appliances which you then had, to make good car-

bons for electric lamps, by cutting the blank out straight, and then bending and carbonizing it, than by first cutting it in horseshoe form and carbonizing it?

A. We found it more difficult to get as great a percentage, but when we did get one it was all right.

409 R. X Q. Will you explain precisely how you managed in cutting out those straight blanks in 1879?

A. Some were marked off by a lead pencil running around a form, and then cut with scissors, and others were cut between straight edges.

2625 410 R. X Q. How did you manage at that time in cutting out your curved blanks?

A. We made a form, which was doubled, and put the paper between the two parts of the form, and cut around the edges with a knife.

411 R. X Q. Of the carbons made with those two kinds of blanks, which proved to be the best?

A. I do not think we have put any records in evidence showing which was the best. I have stated that the carbons cut straight can be cut better and evener than those cut in a round form. I think I have some records in 1880 of blanks cut straight and carbonized while bent. I have not looked up the matter. It was not a question at that time of which was the best, but which was the most convenient way to get out the carbons.

412 R. X Q. Still, it is a fact, is it not, that of the carbons made in 1879, a larger percentage proved good when made from blanks cut out in a curved form, than when made from blanks cut out straight?

A. A greater percentage of the carbon filaments put in the mould came out good when cut in the form of a horseshoe than when cut straight and bent.

413 R. X Q. And how about the relative value of those carbons, when completed, at that time?

A. I think the carbons were as good, if not better than the others when we did get a good one; that is to say, when we did get a good straight carbon, it was as good if not better than a good carbon cut from a horseshoe; it is a mechanical question entirely.

414 R. X Q. Do your record books show that the one kind of carbons was as good if not better than the other?

A. None of those in evidence.

415 R. X Q. Do any others show it?

A. Perhaps they do; I have not looked.

416 R. X Q. So far as you know, do they?

A. I could not tell without looking to see.

417 R. X Q. You don't know then, that they do?

A. I do not know that I have records containing the re-
2626 sult of a competitive experiment between the two kinds, but
I think very probably that I have.

418 R. X Q. If you have, will you please produce such records and make them a part of your testimony?

A. If I have time I will look the records over, and if I find anything I will annex it.

419 R. X Q. You have, on your redirect examination, referred to the following paragraph in the twelfth bulletin of the Edison Electric Light Company, which is as follows: "All that Mr. Swan claims are only some minor features of alleged improvements, but it is doubtful if they really are improvements, all of them having been tried and discarded by Edison for simpler and more economical means equally or more efficient for the ends sought, long before Mr. Swan's patents were issued." You have said that under one interpretation of the word "discarded" this statement is not correct. Please state under what interpretation of the word "discarded" this statement would be correct.

A. For instance, if I were making a certain kind of lamp by one method, and I had devised another lamp with another method which was far superior to the previous one employed, I might stop making the inferior one and go ahead with the superior one. The word "discarded" might be employed to explain the stoppage in making the first kind or inferior lamp.

420 R. X Q. With that interpretation of the word "discarded," would that statement quoted from the bulletin be true?

A. It would be true that I do not use parchment paper, but do make lamps of filaments of bamboo cut straight and bent in the form of an arc, and carbonized while so bent.

421 R. X Q. I still desire to ask you whether the paragraph in question is true, except as the word "discarded" is to be qualified in the manner you have indicated?

A. It is true that I do not use parchment papers. It is 2627 also true that I do not use parchment paper cut straight and bent in the form of a loop, and carbonized while thus bent, at the present time. But I will fill orders for the same.

422 R. X Q. I understand you, on your redirect examination, to criticize this paragraph of the bulletin because the word "discarded" is liable to a misinterpretation. Have you any other criticism to make upon the accuracy of this paragraph, and if so, what?

A. I have no desire to make any further criticism.

423 R. X Q. So far as you know, is the paragraph susceptible of any other criticism?

A. Perhaps it may be.

424 R. X Q. What?

A. It is open to the criticism that the paragraph is not sufficiently explanatory.

425 R. X Q. Is it open to the criticism that it is not true, assuming your interpretation to be put upon the word "discarded"?

A. I cannot make any statement about the truth of the matter when the paragraph itself contains the words "it is doubtful."

426 R. X Q. Do you mean, then, to say that it is not doubtful?

A. It would be doubtful for a man to make an improvement on a thing which I had previously made in the same manner.

427 R. X Q. You said on your redirect examination, making reference to the second paragraph of page 15 of the twelfth bulletin of

the Edison Electric Light Co., that your practice at the date of the said bulletin, and for a long time prior thereto, refutes this statement contained in the bulletin. You, of course do not mean by that to imply that at the date of the bulletin—which is July 27, 1882—you were making the electric lamps with paper carbons?

A. No, sir; only in respect to the fact that we were cutting filaments straight, bending them and carbonizing them while so bent.

2628 428 R. X Q. Those filaments were made from bamboo?

A. Yes, they were made of bamboo, but in 1880 we made some of parchment paper.

429 R. X Q. And in making carbons from bamboo it is necessary to cut the blanks out straight, is it not?

A. Yes, sir; but it was not necessary to cut the parchmentized paper out straight that I made in 1880; nevertheless, we did so for the reasons that I have already testified to.

430 R. X Q. And it is practically impossible, is it not, to cut the bamboo blanks out in horseshoe form?

A. No, it is possible.

431 R. X Q. And to make carbons efficient for commercial lamps?

A. I have never cut out any in this form, but bamboo, if the stick is large enough, can be cut green, and flattened and shaved, and from which loops would be cut. Whether they would be commercially efficient I do not know. Narrow splints shaved down with an eighth of an inch wide might be cut with facility in the form of a loop.

432 R. X Q. You do nothing of that kind in your commercial lamps?

A. No, sir.

433 R. X Q. And never have?

A. I don't remember.

434 R. X Q. You understand the second paragraph on the 15th page of the twelfth bulletim to relate to lamps having carbons made from paper, do you not?

A. It is hard to say what the interpretation may be. It states: "The claim in Mr. Swan's patent is for a straight strip of paper, bent in a loop or horseshoe;" then it also states: "This was the form first used by Edison." Now, whether it refers to the form of the thing independent of the material, or whether in speaking of the form it means a paper form, it is difficult to say. Several interpretations might be put upon the paragraph.

2629 435 R. X Q. I asked you for your understanding of that paragraph; whether you do not understand that that paragraph is dealing with the subject-matter of Swan's second claim, and whether you do not understand that second claim to relate to a carbon made from paper?

A. It is stated in such a muddy way that I cannot understand it.

436 R. X Q. The paragraph in question is as follows: "The second claim in Mr. Swan's patent is for a straight strip of paper bent into a loop or horseshoe. This was the form first used by Edison, and probably by every other experimenter on lamps, but Edison

improved upon it. His improvement consists of cutting the paper into shape instead of bending it, it being evident to any one that by cutting paper into exact shape, greater uniformity of result can be obtained than by bending it, and no special care or work is needed in insuring that all loops shall be uniform." Do you not understand that that paragraph relates to carbons made from paper?

A. No, sir; I cannot understand whether in this paragraph he means the bare fact of cutting straight and bending, or whether the main thing was paper and did not refer to any filament cut straight and bent.

437 R. X Q. Do you understand that the making of a carbon out of bamboo, cut straight and bent and carbonized, would be an anticipation of Swan's second claim, which, as referred to in that paragraph, relates to a paper carbon?

A. No, sir; the claim is for paper.

438 R. X Q. You state on your redirect examination that among the various inventions made by you before the end of 1879, and on which you had not applied for patents prior to May 27th, 1881, there were carbons made from manilla paper, from linen paper, from straw paper, from United States currency paper. Have you made any applications for patents on these various kinds of paper since may 27th, 1871?

2630 Counsel for Edison objects to the question as incompetent and immaterial, and the witness is instructed that he need not answer the same.

Cross-examination by Mr. H. A. Seymour, counsel for Swan:

439 R. X Q. In your answer to the first question on redirect, you do not mean to be understood as stating that it is not your practice to apply for and obtain patents on modifications which are in your opinion of value and importance, do you?

A. If the modifications are of value and importance I generally apply for a patent.

440 R. X Q. And also you generally embody such modifications in caveats, do you not?

A. Of late years I have not filed many caveats; most all are embodied in applications.

441 R. X Q. Was the carbonized paper used by you in 1887 in experimenting, as you have testified, pieces of paper originally carbonized for the purpose of conducting experiments on improvements in telephones?

A. I think some of the paper used in experiments in 1877 was carbonized for another purpose, perhaps some of the carbon used had been previously used in the telephone.

442 R. X Q. You are quite positive of this fact, are you not?

A. No, sir; not perfectly positive.

443 R. X Q. Will you please give the date of your first application wherein you mentioned the employment of paper for the manufacture of carbon for incandescent electric lamps?

A. I think the first patent is No. 223,898, filed November 4th, 1879, and I think it is the first application.

444 R. X Q. Your 1878 experiment was conducted in a lamp of substantially the construction as that shown in the patent No. 224,329, dated February 10th, 1880, was it not?

A. Yes, sir.

2631 Counsel for Swan here gives notice that he will introduce in evidence a printed copy of letters patent No. 224,329, granted to T. A. Edison, February 10th, 1880.

445 R. X Q. And the paper carbons then used or experimented upon were in the form of sticks or rods as shown in this patent; that is to say, they were rolled up to make a stick?

A. The paper carbons used in this lamp were rolled up to make a rod.

446 R. X Q. But such carbons were not used as incandescent carbons, I understand. Am I correct?

A. Without refreshing my recollection I think we did try experiments with these carbons in vacuum.

447 R. X Q. Why was no mention made in this patent, the application for which was filed February 3d, 1879, of paper for the manufacture of the carbon?

A. Because the patent was for a lamp, and I could not have patented the lamp and patented the process of making carbons for the same in one patent; besides any form of carbon could be used in such a lamp. Hence the patent was for a lamp to work carbons in a peculiar way.

444 R. X Q. Did you not, in November or December 1879, make an application for a patent wherein you did claim the construction of a lamp and also claimed carbon made of paper. I now refer to the application, which is a substantial copy of English patent No. 5127?

A. Yes, sir; but in this case the carbon itself was the lamp, whereas the application of February 3d, 1879, was for a peculiar mechanism forming a lamp. I do not think the Patent Office would have permitted the patenting of two things; that is to say, the mechanism of the lamp and any peculiar form of carbon in the same patent as filed February 3d, 1879, whereas, it was permissible in case of the patent filed some time in November or December, 1879, containing the paper carbon.

2632 449 R. X Q. At the time you experimented with the lamp in the fall of 1878, had you discovered the superiority of carbon made of paper for incandescent electric lighting over other carbon?

A. We had discovered that it was a very easy form of material to manipulate to make conductors for electric lights.

450 R. X Q. (Question repeated.)

A. We knew that carbon made of paper was preferable for incandescent lighting, for the reason that it had a higher resistance than carbon made from hard carbon.

451 R. X Q. I read as follows from your deposition in the inter-

ference case of Sawyer and Man against Edison: "Cross-question 196. At the time you experimented with this lamp of the patent referred to (224,329), had you discovered the superiority of carbon made of paper for incandescent electric lighting over other carbon? A. No; only it was very convenient material to use." Did you testify as above in the interference in question?

A. I think I did. I also think in some other part of this testimony, that I stated that we found it had other advantages, to wit, having high resistance

452 R. X Q. In 1879, how long did you consider that an incandescent filament should burn in order to constitute a lamp which you would have considered a commercial success, or an improvement of any practical benefit to the public?

A. That would depend upon the economy of the lamp. With the lamps we made in the latter part of 1879 and early part of 1880, with the economy that they then had, one hundred hours would have been a commercial success; a greater length of time would have made them of a greater commercial success.

453 R. X Q. What was your aim in 1879; to produce a carbon filament of high resistance, or to produce a carbon filament that should be easy to manufacture regardless of its resistance?

2633 A. Our endeavors were to make a lamp containing a filament of carbon of as high resistance and of as great a life as possible, irrespective of the cost.

454 R. X Q. Cost of manufacture was considered as a very small factor in the conduct of your experiments in 1879; in other words, your sole and main object and purpose was to obtain a carbon of high resistance to insure economy in the operation of an incandescent system?

A. Our object was to produce a lamp of as high resistance as possible, and with as great economy and life at that resistance and produce a great number of lamps which when placed on the circuit would have all the same candle power and concentration, independent of its cost, knowing that when once we obtained what we desired by means of machinery and other things we could make them sufficiently cheap for all commercial purposes.

455 R. X Q. Subsequent to your experiments with carbon filaments in 1877, and also of similar experiments in 1878, you made many experiments and at great expense with other materials than carbon in order to obtain a practical burner for an incandescent lamp, did you not?

A. Yes, sir.

456 R. X Q. In your Note Book No. 52 you have recorded a test of a large number of different kinds of paper; did you ever make an application for a patent for an incandescent carbon, made from any of the different kinds of paper therein referred to, except that involved in this interference?

Counsel for Edison objects as incompetent and immaterial, and as calling for information that is privileged, and that the witness is entitled to withhold it on account of the detriment which would accrue to his interests by the disclosure of the same, and the witness is instructed not to answer the question.

457 R. X Q. On your redirect examination you were asked if prior to 1880 you had not experimented with many different kinds of paper for which you had not applied for a patent prior to 2634 May 27th, 1881, and you answered affirmatively and enumerated several different kinds of paper which you stated you used or tested in the fall of 1879 and for which you had made no application for a patent up to May 27th, 1881. Now, I desire to know if by this answer you would have it understood or inferred that you have ever made an application for a patent for a carbon made of any of the different kinds of paper referred to by you in your testimony except parchment paper.

A. I cannot remember whether I have or not. I do not clearly understand the question.

458 R. X Q. As your memory fails you in this matter, and, as you keep full records of all your applications, will you please refer to your records for the purpose of ascertaining whether or not you have subsequent to May 27th, 1881, made an application for a patent, one or more, for any of the different kinds of paper you referred to?

Counsel for Edison objects as incompetent and immaterial, and as calling for information that counsel for Swan is not entitled to; and the witness is instructed not to answer the question.

459 R. X Q. Please give the dimensions of the carbons made in the latter part of 1880 from vulcanized fibre, or what you have sometimes called parchment paper; give approximately the length and width and thickness.

A. I don't remember exactly the size, but I think they were about six inches long, eight one-thousandths thick, ten one-thousandths or twelve one-thousandths wide.

460 R. X Q. Please describe the form of the vulcanized fibre from which these filaments were made.

A. It was a sheet, I should say, two feet square, and I am not sure whether it was rolled to the right size, or whether it had to be scraped or shaved down. If it had to be shaved down, a very little had to be shaved off. These are the ones made, I think, by Mr. Bradley.

461 R. X Q. Does the Edison Company own your invention that is involved in this interference?

A. Yes, sir.

2635 462 R. X Q. Were you an officer of the Edison Company July 27th, 1882, the date of the publication of bulletin 12?

A. No, sir; I am the inventor of the company.

Adjourned to Tuesday, June 5th, 1883, at 10 a. m.

Met pursuant to adjournment and adjourned by consent to Wednesday, June 13th, '83, at 10.30 a. m.

Met pursuant to adjournment and adjourned by consent to Thursday, June 28th, 1883, at 10.30 a. m.

Adjourned by consent to Friday, June 29th, '83, at 10.30 a. m.

Met pursuant to adjournment this 29th day of June, 1883.

Present: W. C. Witter and H. A. Seymour for Swan, and Richard N. Dyer and Eugene H. Lewis for Edison.

Deposition of THOMAS A. EDISON continued.

Recross-examination — H. A. SWAN, counsel for Swan:

463 R. X Q. Will you now produce in evidence your original Record Book No. 85?

The witness is instructed by his counsel not to answer this question, and it is stated that the original Record Book No. 85 will not be produced in evidence to any greater extent than has already been done.

2636 464 R. X Q. Will you produce in evidence photographic copies of all the pages of your original Record Book No. 85, retaining the book itself in your possession?

The witness is instructed not to answer, and the request of counsel for Swan is refused for various reasons, a sufficient reason being that the pages of Book 85 which have not already been produced are not material to this controversy, but are material to other controversies.

465 R. X Q. Will you produce your original Record Book No. 85 and allow counsel for Swan to inspect the main portion of the book which has not thus far been introduced in evidence and has thus far been carefully concealed from such inspection; by main portion I mean all of the pages except such as have been introduced in evidence?

The same instruction is given witness and the same reply made to the request.

466 R. X Q. Will you produce in evidence all of the pages of Record Book No. 85, on which are recorded the tests of the lamps referred to in Record Book No. 52?

It is stated by counsel for Edison that photographs of all the pages of Book No. 85 have been put in evidence, on which are recorded the tests of all such lamps referred to in Book No. 52 as are material to the issues of this controversy, and counsel for Swan and Maxim have been given full opportunity to examine the pages of Book No. 85 of which photographs have been put in evidence. The request of counsel for Swan is refused and the witness is instructed not to answer the question.

Counsel for Swan admits that he has been allowed to examine the few pages of Book 85 of which photographs have been introduced for the purposes of comparison, but asserts that all the remaining portions of the book have been carefully strapped and pinned up so as to render every other portion safe from inspection. As to 2637 the materiality of the remaining portions of the book, counsel for Swan insists that the office should be the judge instead of counsel for Edison.

467 R. X Q. Will you produce in evidence or for inspection all the record or memorandum books of experiments or tests, including Record Book No. 52 and No. 85, relating to paper carbons for incandescent lights, which were kept during the period covered by your testimony in this interference, from August, 1877, to the date of the Swan patent?

It is stated by counsel for Edison that a compliance with this request would bring into the case and make public a vast amount of matter not in any way material to the controversy, but which is or may be material to other controversies. The witness is instructed not to answer the question.

468 R. X Q. Were you ever an officer or director or trustee of the Edison Electric Light Company?

A. Trustee and director.

469 R. X Q. Covering what period of time?

A. I have been a director since the organization of the company and am now.

THOMAS A. EDISON.

2638 COMPLAINANT'S EXHIBIT EDISON FILE-WRAPPER AND CONTENTS. W. T. F., Examiner. April 10, 1889.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the files of this office, of the file-wrapper and contents, in the matter of the application of Thomas A. Edison, filed December 11, 1879, serial number 14630, for improvement in electric lamps, and method of making the same.

In testimony whereof I, Benton J. Hall, Commissioner of Patents, have caused the seal of the Patent Office to be affixed [SEAL.] this 28th day of March, in the year of our Lord one thousand eight hundred and eighty-nine, and of the Independence of the United States the one hundred and thirteenth.

BENTON J. HALL,
Commissioner.

Model, 1 drawing, $15 check.

To the honorable Commissioner of Patents:

Your petitioner, Thomas A. Edison, of Menlo Park, in the State of New Jersey, prays that letters patent may be granted to him for the invention of an improvement in electric lamps, and in the method of manufacturing the same set forth in the annexed specification. (Case No. 187.)

2639 And further prays that you will recognize Lemuel W. Serrell, of the city of New York, N. Y., as his attorney with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to receive the patent and to transact all business in the Patent Office connected therewith.

THOMAS A. EDISON.

Menlo Park, Dec. 8th, 1879.

UNITED STATES OF AMERICA.

STATE OF NEW JERSEY, }
County of Middlesex. }

On this eighth day of December, in the year one thousand eight hundred and seventy-nine, before the subscriber, a notary public in and for said State, personally appeared the within named Thomas A. Edison, and made solemn oath that he verily believes himself to be the original and first inventor of the within-described improvement in electric lamps, and in the method of manufacturing the same, and that he does not know and does not believe that the same was ever before known or used, and that he is a citizen of the United States, and a resident of Menlo Park, New Jersey.

THOMAS A. EDISON.

Sworn to before me the day and year above written.

S. L. GRIFFIN,
Notary Public.

[L. S.]

To all whom it may concern:

Be it known that I, Thomas Alva Edison, of Menlo Park in the State of New Jersey, United States of America, electrician, have invented an improvement in electric lamps and in the method of manufacturing the same, of which the following is a specification.

2640 In a former application made by me for letters patent in the United States (case 186) an improvement in electric lamps is set forth wherein a filament of carbon is inclosed in a glass bulb and the atmosphere removed as nearly as possible, and the carbon is brought to incandescence by an electric current to form the lamp.

My present invention relates to an improvement in the process of manufacturing the carbon filament and in the means for securing the same to the conductors.

I make use of paper of the desired thickness as free as possible from foreign substances or adulterations and for this purpose I prefer and use "bristol-board." With suitable instruments, such as a punch and die, I, cut out a narrow strip of this paper, preferably in the form of an elliptical bow or an arc of a circle, the ends of the strip being by preference wider than the other portions.

A number of these pieces of paper are laid flatwise in the bottom of a mold, preferable of wrought iron, and there is laid on them a light weight in the form of a flat piece of gas-retort carbon or other device that will not be distorted by the heat. If several of these are laid one on the other in the mold, a piece of tissue paper is interposed between each one and the next.

A cover is used to close the mold and the mold is raised very gradually to a temperature of about six hundred degrees Fahr. This allows the volatile portions of the paper to pass away and at the same time the mold retains the paper in its proper shape and the paper is prevented from curling up or becoming distorted as it would be likely to do if the heat
2641 were applied suddenly, or the light weight dispensed with.

The mould is now placed in a furnace and heated almost to a white heat and then removed and allowed to cool gradually.

The carbon filaments will be found to be smaller than the card-board blanks and to be sufficiently strong and flexible for handling. The ends of the carbon are to be secured to the metallic conductors in any convenient manner—

The carbon filaments prepared as aforesaid are very uniform in their resistance to the electric current, and I make them thin and of a sufficient length to offer a great resistance to the passage of the current.

The clamps that connect the conductors to the ends do not require to be pressed with much force on the carbon, because the resistance to the passage of the current between the clamps and the carbon will be less than the resistance of the carbon filament, hence but little heat will be developed at the clamps.

In ordinary electric lamps the large

carbons do not offer much resistance to the electric current and unless the clamps are very firmly pressed upon the carbon, the current meets with considerable resistance at the clamps, and hence heat is developed at such clamps.

The clamps that I prefer are made of a steel spring tipped at the ends with platina or similar metal; the spring is bent into a circle or bow and the
2642 ends crossed and turned back towards each other similar in shape to the figure 8 with the opening for the carbon between the spring ends at the upper part: the object of this shape is that the pressure of the clamps on the carbon may be increased by the expansion of the spring by the heat of the lamp, instead of being lessened as it would be if the wire, was only bent into a single bow.

The spring clamps are connected to the platina or similar conducting wires by dips, and the platina wires pass through the glass of the globe or bulb that contains the lamp: the air is to be exhausted from the bulb by any suitable means and it is preferable to exhaust said air as perfectly as possible, say to the one eight-hundred thousandth of an atmosphere.

The lamps are suspended or supported in any convenient manner, and the electric current from a magneto-electric machine, or other source of electricity is passed through the lamp and brings the carbon filament to a high incandescence and the lamp is very durable and a large number of such lamps can be placed in the electric circuit in multiple arc, or otherwise as desired.

In the drawing:—

Fig. 1, is a vertical section of the lamp complete.

Fig. 2, is a side view in larger size of the clamping device.

2643 Fig. 3, is a section at the line *x x*, in still larger size.

Fig. 4, is the wire forming one of the clamps before it is bent up to shape.

Fig. 5, is the paper blank before it is carbonized, and Fig. 6, is a section of the box.

The blank *a*, is cut out of paper material such as "bristol-board," in the proper shape; the form shown in Fig. 5, is preferred.

The same is laid in the metal mold *b* and when several are laid one on the other, pieces of thin paper are introduced between them. The weight *d*, is laid on these; it is to be heavy enough to prevent the paper curling up under the action of the heat, but it allows the paper to contract as the volatile matters are expelled by the heat. This weight *d*, is of gas-retort carbon. The cover *e*, is placed on the mold and secured, and the mold is heated as before described.

The carbon filament *i*, forms the lamp when rendered incandescent by the electric current passed through it.

The clamp is made of the wire *h*, at the ends of which are tips or small rivets *r*, of platina or similar material.

The wire is bent up and crossed as shown so as to act as a spring in clamping the end of the carbon filament that is placed within such clamp. The wire is attached to a small stock *o*, into which the conducting wire *t*, passes and is clamped.

The conductors for the two ends of the carbon are inserted into the glass and
2644 the latter intimately melted around
them, the carbon and clamps are connected to the wires and the parts introduced within the neck of the bulb *m* and the glass melted at *v*, the air is exhausted from the globe by the tube *k*, that passes away as shown by dotted lines, and the tube melted together while the vacuum is maintained.

The lamp is ready for the conductors to be attached to it and the carbon is rendered incandescent by the current that passes through the same. It is durable as there is nothing to combine with the carbon and it is substantially indestructible.

I claim as my invention

First. The manufacture of carbons for electric lights from paper.

Second. The method herein specified of manufacturing carbons for electric lights consisting in exposing the filaments of paper to the action of heat in a mold to drive off the volatile portions and carbonize the paper, substantially as set forth.

Third. A carbon for electric lights made as a filament with the ends broader for the clamping devices that connect the conductors.

Fourth. The clamp for the carbon of an electric lamp composed of a bow or elliptical spring with the ends crossing each other and receiving between
2645 them the carbon substantially as set forth.

Signed by me this 8th day of December, A. D., 1879.

THOMAS A. EDISON.

Witnesses:
S. L. GRIFFIN.
J. F. DOWNING.

(Endorsement: 146–30; case No. 187; dated Dec. 8, 1879; Thomas A. Edison; improvement in electric lamps, and the method of manufacturing the same. U. S. Pat. Office, Dec. 11, 1879.)

Copied.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Dec.* 30, 1879.

Case 187.

T. A. Edison, care L. W. Serrell, box 4689, N. Y. city.

Electric lamps and methods of making the same. Filed Dec. 11, '79.

Claim 1 is ambiguous, it not being clear whether the claim covers an article or a process. Claim 3 is too broad. The word filament does not distinguish applicant's carbon from others except in degree.

C. L. BUCKINGHAM, *Ass't.*

H. C. TOWNSEND, *Ex'r.*

(Endorsed: 146–30; rejection, Dec. 30, 1879.)

2646 NEW YORK, *January* 2, 1880.

Hon. Com. of Patents.

SIR: In the matter of my application No. 187 for patent on electric lamps filed Dec. 11, 1879 I amend the specification by inserting after title
"(case No. 187)"

The first claim is erased and the following substituted

"First. An electric lamp formed of carbonized paper."

The third claim is believed to be correct, no other meaning than "thread-like" is known to attach to the word "filament" and this claim is meant to apply to a thread-like carbon with broad ends and that is believed to be new.

Respectfully yours, THOMAS A. EDISON,
Per LEMUEL W. SERRELL, *Att'y.*

(Endorsed: 146–30; "A;" 2; amendment; Jan. 3, 1880; cancelled; Thos. A. Edison; electric light; case 187; amendment; U. S. Patent Office, Jan. 3, 1880.)

To the Comm'r of Patents:

In the matter of my app'n for patent for imp't in electric lights No. 187 filed December 11, 1879, I hereby appoint G. W. Dyer and Z. F. Wilber of the firm of Dyer & Wilber, associate attorneys to prosecute said application, to make alterations and amendments 2647 therein, to receive the patent, and to transact all business in the Patent Office connected therewith in my place and stead.

Correspondence to be with them.

Signed at Menlo Park, New Jersey, this 24th day of January, 1880.

T. A. EDISON.

Hon. Commissioner of Patents.

SIR: In the matter of my application No. 187 for a patent for "electric light" filed Dec. 11th, 1879—I amend as follows:

Cancel amendment of January 3d, 1880.

Erase words "filament of" in 11th line, 1st page.

Erase "filament" line 18, page 1.

Insert after line 19, page 1,

"I have found, that it is desirable in an electric lamp that there should be a very great resistance in a very small amount of incandescing material, and that carbon prepared from paper by my process possesses the necessary high resistance.

By using such carbon, I am enabled to use an exceedingly small carbon so small that its dimensions are best expressed by applying to it the term filament, it being thread-like in size."

Erase first claim and insert—

"First. The incandescent conductor, for an electric lamp formed of carbonized paper, substantially as set forth."

It is believed these amendments obviate the office objections.

DYER & WILBER,
Att'ys for Edison.

Feb. 17th, '80.

(Endorsed: 146–30; "B–C;" 4; amendment Feb. 17, 1880; Edison, 187; room 118; U. S. Pat. Office, Feb. 17, 1880.)

2648 Copied.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Sep.* 23, 1880.

U. S. Patent Office,
Ex'r of Interferences,
September 25, 1880.

T. A. Edison, care Dyer & Wilber, present:

Please find below a copy of a communication from the examiner concerning your application filed Dec. 11, 1879, for electric lamps, etc., (case No. 187.)

Very respectfully,
E. M. MARBLE,
Commissioner of Patents.

Room No. 152.

All communications should be addressed to "The Commissioner of Patents, Washington, D. C."

Your case, above referred to, is adjudged to interfere with others hereafter specified, and the question of priority will be determined in conformity with the rules.

The statement demanded by rule 105 must be sealed up and filed on or before the 25th day of October, 1880, with the subject of the invention, and name of party filing it, indorsed on the envelope. The subject-matter involved in the interference is

The incandescent conductor for an electric lamp formed of carbonized paper.

Edison's 1st claim, Sawyer and Man's 4th claim.

2649 The other parties to this interference are Sawyer and Man, whose application was filed Jan. 9, 1880, No. 547.

Wm. E. Sawyer, New York city.

Albon Man, Brooklyn, N. Y. Care Baldwin, Hopkins — Peyton, asso. att'ys, Washington, D. C.

H. C. TOWNSEND, *Examiner.*

P. W. PAGE, *Ass't Ex'r.*

(Indorsement: 146–30; 5 int. 155–73; Sept. 23, '80.)

(Edison, number 187.)

T. A. Edison, electric lamps. Room 152. Filed Dec. 11th, 1879.

Hon. Commissioner of Patents:

This application is now in interference with an application filed by Sawyer and Man, as to a part of the subject-matter contained therein only, there being claims and subject-matter not interfering with the claims made by Sawyer and Man, or with any claims which could be made upon the subject-matter shown or described by them.

The application can be legitimately divided. 2650 I have therefore determined to take advantage of the provisions of rule 125, cancel by amendment the matter herein adjudged not to interfere, and to file a new application therefore, which application is this day filed and bears my serial number 264, and which is, as to such matter, a continuation of this application relating back thereto.

The present application is accordingly amended as follows:

Erase the words "and in the means for securing the same to the conductors," lines 18 & 19, page 1.

Erase from line 5, page 4, to line 13, page 5 inclusive and insert in lieu thereof:

"In order that not only the improvement in the carbon may be understood, but that the manner of the embodiment in a complete lamp, and its utility may be better understood, a complete lamp and the method of its manufacture will be illustrated and described."

In lines 25 and 26, page 6 erase "is attached to" and insert "passes through."

In line 10, page 7 erase "that passes away" and insert "which originally is."

In line 11, page 7, erase "and the tube" and insert "but which is."

At end of line 11 insert "when a 2651 proper vacuum has been attained."

Before claims insert:

"It is not intended to claim anything herein shown and described except the incandescing conductor made of paper, as all such other matters of invention as are herein shown or described are only shown as incidental to, and illustrative of the manner of manufacture and use of the paper carbon, and from the subject-matter of another and separate application for a patent made by me."

Erase all claims except the first.

T. A. EDISON,
Per DYER & WILBER,
His Attorneys.

Washington, D. C., December 15, 1880.

(Endorsement: 146–30; No. 1876; 152. Amendment, Dec. 15th, 1880, "B. D." U. S. Patent Office, Dec. 15, 1880.)

2652 New York, *Feb.* 18, 1882.

In Re Interference Sawyer and Man *vs.* Edison. } On Appeal to Ex'rs-in-chief.

"Incandescent paper carbons."

Hon. Commissioner of Patents.

Sir: In the above-entitled cause, please recognize the Hon. Roscoe Conkling as an associate in the case.

He will take charge of the argument on appeal.

Very respectfully, &c., Z. F. WILBER.

(Endorsement: Asso. att'y to Hon. Roscoe Conkling, Feb. 18, 1882.)

In Re Edison, case 187.

T. A. Edison, electric lamps. Filed December 11, 1879.

Hon. Comm'r Patents.

Sir: This app'n is in interference — a subject-matter set forth in one claim out of four in a pending app'n of Sawyer and Man.

The remaining 3 claims in the Sawyer and Man app'n stand rejected.

2653 In the declaration of the interferences in the letter to Sawyer and Man, the office stated "In declaring this interference the objections standing against Sawyer and Man's 1, 2 and 3 claims are not removed."

In view, however, of the very peculiar rules now prevailing in the office as to declaring interferences and as to when applications interfere, there is great risk, should the examiner change the decision in such claims, or he be overruled by any of the appellate tribunals, that such claims might be issued without notice to me and in derogation of my rights under the law. I therefore amend by adding such claims to my application in order that nothing possible to be done by me in the matter, be left undone.

Formal action thereon, however, will not be expected until the termination of the present interference proceedings.

Insert the numeral 1 before present claim in case and add claims.

"2. An incandescing arc for an electric lamp of carbonized fibrous or textile material, of an arch or horseshoe shape, substantially as set forth.

"3. Th*is* combination of an incandescing arc of carbon for an electric lamp, of an aren or horseshoe shape, and a transparent hermetically sealed chamber, from which oxygen or other gases capable of combining with carbon at a high temperature are excluded.

"4. The combination of an incandescing arc of carbon for an electric lamp of an arch or horseshoe shape included in and forming part of an electric circuit, and a transparent hermetic-
2654 ally sealed chamber, from which oxygen and other gases
capable of combining with carbon at a high temperature are excluded."

T. A. EDISON.
Z. F. WILBER,
His Attorney.

March 10, 1882.

(Endorsement: No. 146–30; paper No. 9; am'd't E; filed March 11, 1882, Sawyer and Man: motion denied; 1, 28 '82. U. S. Patent Office, Mar. 11. 1882.)

Edison's case, No. 187.

Interference, SAWYER AND MAN
vs.
EDISON.

Serial No., —. Filed Dec. 11, 1879. Improvement in electric lamps.

To the Commissioner of Patents:

In the above-named application, I hereby revoke the power of attorney given by me to Lemuel W. Serrell, Z. F. Wilber, or to Dyer & Wilber, and appoint instead as my attorney, Richard N. Dyer, of Menlo Park, New Jersey, with full power of substitution and revocation, to prosecute said application, to make alterations and amendments therein, to receive the patent, and to transact all business in the Patent Office connected therewith.

Signed at Menlo Park, N. J., Aug. 8, 1882.

THOMAS A. EDISON.

2655–2665 The undersigned, the Edison Electric Light Company, assignee of the invention set forth in the above application, hereby concurs and joins in the foregoing power of attorney.

Signed at New York city, August 10, 1882.

THE EDISON ELECTRIC LIGHT COMPANY,
By T. W. EATON, *Vice-president.*

(Endorsement: Power of attorney and revocation; U. S. Patent Office, Aug. 14, 1882.)

Application of Thomas A. Edison.

Improvement in electric lights. Filed Dec. 11, 1879. Serial No., —. Edison's —, No. 187.

State of New York,
County of New York, } *ss:*

Thomas A. Edison, being duly sworn, deposes and says that the improvement set forth in the above-entitled application for patent was not, to his knowledge, in public use or on sale in the United States more than two years prior to said application.

THOMAS A. EDISON.

Sworn to and subscribed before me this 7th day of Oct., A. D., 1882.

WM. H. MEADOWCROFT,
[L. S.] *Notary Public, New York County.*

(Endorsement: Dec. 11, 1879; C 187; U. S. Patent Office; Oct. 11, 1882; interference.)

2666 Room 91.

C. Department of the Interior,
United States Patent Office,
Washington, D. C., *Feb.* 19, 1885.

Thomas A. Edison, care Richard N. Dyer, 65 5th Ave., New York city.

"Application electric lamps and method of making the same."
Filed Dec. 11, 1879, Book No. (146–30).

The interference with Sawyer and Man having been decided against applicant, this case has been reconsidered with reference to the amendment filed March 11, 1882.

Reference is made in the specification to another application which is referred to as "(case 186);" the number thus given, fails to identify the case referred to, and if the reference is retained, the date of filing should be given.

It is also found that by amendment filed Dec. 15, 1880, applicant limits the scope of this application to an "incandescing conductor made of paper;" the claims presented by amendment of March 11, 1882, which cover matter different from an incandescing conductor made of paper, are therefore, not properly in this case.

Besides this, the first claim which is commensurate with the issue of the late interference cannot be allowed to applicant, since the interference has been decided in favor of Sawyer and Man; the second claim which is broader than the interference issue cannot be considered in this case for this reason alone. A defeated party cannot put under contribution the party which has been proved to be the prior inventor.

Claims 3 and 4, are anticipated by English patent No. 3809 of 1872, Fig. 8.

The application is rejected.

C. J. KINTNER, *Examiner.*

JOS. LYONS,
First Assistant.

(Endorsed: No. 146–30. Paper No. 10. Rejected. Dated Feb. 19, 1885.)

2667 Thomas A. Edison, electric lamps. Filed December 11, 1879. Edison, No. 187.

To the Commissioner of Patents:

SIR: In the above case I submit the following:

Erase the disclaimer inserted before the claims and designated amendment "D."

Erase 2d, 3d, and 4th claims inserted by amendment, dated March 10, 1882, and insert instead thereof the following:

Second. An incandescing conductor for an electric lamp, of carbonized fibrous or textile material, and of an arch or horseshoe shape, substantially as hereinbefore set forth.

Third. The combination substantially as hereinbefore set forth, of an electric circuit and an incandescing conductor of carbonized fibrous material, included and forming part of said circuit, and a transparent hermetically sealed chamber in which the conductor is inclosed.

Fourth. An incandescing electric lamp consisting of the following elements in combination: first, an illuminating chamber made wholly of glass hermetically sealed, and out of which all carbon-consuming gas has been exhausted or driven; second, an electric circuit conductor passing through the glass wall of said chamber and hermetically sealed therein, as described; third, an illuminating conductor in said circuit, and forming part thereof within said chamber, consisting of carbon made from a fibrous or textile material, having 2668 the form of an arch or loop, substantially as described, for the purpose specified.

In the issue of patent No. 317,676, based on an application of Sawyer and Man, after an interference with this application, the office evidently overlooked the fact that the issue in that interference was upon the use specifically of carbonized paper as the incandescent conductor of an electric lamp, and, proceeding upon the illogical reasoning that the less includes the greater, granted a patent for the use of fibrous material without an interference with this application. To prevent just such an occurrence, applicant during the pendency of the interference inserted a claim to fibrous material, and demanded an interference with the application of Sawyer and Man whenever the office should decide that the claim was patentable. Sawyer and Man's claim at the time standing rejected.

This amendment and demand is the paper dated March 10th, 1882, and filed March 11, 1882.

The present amendment is made so that the claims will conform precisely to the claims of Sawyer and Man, as since amended, and an interference is now demanded with the first, second and fourth claims of their patent No. 317,676.

The claim on carbonized paper is retained, since it is proposed to commence proceedings to obtain a patent on this claim by bill in equity under section 4915 R. S.

Respectfully,

RICHARD N. DYER,
Attorney for Edison.

June 19, 1885.

2669 STATE OF NEW YORK, }
County of New York, } *ss:*

Thomas A. Edison, whose application for letters patent for an improvement in electric lamps was filed in the United States Patent Office on the 11th day of December, 1879, being duly sworn, deposes and says that he verily believes himself to be the original and first inventor of the improvement as described and claimed in the foregoing amendment, in addition to that which was embraced in the claims originally made, and that he does not know and does not believe that the same was ever known or used before his invention thereof, and that the matter sought to be inserted formed a part of his original invention at the date of filing said application.

THOS. A. EDISON.

Sworn to and subscribed before me this 19th day of June, 1885.

JOHN C. TOMLINSON,
[L. S.] *Notary Public, N. Y. Co.*

(Endorsed: No. 146–30; paper No. 11; am'd't F. Filed June 20, 1885, 91; U. S. Pat. Office, Jun- 20, 1885; division XVI.)

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *June* 27, 1885.

Mailed June 30, 1885.

Thos. A. Edison, care R. N. Dyer, New York city.

Improvement in electric lamps, No. 146–30. Filed Dec. 11, 1879.

2670 The amendment filed 20th inst., in the matter of the above-named application has been considered.

In view of the limited statement of invention found in the application as originally filed, the claims then submitted and particularly in view of the specific terms of the disclaimer filed Dec. 15, 1880, it is believed that the last official action of Feb. 19 was correct, and that applicant cannot now be allowed to broaden the scope of his alleged invention by putting up a new state of facts. It appears that applicant has specifically disclaimed all matter in this application except the paper filament, and upon this state of facts entered into and passed through an interference proceeding in which contest he failed to succeed. He has also signified his intention, in the last amendment, of proceeding by a bill in equity to have the Commissioner's decision reversed.

The examiner is firmly of the opinion that he should proceed in this course direct and not be now permitted to set aside as for naught that which he, the applicant, has in a clear and well-defined manner delineated as his invention.

If this course of proceedings were admissible there would be no end to litigation.

By his own actions must an applicant's case stand or fall, and when he distinctly rules out a line of action designed to govern his application, by that line of action must he be held.

Applicant will be required to reinstate his disclaimer and to erase all matter not in strict accord therewith, in order that he may proceed by bill in equity as indicated.

From this action refusing to admit the claims now submitted and requiring applicant to reinstate the disclaimer noted, an appeal may be taken at once, if desired, to the Commissioner in person.

Further action pending such appeal is suspended.

C. J. KINTNER, *Examiner.*

(Endorsement: Serial No. 146–30; paper No. 12; rej.; dated June 27, 1885.)

2671 Thomas A. Edison, electric lights. Filed December 11, 1879.

To the honorable Commissioner of Patents.

SIR: In the above-entitled case, appeal is hereby taken to the honorable Commissioner in person from the decision of the principal examiner, refusing to grant applicant's request for an interference with patent of Sawyer and Man, No. 317,676, granted May 12, 1885.

For reasons of appeal it is submitted that the examiner erred:

(1.) In deciding that his action of February 19th, 1885, was correct;

(2.) In deciding that the amendatory paper filed March 11th, 1882, did not entitle Edison to an interference with Sawyer and Man's application while pending;

(3.) In deciding that Edison, is not now entitled to an interference with their patent.

An oral hearing is asked.

Respectfully, RICHARD N. DYER,
Attorney for Edison.

July 8th, 1885.

(Endorsement: Filed Dec. 11, '79; paper No. 13; interlocutory appeal; filed July 11, 1885; Mr. Emory, room 4; the request for a declaration of an interference with the patent of Sawyer and Man, is denied, for the reasons stated by the examiner; Benton J. Hall, Commissioner; Feb. 24, 1888; United States Patent Office, July 11, 1885.)

2672 Room No. 4.

All communications should be addressed to "The Commissioner of Patents, Washington, D. C."

Duplicate.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *July 14th*, 1885.

In the Matter of the Application of THOMAS A. EDISON, "Electric Lights." } Interlocutory Appeal.

Filed Dec. 11, '79.

SIR: You are hereby informed that a hearing on the above appeal from the decision of the primary examiner is fixed for Friday, July 31st, 1885, at 1 p. m.

By direction of the Commissioner.

Very respectfully, SCHUYLER DURYEE,
Chief Clerk.

Thomas A. Edison, care Rich'd N. Dyer, 65 5th Ave., N. Y.

(Endorsed: Serial No. —; paper No. 14; notice of hearing; dated July 14, 1885.)

2673 In the U. S. Patent Office.

In Re T. A. Edison, electric lights. Filed Dec. 11, 1879. Appeal to the Commissioner of Patents.

Examiner's Statement.

This appeal is taken from the examiner's decision refusing to declare an interference between certain claims specified, and similar claims found in patent to Sawyer and Man, 317,676, granted May 12, 1885.

The examiner's refusal was based upon three reasons as follows:

1. This application was involved in an interference with the application upon which Sawyer and Man's patent was granted, and decided adversely to applicant.
2. This application was specifically limited to the issue of said interference, by a disclaimer to all other subject-matter, filed Dec. 15, 1880, and hence applicant cannot now seek to avoid such disclaimer by reinstating matter so disclaimed.
3. A suit has been instituted by bill in equity, on the part of Sawyer and Man, on the patent indicated, against this applicant and upon the identical claims applicant is now seeking to inject into this application.

With reference to the first point made by the examiner, it should be stated that the issue of the interference was as follows:

"An incandescent conductor for an electric lamp 'formed of carbonized paper.'"

This was to a species of filament of carbonized paper, which is acknowledged to be vegetable fibre. On the conclusion of the interference, Sawyer and Man having established their right to this species of vegetable filament, came before the examiner with broad claims to the genus, or to a carbonized filament of vegetable fibre and were permitted — take such claims.

2674 The examiner has not examined the testimony set up by applicant and hence cannot pass upon this point, indeed, he is not called upon to do so. It is to be presumed that applicant made the strongest case he could, and that if Sawyer and Man were the first inventors of the species, they were also of the genus.

Concerning the second objection, the examiner simply calls attention to the disclaimer, which is as follows:

"It is not intended to claim anything herein shown and described except the incandes*cend*ing conductor made of paper, as all such other matters of invention as are herein shown or described are only shown as incidental to and illustrative of the manner of manufacture and use of the paper carbon, and form the subject-matter of another and separate application for a patent made by me." The examiner is at a loss to know how any one can misinterpret this language.

Now, after a period of over four years, it is sought to nullify this act, and to claim every feature shown and described.

It is respectfully submitted that an applicant should be held to his statements made deliberately and with an undoubted intent.

The third objection was not urged in the official action, but applicant was advised, verbally, that such an objection was entirely pertinent.

The examiner is advised, and has in his possession a copy of the bill in equity, filed by the Consolidated Electric Light Co., against the applicant, said bill being based upon the patent of Sawyer and Man, above referred to. The question then arises should this office be put to the expense of instituting a proceeding which will be tried elsewhere, and should parties be put to a duplicate expense for determining a single issue.

In this connection attention is called to Commissioner Marble's decision in Frazier *vs.* Nicodemus and Weeks, Commissioner's MS. Dec., vol. 23, p. 161, wherein he says:

"The motion to suspend proceedings in this case until the
2675 court is decided, which in substance involves the same issue, I think should be granted. It is unnecessary that parties should be put to the expense of taking their testimony twice to determine which is the prior inventor, and, inasmuch as that question will necessarily be determined by the court, this case should be suspended to await such determination."

This, it will be observed, was with relation to an interference already declared. It is thought that the rule should be more strongly observed concerning cases where there is no actual contest in progress.

In view of these reasons the examiner begs to submit that his course of action was entirely correct.

Respectfully submitted.

C. J. KINTNER,
Examiner Division XVI.

July 30, 1885.

(Endorsement: Serial No. 146-30; paper No. 15; ex'r's statement; dated July 30, 1885.)

Thos. A. Edison, electric lights. No. —. Filed December 11, 1879.

To the Hon. Com'r of Patents:

In the above cause set for hearing on July 31, 1885, an interlocutory appeal to your honor, I respectfully ask for a postponement of the hearing for one month, on account of the inability of Mr.

R. N. Dyer, the regular attorney, to attend to the same, by reason of the serious illness of his wife.

GEO. W. DYER,
Counsel for Edison.

(Endorsement: Serial No. 141–30; paper, No. 16; req. for postponement; filed July 30, 1885; U. S. Patent Office, July 30, 1885.)

2676 Duplicate.

Department of the Interior,
United States Patent Office,
Washington, D. C., *July* 30, 1885.

In the Matter of the Application of Thomas A. Edison, "Electric Lights." Filed Dec. 11, 1879. } Interlocutory Appeal.

Sir: You are hereby informed that the hearing on the above appeal has been continued to Friday, August 28, 1885, at 1 p. m.

By direction of the Commissioner:

Very respectfully, SCHUYLER DURYEE,
Chief Clerk.

Thomas A. Edison, care Richard N. Dyer, 65 5th Ave., N. Y. city.

(Endorsement: No. 146–30; paper No. 17. Notice of postponement, dated July 30, 1885).

2677 Duplicate.

Department of the Interior,
United States Patent Office,
Washington, D. C., *August* 27, 1885.

In the Matter of the Application of Thomas A. Edison "Electric Lights." Dated Dec. 11, 1879. } Interlocutory Appeal.

Sir: You are hereby informed that the hearing on the above appeal has been continued to Tuesday, Sept. 29, 1885, at 11 a. m.

By direction of the Commissioner:

Very respectfully, SCHUYLER DURYEE,
Chief Clerk.

Thomas A. Edison, care R. N. Dyer, No. 65 5th Ave., N. Y. city.

(Endorsement: Serial No. 146–30; paper No. 18. Notice of postponement, dated Aug. 27th, 1885).

2678 Duplicate.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Sept. 23rd*, 1885.

In the Matter of the Application of THOMAS A. EDISON, "Electric Lights." Filed Dec. 11, '79. } Interlocutory Appeal.

SIR: You are hereby informed that the hearing on the above appeal has been continued to Friday, October 16th, 1885, at 1 p. m.

By direction of the Commissioner:

Very respectfully, SCHUYLER DURYEE,
Chief Clerk.

Thomas A. Edison, care Dyer & Seely, 65 5th Ave., N. Y. city.

(Endorsed: No. 146–30; paper No. 19; notice of postponement; dated Sept. 23, 1885.)

2679 Duplicate.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Oct. 19th*, 1885.

In the Matter of the Application of THOMAS A. EDISON, "Electric Lights." Filed Dec. 11, '79. } Interlocutory Appeal.

SIR: You are hereby informed that the hearing on the above appeal has been continued to Tuesday, November 17th, 1885, at 11 a. m.

By direction of the Commissioner:

Very respectfully, SCHUYLER DURYEE,
Chief Clerk.

Thos. A. Edison, care Dyer & Seely, 65 5th Ave., New York.

(Endorsed: No. 146–30; paper No. 20; notice of postponement; dated Oct. 16, 1885, Dec. 17, '85, 11 a. m.)

2680 Duplicate.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C. *Nov. 18th*, 1885.

In the Matter of the Application of THOMAS A. EDISON, "Electric Lamps." Filed Dec. 11, 1879. } Interlocutory Appeal.

SIR: You are hereby informed that the hearing on the above appeal has been continued to Thursday, December 17th, 1885, at 11 a. m.

By direction of the Commissioner,

Very respectfully, M. GARDNER,
Acting Chief Clerk.

Thos. A. Edison, care R. N. Dyer, 65 5th Ave., N. Y. city.

(Endorsed: No. 146–30. Paper No. 21. Notice of postponement. Dated Nov. 18, 1885.)

2681 Duplicate.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Dec. 15th*, 1885.

In the Matter of the Application of THOS. A. EDISON. Filed Dec. 11, 1879. } Interlocutory Appeal.

SIR: You are hereby informed that the hearing on the above appeal has been continued to Tuesday, January 19th, 1886, at 12 m.

By direction of the Commissioner,

Very respectfully, SCHUYLER DURYEE,
Chief Clerk.

Thos. A. Edison, care R. N. Dyer, 65 Fifth Ave., N. Y city.

(Endorsed: No. 146–30. Paper No. 22. Notice of postponement. Dated Dec. 15, 1885.)

2682 Duplicate.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Jan.* 19, 1886.

In the Matter of the Application of THOMAS A. EDISON, Electric Lamps and Methods of Making the Same. Filed Dec. 11, 1879. } Interlocutory Appeal.

SIR: You are hereby informed that the hearing on the above appeal has been continued to Friday, February 19th, 1886, at 12 m.

By direction of the Commissioner:

Very respectfully, SCHUYLER DURYEE,
Chief Clerk.

Thos. A. Edison, care R. N. Dyer, 65 5th avenue, New York city.

(Endorsed: No. 146–30. Paper No. 23. Notice of postponement, dated January 19, 1886.)

2683 Duplicate.

Department of the Interior,
United States Patent Office,
Washington, D. C., *Feb.* 11, 1886.

In the Matter of the Application of Thomas A. Edison, "Electric Lamp and Method of Making the Same." Filed Dec. 11, 1879. } Interlocutory Appeal.

Sir: You are hereby informed that the hearing on the above appeal has been continued, as per oral request, to Tuesday, May 18th, 1886, at 12 m.

By direct- of the Commissioner:
Very respectfully, SCHUYLER DURYEE,
Chief Clerk.

Thos. A. Edison, care R. N. Dyer, 65 5th avenue, New York city.

(Endorsed: No. 146–30. Paper No. 24. Notice of postponement, dated Feb. 11, 1886.)

2684 Duplicate.

Department of the Interior,
United States Patent Office,
Washington, D. C., *May* 17*th*, 1886.

In the Matter of the Application of Thomas A. Edison, "Electric Lamps." Filed Dec. 11, 1879. } Interlocutory Appeal.

Sir: You are hereby informed that the hearing on the above appeal has been continued to Friday, June 18, 1886, at 12 m.

By direction of the Commissioner:
Very respectfully, SCHUYLER DURYEE,
Chief Clerk.

Thos. A. Edison, care R. N. Dyer, 65 5th avenue, New York city.

Endorsement: 146–30; paper No. 25; notice of postponement; dated May 17, 1886.

2685 Thomas A. Edison, Electric lights. Filed December 11th, 1879. Serial No. —.

Commissioner of Patents.

Sir: In the above-named case I have to ask that the hearing on the appeal to the Commissioner in person, now set for the 18th inst. may be postponed one month from that date, since I find my engagements will not permit me to attend to the matter at present.

I trust there will be objection to this postponement.

Respectfully, RICHARD N. DYER,
Attorney for Edison.

June 14th, 1886.

(Endorsed: No. 146–30; paper No. 26; request; filed June 15, 1886; U. S. Patent Office, June 15, 1886.)

Duplicate.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *June 16th*, 1886.

In the Matter of the Application of THOMAS A. EDISON, "Electric Lamps." Filed Dec. 11th, 1879. } Interlocutory Appeal.

2686 SIR: You are hereby informed that the hearing of the above appeal has been continued to Tuesday, July 20th, 1886, at 12 m.

By direction of the Commissioner:

Very respectfully, SCHUYLER DURYEE,
Chief Clerk.

Thos. A. Edison, care R. N. Dyer, 65 5th Ave., New York city.

(Endorsed: No. 146–30; paper No. 27; notice of postponement; dated June 16, 1886.)

Duplicate.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *July 19th*, 1886.

In the Matter of the Application of THOMAS A. EDISON, "Electric Lamps." Filed Dec. 11th, 1879. } Interlocutory Appeal.

2687 SIR: You are hereby informed that the hearing on the above appeal has been continued to Tuesday, September 21st, 1886, at 12 m.

By direction of the Commissioner:

Very respectfully, SCHUYLER DURYEE,
Chief Clerk.

Thos. A. Edison, care R. N. Dyer, 65 5th Ave., New York.

(Endorsed: No. 146–30; paper No. 28; notice of postponement; dated July 19, 1886.)

Thomas A. Edison, electric lights. Filed Dec. 11th, 1879.

Commissioner of Patents.

SIR: It is requested that the hearing before the Commissioner in this case may be postponed one month.

Respectfully, RICHARD N. DYER,
Att'y for Edison.

Aug. 28, 1885.

(Endorsed: 146–30; 29; Aug. 27, 1886. Request for postponement, Sept. 29, 1885, at 11 a. m. U. S. Patent Office, Aug. 27, 1886.)

2688 Duplicate.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Sept.* 22, 1886.

In the Matter of the Application of THOMAS A. EDISON, "Electric Lamps." Filed Dec. 11, 1879. } Interlocutory Appeal.

SIR: You are hereby informed that the hearing on the above appeal has been continued to Friday, November 19th, 1886, at 12 m.

By direction of the Commissioner:

Very respectfully, SCHUYLER DURYEE,
Chief Clerk.

Thomas A. Edison, care R. N. Dyer, 65 5th avenue, New York.

(Endorsed: No. 178; paper No. 30. Notice of postponement, dated September 22d, 1886.)

2689 NEW YORK, *Nov.* 15, 1886.

Commissioner of Patents.

SIR: In the matter of the application of Thomas A. Edison, relating to electric lights, filed December 11, 1879, on appeal to the Commissioner in person, I have to request a postponement of the time set for hearing for one month from the date last set, since my engagements render it impossible for me to appear in the matter on that date.

Respectfully, RICHARD N. DYER,
Att'y for Edison.

(Endorsed: No. 146–30, paper No. 31. Request filed Nov. 16, 1886. United States Patent Office, Nov. 16, 1885.)

Duplicate.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Nov.* 18, 1886.

In the Matter of the Application of THOMAS A. EDISON, "Electric Lamps." Filed Dec. 11, 1879. } Interlocutory Appeal.

SIR: You are hereby informed that the hearing on the
2690 above appeal has been continued to Wednesday, December
22nd, 1886, at 12 m.

By direction of the Commissioner:

Very respectfully, SCHUYLER DURYEE,
Chief Clerk.

Thos. A. Edison, care R. N. Dyer, 65 5th Ave., N. Y. city.

(Endorsed: No. 146–30; paper No. 32. Notice of postponement. Dated Nov. 18, 1886.)

Duplicate.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *December* 22, 1886.

In the Matter of the Application of THOMAS A EDISON, "Electric Lamps." Filed Dec. 11, 1879. } Interlocutory Appeal.

SIR: You are hereby informed that the hearing on the
2691 above appeal has been continued to Tuesday, January 25, 1887, at 12 m.

By direction of the Commissioner:

Very respectfully, SCHUYLER DURYEE,
Chief Clerk.

Thos. A. Edison, care R. N. Dyer, 65 5th Ave., N. Y. city.

(Endorsed: No. 146–30; paper No. 33. Notice of postponement. Dated Dec. 22, 1886.)

NEW YORK, *Jan.* 24, 1887.

Commissioner of Patents.

SIR: In the matter of the appeal to the Commissioner in the application of Thomas A. Edison, filed Dec. 11, 1879, in which a hearing was appointed for the 25th inst. I have to ask a further postponement of the hearing since my engagements will not permit my attendance on the day set. I would like a postponement of at least one month.

Respectfully, RICH'D N. DYER,
Att'y for Edison.

(Endorsement: No. 146–30; paper No. 33½. Request filed Jan. 25th, 1887. U. S. Pat. Office, Jan. 25, 1887.)

2692 Duplicate.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *January* 25, 1887.

In the Matter of the Application of THOMAS A. EDISON, "Electric Lamps." Filed Dec. 11, 1879. } Interlocutory Appeal.

SIR: You are hereby informed that the hearing on the above appeal has been continued as per request to Friday, February 25, 1887, at 12 m.

By direction of the Commissioner:

Very respectfully, SCHUYLER DURYEE,
Chief Clerk.

Thomas A. Edison, care R. N. Dyer, 40 Wall St., N. Y.

(Endorsed: No. 146–30; paper No. 34; notice of postponement; dated Jan. 25, 1887.)

2693 Duplicate.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Feb.* 24, 1887.

In the Matter of the Application of THOMAS A. EDISON, "Electric Lamps." Filed Dec. 11, 1879. } Interlocutory Appeal.

SIR: You are hereby informed that the hearing on the above appeal has been continued to Tuesday, April 26, 1887, at 12 m.

By direction of the Commissioner.

Very respectfully,
SCHUYLER DURYEE,
Chief Clerk.

Thomas A. Edison, care R. N. Dyer, 40 Wall St., N. Y. city.

(Endorsed: Filed Dec. 11, '79. Paper No. 35. Notice of postponement. Dated Feb. 24, 1887.)

2694 Duplicate.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *April* 21, 1887.

In the Matter of the Application of THOMAS A. EDISON, "Electric Lamps." Filed Dec. 11, 1879. } Interlocutory Appeal.

SIR: You are hereby informed that the hearing on the above appeal has been continued to Tuesday, June 28, 1887, at 12 m.

By direction of the Commissioner.

Very respectfully,
SCHUYLER DURYEE,
Chief Clerk.

Thos. A. Edison, care R. N. Dyer, 40 Wall St., N. Y. city.

(Endorsed: Filed Dec. 11, '79. Paper No. 36. Notice of postponement dated April 21, 1887.)

2695 Duplicate.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *June* 28, 1887.

In the Matter of the Application of THOMAS A. EDISON, "Electric Lamps and Method of Making the Same." Filed Dec. 11, 1879. } Interlocutory Appeal.

SIR: You are hereby informed that the hearing on the above appeal has been continued as per request to Thursday, July 28th, 1887, at 12 m.

By direction of the Commissioner.

Very respectfully, M. GARDNER,
Acting Chief Clerk.

Thos. A. Edison, care Dyer & Seely, 40 Wall street, N. Y.

(Endorsed: No. 146–30; paper No. 37; notice of postponement; dated June 28, 1887.)

2696 Duplicate.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *July* 27, 1887.

In the Matter of the Application of THOS. A. EDISON,
Electric Lamps and Method of Making the Same.
Filed Dec. 11, 1879.
} Interlocutory Appeal.

SIR: You are hereby informed that the hearing on the above appeal has been continued to Wednesday, September 28, 1887, at 12 m.

By direction of the Commissioner,

Very respectfully, JAS. N. LIPSCOMB,
Chief Clerk.

Thomas A. Edison, care Dyer & Seely, 40 Wall St., N. Y. city.

Endorsed: (No. 146–30; paper No. 38; notice of postponement; dated July 27, 1887.)

2697 NEW YORK, *June* 27, 1887.

Col. Geo. W. Dyer.

DEAR SIR: Will you please see Mr. Emory early to-morrow Tuesday morning and get a postponement of the hearing before the Commissioner in the *ex parte* appeal in the application of T. A. Edison, No. 187, which is set for to-morrow morning. Emory will no doubt consent to put it over another month.

Yours truly, DYER & SEELY.

(Endorsed: 146–30; paper No. 39; request for postponement; filed July 28, 1887; continued to July 28, 1887; U. S. Patent Office; June 28, 1887.)

Duplicate. J. M. E.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Sept.* 28, 1887.

In the Matter of the Application of THOMAS A. EDISON, Electric Lamps and Method of Making the Same. Filed December 11, 1879. } Petition.

2698 SIR: You are hereby informed that the hearing on the above petition has been continued to Friday, October 28, 1887, at 12 m.

By direction of the Commissioner.

Very respectfully, JAS. N. LIPSCOMB,
Chief Clerk.

Thos. A. Edison, care R. N. Dyer, 40 Wall St., N. Y.

(Endorsement: No. 146–30; paper No. 40; notice of postponement; dated Sept. 28, 1887; continued—one month.)

Duplicate. J. M. E.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Oct.* 22, 1887.

In the Matter of the Application of THOMAS A. EDISON, Electric Lamp and Method of Making the Same. Filed Dec. 11, 1879. } Petition.

2699 SIR: You are hereby informed that the hearing on the above petition has been continued to Wednesday, Nov. 30, 1887, at 12 m.

By direction of the Commissioner.

Very respectfully, JAS. N. LIPSCOMB,
Chief Clerk.

Thomas A. Edison, care R. N. Dyer, 40 Wall street, New York city.

(Endorsed: No. 146–30. Paper No. 41. Notice of postponement. Dated Oct. 22, 1887.)

Duplicate. J. M. E.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Nov.* 30, 1887.

In the Matter of the Application of THOMAS A. EDISON, Electric Lamp and Method of Making the Same. Filed Dec. 11, 1879. } Interlocutory Appeal.

2700 SIR: You are hereby informed that the hearing on the above appeal has been continued to Friday, Dec. 30, 1887, at 12 m.

By direction of the Commissioner:

Very respectfully, JAS. N. LIPSCOMB,
Chief Clerk.

Thomas A. Edison, care of R. N. Dyer, 40 Wall street, New York city.

(Endorsed: Thos. A. Edison. No. 146–30. Paper No. 42. Notice of postponement. Dated Nov. 30, 1887.)

Duplicate. J. M. E.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Dec.* 31, 1887.

In the Matter of the Application of THOMAS A. EDISON, Electric Lamps and Method of Making the Same. Filed Dec. 11th, 1879. } Interlocutory Appeal.

2701 SIR: You are hereby informed that the hearing on the above appeal has been continued to Wednesday, January 18th, 1888, at 12 m. You are also informed that there will be no further continuance without good and sufficient showing.

By direction of the Commissioner:

Very respectfully, JAS. N. LIPSCOMB,
Chief Clerk.

Thomas A. Edison, care R. N. Dyer, 40 Wall St., N. Y.

(Endorsed: Thomas A. Edison. No. 146–30; paper No. 43. Notice of postponement. Dated Dec. 31, 1887.)

Duplicate. J. M. E.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Feb.* 27, 1888.

In the Matter of the Application of THOMAS A. EDISON, Electric Lamps and Method of Making the Same. Filed Dec. 11, 1879. } Interlocutory Appeal.

SIR: You are hereby informed that the decision of the Commissioner on the above appeal is as follows:

2702 "The request for a declaration of an interference with the patent of Sawyer and Man is denied, for the reasons stated by the examiner.

By direction of the Commissioner:

Very respectfully, JAS. N. LIPSCOMB,
Chief Clerk.

Thomas A. Edison, care R. N. Dyer, 40 Wall St., N. Y.

(Endorsed: Thos. A. Edison, No. 146–30. Paper No. 44. Notice of Commissioner's decision. Dated Feb. 27th, 1888.)

Kintner. 1879. 146.
No. —. 30.
(No. 187.)

Thomas A. Edison, ass'or to the Edison Electric Light Company of New York, N. Y.

Of Menlo Park,
County of ——,
State of New Jersey.
Electric lamps and method of making the same.
Rec'd, Dec. 11, 1879.
Petition, " " "
Affidavit, " " "
Specification, " " "
Drawing, " " "
Model, " " "
2703 Cert. dep., —.
Cash, $15, Dec. 11, 1879.
Add'l fee cert., —.
" " cash, —.
Examined, ——.
Issue, ——.
Patented, ——, 187–.
Circular, ——.

1879.

Contents.

Application papers:
1. Rej., Dec. 30, '79.
2.
3. Asso. power of att'y, Jan. 30, '80.
4.
5. Int. $^{1\,5\,5}_{\,7\,3}$. Sep. 23, 1880.
6.
7., Jan'y 28, '81. Motion to dissolve X denied.
8. June 2, '83. Dec'd favor Sawyer and Man.
9.
10. Feb. 19, 1885. Rej.
11.
12. Feb. 27, '85. Rejected.
13.
14. Notice of hearing. July 14, '85.
15. July 30, 1885. Ex's statement.
16.
17. July 30, 85. Notice of "
18. Notice of postponement, Aug. 27, '85.
19. " " " Sept. 23, '85.
20. " " " Nov. 16, 1885.

Title: Improvement in ——.

2704 Serial No. 146-30. 1884. Ex'r Book No. —.
No. 187.

Patent No. —.
T. A. Edison,
Of ——,
County of ——,
State of ——.
Invention: Elec. lamps and method of making the same.
Parts of application filed:
Petition.
Affidavit.
Specification.
Drawing.
Model.
Specimen.
First fee cash, —.
" " cert., —.
Appl. filed complete ——, Dec. 11, 1879.
Examined, ——.
Countersigned: —— ——, for Commissioner.
Notice of allowance, ——, 188–.
Final fee cash, ——, 188–.
" " cert., ——, 188–.
Patented, ——, 188–.
Att'y of P. O. address, ——.

1884.

Contents.

Application papers:
21. Nov. 18, 1885. Notice of postponement.
22. Dec. 15, " " " "
23. Jan. 19, '86. " " "
24. Feb. 11, " " " "
25. May 17, '86. " " "

2705

26.
27. June 16, '86. Notice of postponement.
28. July 19, " " " "
29.
30. Sept. 22, '86. Notice of postponement.
31.
32. Nov. 18, '86. Notice of postponement.
33. Dec. 22, '86. " " "
34. Jan. 25, '87. Notice of postponement.
35. Feb. 24, " " " "
36. Ap'l 21, " " " "
37. June 28, " " " "
38. July 27, " " " "
39.
40. Sept. 28, '87. Notice of postponement.

Title: Improvement in ——, Edison, 146–30. No. 187.

1884.

Contents.

Application papers:
41. Oct. 22, '87. Notice of postponement.
42. Nov. 30, " " " "
43. Dec. 31, '87. " " "
44. Feb. 27, '88. " " Comm'r Dec.
45.
46.
47.
48.
49.
50.
Ex'd: E. L. L.
E. C. C.

T. A. EDISON.
Electric-Lights.

No. 214,636. **Patented April 22, 1879.**

Cons E L Co
vs
McKeesport Co
Complainants Ex-
hibit Edison
patent no 1
Feby 2 1889
W. D. F.
S. E.

NO 286.
C. E. Light Co.
v.
McK. Light Co.
2706

Fig. 1.

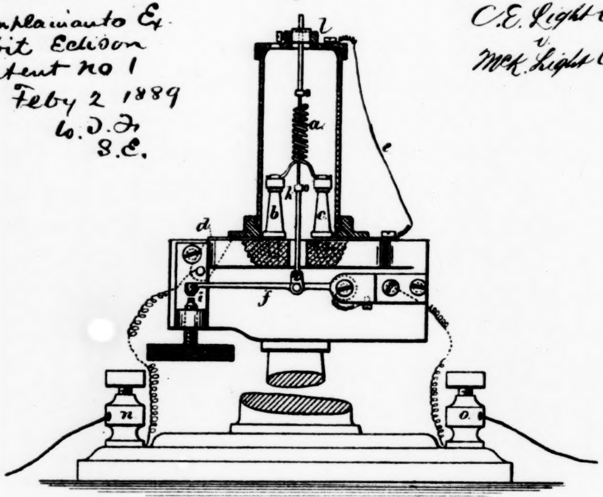
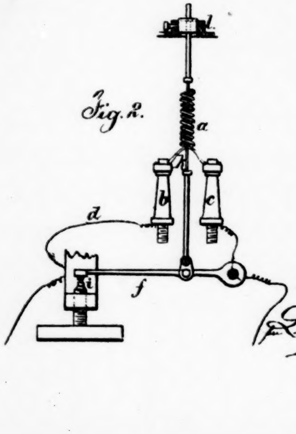


Fig. 2.



Witnesses
Chas. H. Smith
Geo. D. Pinckney

Inventor
Thomas A. Edison
per Lemuel W. Serrell
Atty.

2707

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, of Menlo Park, New Jersey.

Improvement in Electric Lights.

Specification forming part of Letters Patent No. 214,636, dated April 22, 1879; application filed October 14, 1878.

To all whom it may concern:

Be it known that I, Thomas A. Edison, of Menlo Park, in the State of New Jersey, have invented an improvement in electric lights, of which the following is a specification.

Electric lights have been produced by a coil or strip of platina or other metal that requires a high temperature to melt, the electric current rendering the same incandescent. In all such lights there is danger of the metal melting and destroying the apparatus, and breaking the continuity of the circuit.

My improvement is made for regulating the electric current passing through such incandescent conductor automatically, and preventing its temperature rising to the melting-point, thus producing a reliable electric light by rendering conducting substances incandescent by passing an electric current through them.

In my apparatus the heat evolved or developed is made to regulate the electric current, so that the heat cannot become too intense, because the current is lessened by the effect of the heat when certain temperatures are reached, thereby preventing injury to the incandescent substance, by keeping the heat at all times below the melting-point of the incandescent substance.

Various devices for carrying my improvement into practice may be employed, and I have tested a large number. I however have shown in the drawings my improvement in a convenient form, and contemplate obtaining separate patents hereafter for other and various details of construction, and I state my present invention to relate, broadly, to the combination with an electric light produced by incandescence, of an automatic thermal regulator for the electric current.

(Here follows diagram marked p. 2706.)

Figure 1 represents the electric-light apparatus in the form in which the thermal regulator acts by the heating effect of the current itself, and Fig. 2 illustrates the same invention when the radiated heat from the incandescent conductor operates the thermal regulator.

The incandescent metal is to be platinum, rhodium, iridium, titanium, or any other suitable conductor having a high fusing-point, and the same is used in the form of a wire or a thin plate or leaf.

I have shown the platinum wire *a* as a double spiral, the two ends terminating upon the posts *b c*, to which the conductors *d e* are connected. The double spiral *a* is free to expand or contract by the heat, as both ends are below the spiral.

A circuit-closing lever, *f*, is introduced in the electric circuit, the points of contact being at *i*, and there is a platina or similar wire, *k*, connected from the lever *f* to the head-piece or other support *l*.

The current from a magneto-electric machine, a battery, or any other source of electric energy, is connected to the binding-posts *n o*, and when contact at *i* is broken the current passes from *o* through lever *f*, wire *k*, support *l*, wire *c*, post *c*, platina coil *a*, post *b*, and wire *d*, or metallic connection, to binding-screw *n*. In this instance the wire *k*, being small, is acted upon by the electric current and heated, and by its expansion the lever *f* is allowed to close upon *i* and short-circuit the current.

The contact-point *i* is movable, and it is adjusted so that the shunt will not be closed until the temperature of the apparatus arrives at the desired height, and, by diverting a portion or the whole of the current, the temperature of the incandescent conductor is maintained in such a manner that there will be no risk of the apparatus being injured by excessive heat or the conductor fused.

If the wire *k* is small, so as to be heated by the electricity itself, it may be placed in any convenient position relatively to the light; but if such wire is heated by radiation from the electric light, then it should be adjacent to the incandescent material.

In all instances, the expansion or contraction of a suitable material under changes of temperature forms a thermostatic current-regulator that operates automatically, to prevent injury to the apparatus and to the body heated by the current.

In Fig. 2 the current does not pass through the wire *k*, and the short-circuiting lever is operated by the radiated heat expanding the wire *k*. This in practice does not operate as rapidly as the device shown in Fig. 1.

2708 The electric light may be surrounded by a glass tube or any other suitable device, such as two concentric glass tubes with the intervening space filled with alum-water or other bad conductor of heat, the object being to retain the heat of the incandescent metal and prevent loss by radiation, thus requiring less current to supply the loss by radiation.

I am aware that the electric current has been used to produce heat, and that such heat has been employed to vary the relative position of the light-giving electrodes and the length of the intervening arc. In my light there is no electric arc.

I claim as my invention—

1. In combination with an electric light having a continuous incandescent conductor, a thermostatic circuit-regulator, substantially as set forth.

2. In combination with an electric light, a thermostatically-operated shunt, substantially as set forth.

Signed by me this 5th day of October, A. D. 1878.

THOMAS A. EDISON.

Witnesses:
ALFRID SWANSON.
STOCKTON L. GRIFFIN.

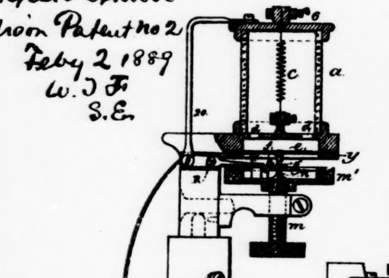
No. 286
E Light Co.
v
McK Light Co. } p 2709.

T. A. EDISON
Thermal-Regulator for Electric-Lights.

No. 214,637. **Patented April 22, 1879.**

Cons E L Co
vs
McKeesport Co
Complts Exhibit
Edison Patent No 2
Feby 2 1889
W. J. F.
S. E.

2
Fig. 1.



2
Fig. 2

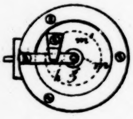
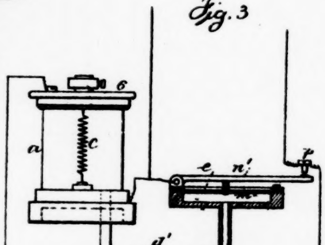
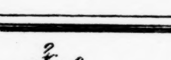


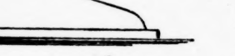
Fig. 3



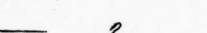
2
Fig. 6



2
Fig. 5



2
Fig. 4



Witnesses
Chas H. Smith
Geo. T. Pinckney

Inventor
Thomas A. Edison
for Lemuel W. Serrell
atty

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, of Menlo Park, New Jersey.

Improvement in Thermal Regulators for Electric Lights.

Specification forming part of Letters Patent No. 214,637, dated April 22, 1879; application filed November 18, 1878.

To all whom it may concern:

Be it known that I, Thomas Alva Edison, of Menlo Park, in the State of New Jersey, have invented an improvement in electric lights, of which the following is a specification. (No. 162.)

The object of this invention is to devise a reliable and economical electric lamp to give light by incandescence due to the passage of the electric current through conductors of electricity, so that a great number of lamps may be used in one electric circuit.

The invention consists in causing the heat generated by the incandescent conductor to expand the air or fluid in the containing-chamber as its temperature rises, the pressure thus created serving to move outwardly a yielding material, such as a diaphragm, which, in its turn, serves to control the passage of the electric current through the incandescent body by means of contact-points or circuit-regulators, and thus the temperature of the incandescent conductor will be regulated automatically.

(Here follows diagram marked p. 2709.)

In the drawings, figure 1 is a sectional elevation of the electric lamp, and Fig. 2 is a plan of a portion of the same. The other figures are separately referred to.

a is a glass tube or vessel containing spiral or strip *c* of iridium or equivalent metal, through which the current passes. *b* is the top plate to which the spiral *c* is connected. The glass tube is secured to the metallic standard Q. *e* is a diaphragm closing the bottom of the lower chamber. There is a partition between the chamber containing the spiral *c* and the chamber of the diaphragm; but air circulates freely between the chambers through the holes *d d d d*. When the spiral is heated by the passage of the current the air in the chambers expands and bulges the diaphragm outwardly .On the center of the diaphragm is a platina point, *f*, immediately opposite another platina point, *g*, on a spring, *h*. This, again, is opposite another platina point, *n*, on the screw *m*.

m' is a disk of insulating material, on the top of which is a brass ring in electrical connection with the spring *h*. A rubbing contact-spring, *v*, connects this ring to the insulated plate R and the binding-post 2 on the base. The frame Q is connected to the other binding-post, 1. A wire, 20, connects the spiral of the light with the plate R and binding-post 2.

When no current passes in the circuit containing this instrument the air in the chamber is of the same pressure as the atmosphere, and the points *f* and *g* and *n* are not in contact. If, now, the current is allowed to circulate in the line, it passes, say, from binding-post 2 to R, thence through wire 20 to the top *b*, down through spiral *c* to base Q, to the other binding-post, 1. When the spiral *c* reaches within a few degrees of its melting-point the expansion of the air will have bulged out the diaphragm *e* and brought the points *f* and *g* together, thus short-circuiting the current from the spiral, as it now must nearly all pass from binding-post 2 to R, thence through spring *v* to the ring *y*, through spring *h* to *g*, through *f* to diaphragm *e*, to Q, and back to binding-post 1. When thus short-circuited the temperature of both the air and spiral falls by radiation, and when it reaches a certain point the diaphragm and point *f* leaves *g*, and the current again passes through *c* and raises its temperature, and the same action takes place. This regulation is so rapid that the eye does not perceive any diminution in the strength of the light. The object of the contact between *g* and *n* is that in case *f* and *g* should fail to make contact the short circuit would still take place, as *n* and *f* are both connected to Q. It is obvious that this method may be applied in many ways. For instance, the diaphragm might give motion to a lever or spring through which the contacts might be made, and this second chamber may be separated from the one containing the spiral *c*, as shown in Fig. 3. A tube, *d'*, leads from the chamber containing the spiral to the second chamber, m^2, closed by the diaphragm *e*.

n' is a lever which is moved by the movement of the diaphragm, and serves to short-circuit the spiral *c* when it comes in contact with the point *p*.

Mercury may replace air in the tube *d* and chamber m^2, the pressure of the air or gas in *a* acting through such mercury on the diaphragm *e*; or the mercury may come into contact with the point *p* to make direct circuit through the mercury.

The incandescent conductors may be made in either of the forms shown in Figs. 4, 5, or 6.

In my application No. 156, filed October 14, 1878, I have
2711 shown a thermostatic circuit-regulator in connection with the
electric light. I do not therefore herein claim any feature
set forth in said prior application.

I claim as my invention—

The method specified of regulating the temperature of the incandescent light-giving body by the expansion of the air or gas in the closed vessel containing the light, acting automatically in the electric circuit, substantially as set forth.

Signed by me this 14th day of November, A. D. 1878.

THOMAS A. EDISON.

Witnesses:

STOCKTON L. GRIFFIN.
CHAS. BATCHELOR.

T. A. EDISON.
Electric Lighting Apparatus.

No. 218,866. **Patented Aug. 26, 1879.**

Cons. E L Co
v
McKeesport Co

Complts Exhibit
Edison Patent
No 3. Feby 2 1889
W.D.J. S.E.

No. 286
C E Light Co
v
McK Light Co
} p. 2712

Fig. 1

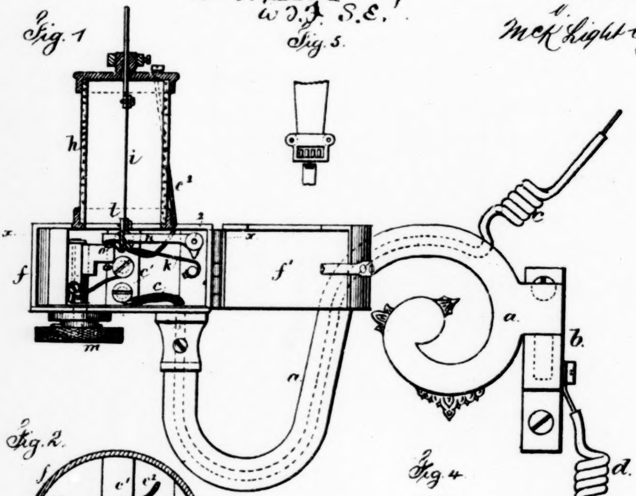


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Fig. 5.

Fig. 2.

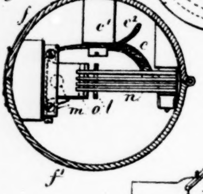

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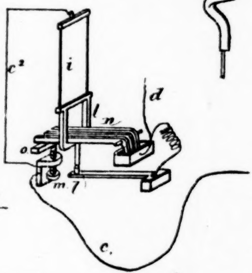
Fig. 4



c²
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m
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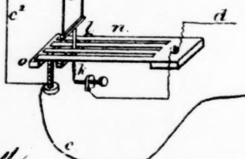
Fig. 3.



Witnesses
Chas H. Smith
Harold Serrell

Inventor
Thomas A. Edison
per Lemuel W. Serrell
atty

2713 UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, of Menlo Park, New Jersey.

Improvement in Electric Lighting Apparatus.

Specification forming part of Letters Patent No. 218,866, dated August 26, 1879.

To all whom it may concern:

Be it known that I, Thomas Alva Edison, of Menlo Park, in State of New Jersey, have invented an improvement in electric lighting apparatus, of which the following is a specification.

In an application before filed by me, the light-giving body is combined with the circuit-connections and a thermal regulator that prevents injury to the apparatus by short-circuiting the current or placing a resistance therein. I do not therefore herein claim any such device

My present invention relates to the combination, with the light-giving body, of a range of levers and contact-surfaces arranged in such a manner that the current is short-circuited or shunted to a greater or less extent, according to the heat of the incandescent light-giving body.

(Here follows diagram marked p. 2712.)

In the drawings, figure 1 is an elevation of the bracket and a section of the light-giving apparatus. Fig. 2 is a sectional plan at the line *x x*. Figs. 3 and 4 are diagrams of the circuit-connections; and Fig. 5 is a partial elevation endwise of the shunting-levers.

The bracket *a* is sustained by a socket and pin at *b*, so that it may be swung like a gas-fixture.

c is one of the electric conductors The same is insulated and passes into an opening in the bracket, and thence to the electric light, and the return-circuit is through the pipe *a* to the wire *d*, or to the gas-pipe, if the bracket is upon a gas-pipe.

The conductor *c* passes to the insulated plate c^1 within the case *f*, and, for convenience, this case *f* has a swinging door, *f'*, in one side to give access to the interior parts. Above the case *f* is a glass cylinder, *h*, or other suitable protection for the electric light, and *i* is a strip of platina-foil or other known or desired light-giving material that can be rendered incandescent and produce the necessary light without melting. The conductor c^2 passes to one end of this light, and the other end of *i* is connected by the spring *k* with the metal part of the bracket, and thence to *d*.

The spring *k* serves to keep a slight tension on the foil *i*, and the yoke or frame *l* intervenes between the spring *k* and the foil.

There are levers *n*, or springs, that are connected at 2, and their free ends rest in and upon the yoke or frame *l*, and their ends should be tipped with platina.

The bar *o* is preferably of platina, and it is adjustable by means of the screw *m*, that raises or lowers the same, so as to bring it nearer to or farther from the ends of the levers or springs *n*. This adjustment is made so that the ends of the springs or levers *n* will not be in contact with the bar *o* while the light is in its normal condition; but when the heat of the foil *i* becomes excessive the expansion allows the ends of the springs or levers *n* to come into contact with the bar *o* and set up a shunt or short circuit from *c o*, through *n*, to *d*, and, according to the amount of expansion in *i*, so one, two, or more of the bars or springs *n* will be in contact with *o*, because said bar *o* is farther from the levers *n* at one end than at the other. By this means injury to the light-giving body is prevented, and a path established for the electric current becomes less in resistance as the points of contact between *n* and *o* increase in number.

The lower end of the yoke *l* may come into contact with the spring or stud *t* at the extreme expansive movement, as seen in Fig. 4 to still further lessen the resistance between *c* and *d* and divert the current from the foil *i*.

The ends of the levers *n* may be in a bath of mercury, as seen in Fig. 4, to insure electric contact. If the foil *i* is accidentally broken or injured the circuit through *n* is instantly closed, so that other lights in the same circuit are not extinguished. This device is automatic, so as to avoid the extinguishment of other lights.

I claim as my invention—

1. The combination, with the light-giving body, of two or more circuit levers or springs, *n*, a yoke, *l*, a contact-bar, *o*, and the circuit-connections, substantially as set forth, for lessening the resistance of the shunt as the temperature of the light-giving body increases, as specified.

2. The circuit-connection *t*, in combination with the levers or springs *n*, yoke *l*, light-giving body *i*, and circuit-connections, substantially as set forth.

Signed by me this 3d day of December, A. D. 1878.

THOMAS A. EDISON.

Witnesses:

STOCKTON L. GRIFFIN.
GEO. E. CARMAN.

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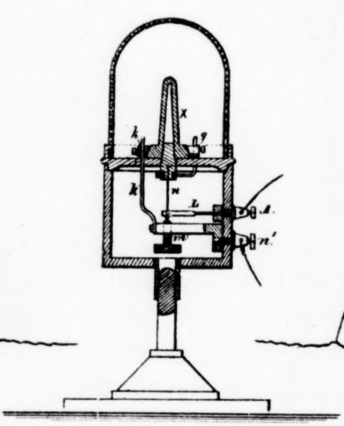
T. A. EDISON.
Electric-Light.

No. 219,628. **Patented Sept. 16, 1879.**

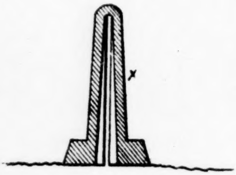
Cons E L Co
vs
McKeesport Co
Compl'ts Exhibit
Edison patent
No 4 Feby 2 1889
W. J. J.
S.E.

No. 286
C. E. Light Co
v.
McK Light Co
} p. 2714

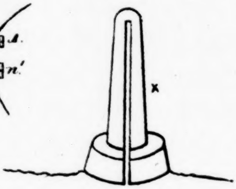
2
Fig. 1.



2
Fig. 2.

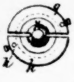


2
Fig. 3.



Case No. 164.

Fig. 4



Witnesses

Chas H Smith
Geo. J. Pinckney

Inventor

Thomas A. Edison.

per Lemuel W. Serrell

atty.

2715

United States Patent Office.

Thomas A. Edison, of Menlo Park, New Jersey.

Improvement in Electric Lights.

Specification forming part of Letters Patent No. 219,628, dated September 16, 1879; application filed December 9, 1878.

To all whom it may concern:

Be it known that I, Thomas Alva Edison, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented an improvement in electric lights, and the following is declared to be a description of the same:

The object of this invention is to produce a candle or light-giving body by the incandescence of a conductor of electricity in the form of a cylinder, prism, or other mass of a size adapted to yield the required volume of light.

The invention consists in an electric light-giving body formed of a conductor, such as finely divided platinum, iridium, ruthinium, or other metal difficult of fusion, incorporated with non-conducting material.

The candle, made as aforesaid, can be of any desired size or shape, and the metallic particles become incandescent by the passage of the current, and the non-metallic materials are luminous and increase the brilliancy. This is accomplished by a comparatively small electric current. I mix with such finely-divided conductors infusible materials—such as oxide of magnesium or zirconium—in different proportions, so as to obtain any degrees of conductivity required.

In some instances I saturate rods, sheets, or other forms of infusible oxides with a salt of the metal difficult of fusion, and reduce the same by heat to a metallic state.

I will mention that the use of a non-conducting material is not absolutely necessary, as the finely-divided metals, owing to their porosity, have high resistance, and become easily incandescent; but I prefer to use the non-conductor.

(Here follows diagram marked p. 2714.)

In Figure 1 is shown a lamp composed of finely-divided iridium mixed with oxide of zerconium and molded in the form of a split hollow cylinder, *x*. Fig. 2 is a detached section of the same. Fig. 3 is a perspective view, and Fig. 4 is a plan view.

The cylinder being split, the current enters the binding-post A, passes through the lever L, through the regulating wire *n* to the plate *g*, thence up one side of the iridium cylinder *x*, down the other side to the plate *h*, thence, by wire *k*, to the regulating-screw *m* and binding-post *n'*.

The regulation of the temperature of the cylinder *x* is obtained by the thermal-current regulator in the same manner as is shown in my application No. 156, filed October 14, 1878.

The incandescent conductor made in this manner may be of any desired shape.

I claim as my invention—

1. For electric lighting, a conductor of electricity formed of finely-divided metal incorporated with a non-conductor of electricity, substantially as set forth.

2. A rigid electric-light-giving body having a longitudinal incision or separation from the base to near the end, for insuring the circulation of the electric current through the entire body, substantially as set forth.

3. In combination with a rigid light-giving body having a longitudinal incision, an expansive thermal-circuit regulator to control the strength of the current by the heat developed, substantially as set forth.

Signed by me this 3d day of December, A. D. 1878.

THOMAS A. EDISON.

Witnesses:
STOCKTON L. GRIFFIN.
GEO. E. CARMAN.

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T. A. EDISON.
Electric-Lighting Apparatus.

No. 224,329. **Patented Feb. 10, 1880.**

Cons E L Co
vs
McKeesport Co }
Complts Exhibit
Edison Patent no 5
Feby 2 1889
W.J.A.
S.C.

No. 286.
C.E. Light Co.
vs.
McK. Light Co. } p. 2716

Fig. 1.

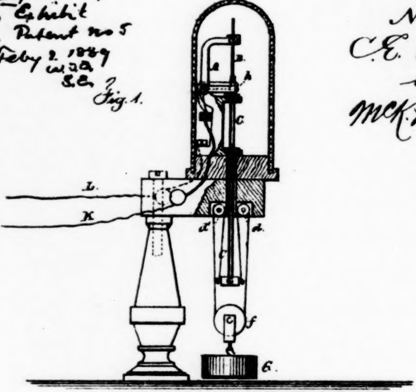
B
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Fig. 3.

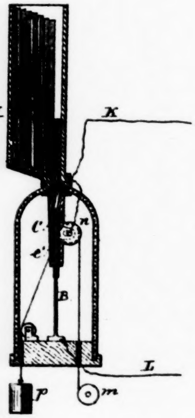
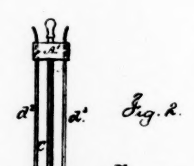


Fig. 2.


A'
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Witnesses
Chas. H. Smith
Geo. T. Pinckney

Inventor
Thomas A. Edison
for Lemuel W. Serrell att.

2717 UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, of Menlo Park, New Jersey.

Electric Lighting Apparatus.

Specification forming part of Letters Patent No. 224,329, dated February 10, 1880. Application filed February 3, 1879.

To all whom it may concern:

Be it known that I, Thomas A. Edison, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented an improvement in electric lighting apparatus, (case No. 170;) and the following is declared to be a description of the same.

The object of this invention is to produce electric illumination by the incandescence of carbon.

The invention consists in making the two poles dissimilar, one being of the carbon in the form of a slender rod, and which serves to give light, while the other is of platinum or platinum-iridium alloy, against which the rod presses. The inferiority of contact which takes place between the metal and the carbon creates a considerable resistance, which, heating the carbon, increases the inferiority of the contact, causing the carbon to become highly incandescent; but no effect is produced upon the platinum or iridium alloy.

(Here follows diagram marked p. 2716.)

In figure 1, A is the frame-work; B, the platina pole; C, the carbon rod. *h h* are springs which rub upon the carbon rod, and are the medium of conveying a current to it by the wires K from the binding-post, the platina rod B and frame A being connected to the other binding-post by the wire L. *d'* and *d* are wheels over which cords or strings are run. These strings are connected to the extreme end of the carbon C, and to the pulley *f* and weight G. The effect of the weight is to cause the carbon rod C to press at all times against the platina or iridium rod B. The carbon rod is insulated from the frame A in any suitable manner; and it will be apparent that as the carbon rod is consumed the weight G moves the carbon upwardly to maintain contact with metallic rod B.

In Fig. 2 is shown a method whereby the carbon rod C is fed downward by means of a weight, A', resting upon the upper end of the carbon and guided by the springs or rods d^2 d^3. Electrical contact is maintained with the weight and carbon by the springs d^2 d^3, or in any other suitable manner.

In Fig. 3 a magazine-lamp is shown. C C C are rods of carbon contained in the case H, which rods rest at their lower end upon the inclosed bottom of the case H, and slide toward the tube *e'*, into which the rods pass, one at a time, by their own weight. *n* is a feed-wheel that acts through an opening at one side of the tube *e'* upon the carbon rod; *p*, a weight, and *m* a spool or coil of thread or fine wire with a slight friction from a spring or otherwise to prevent the thread unwinding too easily. This thread passes around the wheel *n* or a drum on its shaft, and is constantly drawn upon by the weight *p*, so as to move the carbon rod downwardly and keep it in contact with the metal rod B.

It is obvious that a clock-work movement which will run for several days, or an electric engine included in the same circuit, may give motion to the feed-wheel *n*.

I am aware that in some instances the carbon rod has been forced into contact with a large bar tipped with platina. I make use of a rod of platina or iridium that is smaller than the carbon, so as to produce a resistance at the point of contact between the carbon and platina in consequence of the inferior contact, and thereby develop incandescence at this point. I am also aware that rods of carbon have been supplied automatically from a holder. Therefore I do not claim the same.

I claim as my invention—

1. The combination, with the carbon rod in an electric lamp, of a metal rod that is difficult of fusion and smaller than the carbon rod, so as to produce a resistance at the point of contact between the carbon and the metal, and a weight to maintain the necessary pressure at the point of contact, substantially as set forth.

2. The case H, having an inclined bottom and adapted to receive several carbon rods, in combination with the metallic rod B and means for guiding the carbon and maintaining the pressure thereof at the point of contact, substantially as set forth.

Signed by me this 23d day of January, A. D. 1879.

THOMAS A. EDISON.

Witnesses:
S. L. GRIFFIN.
WM. CARMAN.

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T. A. EDISON.
Electric-Lights.

No. 227,227. **Patented May 4, 1880.**

Cons E L Co
vs
McKeesport Co
Complts Exhibit
Edison Patent no 6
Feby 2, 1889
W. J. H.
E. C.

Fig. 1.

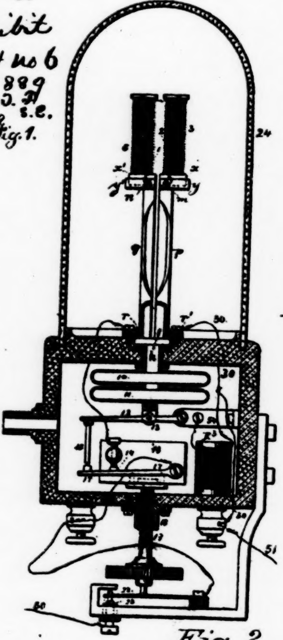
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Fig. 3

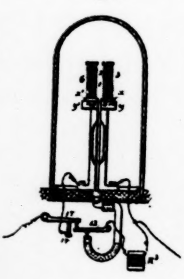
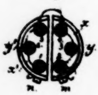
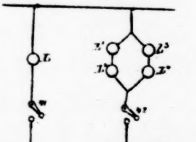


Fig. 4.



No. 286.
C. E. Light Co.
v.
McK Light Co.
p.27

Fig. 2.


L
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Witnesses
Chas H. Smith
Geo T. Pinckney

Inventor
Thomas A. Edison
per Lemuel W. Serrell
atty

2719

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, of Menlo Park, New Jersey.

Electric Light.

Specification forming part of Letters Patent No. 227,227, dated May 4, 1880. Application filed February 10, 1879.

To all whom it may concern:

Be it known that I, Thomas A. Edison, of Menlo Park, in the State of New Jersey, have invented an improvement in electric lights, (case No. 171,) of which the following is a specification.

The object of this invention is to economically apply electricity to lighting, and to insure uniformity of action in the different lamps.

The invention consists, first, in an improved incandescent lamp and regulator; second, in an automatic switch connected with the regulator of the lamp to connect it with the line; third, in grouping several lamps in such a manner that their combined resistance shall be the same as one lamp.

(Here follows diagram marked p. 2718.)

Figure 1 represents the lamp and the circuit-connections. 1, 2, 3, 4, 5, and 6 are coils of wire, preferably flattened wire, formed of an alloy of platinum and iridium or metallic nickel. There are six of these coils, (see Fig. 4,) each of which is slipped over a pencil of pipe-clay, which may be provided at the top end with a head, as shown in Fig. 1. These pipe-clay pencils are secured to pipe-clay disks *x x'*, resting on the split metal cup *y y'*. Coil No. 2 has its lower end connected to the binding-screw *m* of the cup *y*. The top end of the spiral 2 connects to the spiral 3, the bottom of 3 to 4, the top of 4 to 5, the bottom of 5 to 6, the top of 6 to 1. The bottom of 1 connects to the screw *n* of the brass cup *y'*.

q and *p* are electric conductors between the divided cup *y y'* and the divided base *r* and *r'*, and at the same time serve as supports to the burner. The wire of the coils, as it comes from the winding-machine, is stretched to open the coils, and then dipped in a thick milky solution of zircon oxide and clay, and then passed through a hydrogen flame. This causes a very slight coating to adhere to the wire. The coils are pressed together and placed on the fire-clay pencils, and the coils are confined between the heads of the fire-clay pencils and the clay blocks *x x'*, into holes in which blocks the ends of such fire-clay pencils are pressed. The coils forming the spirals are thus in contact, or nearly so; but they do not connect electrically. Hence the current passes through the whole length of the wire. The expansion of the pencil of clay, or clay and zircon, is about equal to that of the metal coils. Hence their condition is not materially altered by the heat. The spirals are of such a size that they nearly touch each other. Hence the light and heat are confined within the circular range of spirals and aid in intensifying the light and heat of the electric candle, and the radiation is mostly from the outside portions of the coils. The pipe-clay disks *y y'* serve both for holding the pencils and preventing the lower ends of the spirals from cooling by having their heat conducted downward by the metal supports *q p*.

24 is a glass globe or shade set over the burner and made air-tight, or nearly so. Air can only pass through the orifice *h*, as shown by the arrow. The regulation by the electric current, and the consequent temperature of the burner, is obtained by the expansion of the air contained in the glass shade 24.

10 and 11 are flexible chambers, similar to those used in an aneroid barometer. The expansion of the air by the heat of the burner causes these chambers to bulge outwardly and gives a downward motion to the lever 12, which is secured to the camber 11 at 13.

15 is a long rod, tipped with platinum.

14 is a contact-point, and the lever 17 usually rests against it; but when the heat of the burner has reached its maximum point it has expanded the air sufficiently to cause the lever 12 and point 15 to separate the lever 17 from 14 and divert the electric current from the lamp.

When the lamp is in operation the current passes from wire 50 to point 22, which is in contact with the spring 22, the regulator-screw 19 keeping 22 and 23 in contact. Thence the current passes to binding-post and lever 17, thence to contact-point 14 to *r*, through the spirals to *r'*, thence by wire 30 to the other binding-post, and out by wire 51. If, now, the temperature of the spirals becomes too great, the lever 12 and point 15 are thrown downward and the lever 17 separated from point 14, thus throwing the lamp entirely out of circuit and placing in circuit a resistance, R^3, equal to it, the object of the resistance being to prevent an excessive spark at the contact-points. I remark that if the current is accurately circulated for the lamp the resistance of R^3 may be much greater than the
2720 lamp, and such resistance may even be in the form of several spirals placed between the spirals 1, 2, 3, 4, 5, and 6. When the lever 17 is in contact with the point 15 and lever 12 the current passes by wire 50 to 23, thence through 22 to binding-post 17, thence through 15 and 12 to the coil R^3 by wire 54, thence by wire 30 to the binding-post, and out by wire 51. The block 16, upon which the lever 17 and point 14 are attached, is movable, and it is adjusted by means of the screw 19, that passes through the stationary nut 18. By moving this block 16 toward the lamp the circuit is broken to the candle and closed through 15 and 17, and in so doing the circuit from 50 is broken between the spring 22 and screw-point 23. The reverse movement causes the lamp to be automatically connected to the circuit when the regulator-screw is turned downward to light the lamp.

The parts can be so arranged that the lamp will be disconnected when it is giving a light equal to about two candle-power.

In Fig. 2 are shown switches 41 and 42, whereby the lamps may be disconnected from the circuit after being turned down, as shown in my previous application, No. 169.

It is obvious that any of the various forms of thermal circuit-regulator already described in my previous patents may be combined with the burner herein shown.

In Fig. 3 is shown the before-described lamp with mercury substituted for the aneroid chambers.

In Fig. 2, I have shown a single lamp, L, having, say, one thousand ohms resistance placed in one branch, and in another branch I have shown four electric candles or burners, L' L^2 L^3 L^4, in one lamp, the burner being in close proximity and arranged in two branch circuits, the resistance of each branch being two thousand ohms. The two branches will jointiy offer a resistance of one thousand ohms, the same as the resistance of the one lamp L. By this arrangement various numbers of lamps may be placed in branch circuits between the same main conductors, and the resistance be equal in each branch.

In my application for a patent, No. 162, I have shown a glass shade in which the air is confined and acts by its expansion upon a diaphragm to operate the electric-circuit regulator, and in my application No. 162 I have represented the confined air as acting upon a column of mercury, and in my application for a patent, No. 166, I have shown the lamp as composed of a flattened coil of wire, and in my application No. 169 I have shown a rheostat or resistance that is thrown into the circuit when the lamp is extinguished.

I claim as my invention—

1. The combination, with the electric lamp and its transparent shade, of the aneroid chambers 10 and 11 and electric-circuit regulator, substantially as set forth.

2. In an electric lamp, the combination, with a core of pipe-clay or equivalent non-conducting material, and a base of similar material, to which the core is connected, a helix of platina or equivalent material surrounding the core, and the wires of the electric circuit connected thereto, substantially as set forth.

3. In an electric lamp, a circular range of parallel devices connected alternately at top and bottom, and at the ends to the electric-conductors, substantially as set forth.

4. The combination, in an electric lamp, of the divided base r r', standards p q, divided cup y y', and a circular range of parallel helices and circuit-connections, substantially as set forth.

5. The combination, with the electric lamp and thermal circuit-regulator, of the movable block 16, levers 12 and 17, contact-points 14 15, adjusting-screw 19, rheostat R^3, and circuit connection, substantially as and for the purposes set forth.

6. The automatic switch 22 23, in combination with the screw 19, block 16, circuit-connections, thermal circuit-regulator, and electric lamp, substantially as set forth.

7. The arrangement of four electric lamps in a divided branch circuit between two main conductors, substantially as and for the purposes set forth.

Signed by me this 6th day of February, A. D. 1879.

THOMAS A. EDISON.

Witnesses:
STOCKTON L. GRIFFIN.
WM. CARMAN.

2722 UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, of Menlo Park, New Jersey.

Electric Light.

Specification forming part of Letters Patent No. 227,228, dated May 4, 1880. Application filed February 3, 1879.

To all whom it may concern:

Be it known that I, Thomas A. Edison, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented an improvement in electric light (case No. 169), of which the following is a specification.

In my patents Nos. 214,636, 219,628, and 218,866 the expansion of metal under heat is availed of in regulating the electric circuit, and hence the same is disclaimed herein.

In my present electric lamp I make use of a coil of wire with a pyroinsulating material between the coils similar to that set forth in my application No. 166, which pyroinsulation is disclaimed herein; but I combine therewith a surrounding case that is rendered incandescent by the heat of the coil, and I combine with the lamp a thermal-circuit regulator arranged so that the amount of light can be varied at pleasure by an adjusting-screw that regulates the point at which the thermal regulator acts to open the electric circuit and lessen the current, so that the incandescent case can be more or less luminous.

The invention also consists in a lamp which is peculiarly adapted to use in multiple arc.

(Here follows diagram marked p. 2721.)

In the drawings, figure 1 is a diagram illustrating the connections, and Fig. 2 shows the peculiar lighting apparatus.

The magneto-electric machines may be of any suitable character and driven by power. They may be arranged between the two main conductors A B in ranges or multiple arcs of three, four, or more in each, and the connections should be made for intensity. I have represented four such magneto-electric machines, M, in each range.

A is a tube laid in the earth, and preferably of iron, and it forms, together with the earth, one-half of the circuit. Within this tube is an insulated conductor, B, preferably of a number of strands of copper twisted together in the form of a cable, one strand of the cable being dropped, say, every one hundred feet, so that at the extreme end of the circuit there shall be but a single strand. This cable is insulated from the tube by any cheap or economical insulation, such as tar or asphaltum.

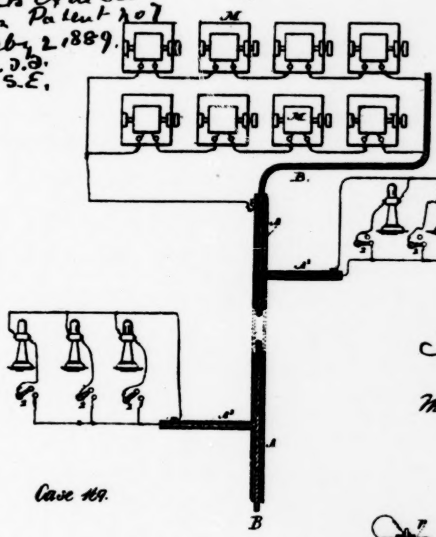
A branch tube, A^2, containing a single strand from the cable, is to enter each house or building, and from the basement smaller

T. A. EDISON.
Electric-Lights.

No. 227,228. **Patented May 4, 1880.**

Cons E L Co
vs
McKeesport Co
Complts Exhibit
Edison Patent No 7
Feby 2, 1889.
W. D.
S. E.

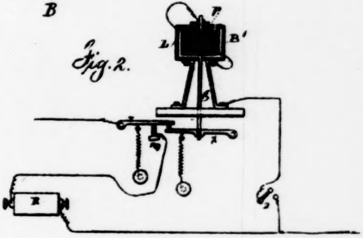
Fig. 1.



Case 149.

No. 286
E. Light Co
v.
M.K. Light Co } p. 2721

Fig. 2.



Witnesses
Chas H. Smith
Geo. T. Pinckney

Inventor
Thomas A. Edison.
per Lemuel W. Serrell
atty.

wires are run to the various parts of the house where the lights are required. Each lamp is to be provided with a switch, 2, so that it may be disconnected from the conducting-wires.

The electric generators at the central station are provided with constant field-of-force magnets, the helices of which are in the electric circuit; hence if all the lamps feeding from the main conductors are disconnected by their switches the circuit will be broken and no current passes through the conductors leading from the station to the lights, and the steam-engine runs lightly and with the expenditure of a very small amount of force. If now the switch of a single lamp is turned the lamp is connected to the branch wires from the main conductors, the circuit is closed, and only sufficient current passes from the central station to supply that lamp, because the external resistance determines the amount of current. In this way the current will be proportioned to the number of lamps in the circuit.

Each lamp I prefer to contain a resistance when incandescent of one thousand ohms. After the switch has been turned on so as to connect the light to the conductors the current will pass through a resistance, R. equal to the lamp; but if the thermal regulating-screw *n* be turned downward the lamp will be thrown in circuit and the current divided according to the extent to which the regulating-screw has been turned downward; if but slightly the lamp will only reach, say, a red heat, when, owing to the expansion of the regulating-rod *g*, the lamp will be thrown out of circuit and the resistance R thrown in, as the lever *x* allows the lever Q to come in contact with the point *n*, the lever *x* breaking contact with it simultaneously. As this takes place the lamp cools and the contraction of *g* places the lamp in circuit again. Thus the resistance of the lamp and its appurtenances is quite regular regardless of the degree of temperat-e or amount of light the lamp is giving out. This feature of this light is similar to that shown in my application No. 166, and therefore does not form part of the present invention.

This apparatus is not a perfect regulator, as the resistance of the incandescent conductor increases with its heat; but if in any case
it is desirable that the resistance should be practically con-
2723 stant at all temperatures the screw *n* may be arranged to
operate contact-levers, so as to decrease or increase the resistance of R when it is thrown upward or downward, several bobbins of wires being used in R, as in my application No. 146, one or more being brought into circuit by the movement of the screw *n* and its levers. By the means above described above nine-tenths of the resistance, except of the main conductors, is light-giving resistance, thus effecting great economy in current.

As before described, as the connecting of one or more lamps causes a sufficient amount of current to be developed at the central station to keep the same incandescent, it follows that if the machines at the station are arranged expressly for tension and quantity many hundreds of lamps may be placed in circuit between the main conductors, the reduction of resistance upon placing each lamp in the circuit drawing the proper quantity of current from the station; hence the greatest economy possible is obtained by causing all the resistance outside of the main conductors to be light-giving resistances.

The lamp shown in Fig. 2 consists of a bobbin of wire insulated with a pyroinsulator, such as zircon, magnesia, lime, or other compounds of high fusibility, as set forth in my application No. 166. This bobbin B′, which has preferably a resistance of one thousand ohms, is placed within a metallic case, L, which is rendered highly incandescent by the radiated heat from the bobbin. The rod *g* is insulated from the case at P, and one end of the bobbin B′ is connected by a wire to this rod, the other end of the bobbin being connected to the case L or to the wire connected to the switch 2. When the lamp is turned off the lever Q is in contact with *n* and the resistance R is in circuit; but when *n* is lowered until the lever Q comes into contact with *x* the lamp is thrown in circuit and the regulating-rod *g* allows more or less intimate contact between *n* and Q.

I will mention that the case L is not necessarily metallic, as it may be of lime or zircon.

I claim as my invention—

1. The lamp consisting of a pyroinsulated coiled wire, in combination with a surrounding case that is rendered incandescent by the radiated heat, substantially as set forth.

2. The combination, with the electric lamp, of the thermal regulator, a resistance, and an adjusting device, *n*, arranged and operating substantially as set forth.

Signed by me this 28th day of January, A. D. 1879.

THOMAS A. EDISON.

Witnesses:
STOCKTON L. GRIFFIN.
J. N. MACKENZIE.

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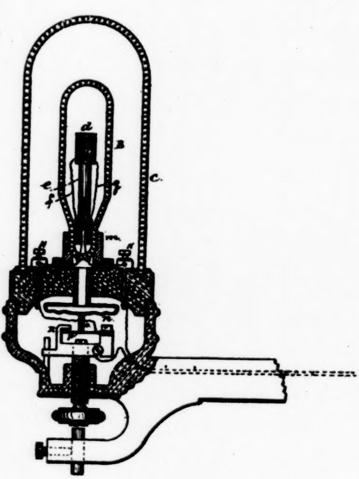
T. A. EDISON.
Electric-Lights.

No: 227,229. **Patented May 4, 1880.**

Cons E L Co
vs
McKeesport Co
—
Compl'ts Exhibit
Edison Patent No 8
Feby 2 1889
W. J. H.
S. E.

No. 286
C. E. Light Co.
v
McK. Light Co
} p. 2724

Case No. 176.



Witnesses
Chas H. Smith
Geo. T. Pinckney

Inventor
Thomas A. Edison.
per Lemuel W. Serrell att'y

2725 UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, of Menlo Park, New Jersey.

Electric Light.

Specification forming part of Letters Patent No. 227,229, dated May 4, 1880; application filed April 21, 1879.

To all whom — may concern :

Be it known that I, Thomas A. Edison, of Menlo Park, in the State of New Jersey, have invented an improvement in electric lights (case No. 176), of which the following is a specification:

When platina and other metals that fuse at a high temperature are exposed to high heat and then cooled in the atmosphere they are injured, so that they are not well adapted to use in electric lights for a long period of time.

I inclose the conductor that forms the electric candle in a transparent case and heat the same gradually to expel any gases from the material of the candle. I form a vacuum in the transparent case and then seal the same hermetically, so that all injurious atmospheric influences are avoided.

The invention further consists of a vacuum receptacle made entirely of glass and sealed by melting the same in combination with an incandescent continuous conductor pyro-insulated.

The invention further consists in winding pyro-insulated wire upon a bottom of a compressed infusible substance, such as lime.

The invention further consists in placing the vacuum-bulb within another glass receptacle, also closed from the air, and employing the expansion of the air between the two receptacles due to the heat of the incandescent bobbin to produce a movement which shall disconnect the lamps from the electric circuit when its temperature is too great.

(Here follows diagram marked p. 2724.)

The drawing shows a section of the apparatus, in which B is the transparent bulb. This bulb is open at the smaller end and the burner *d* inserted, and the open end of the tube is placed in connection with a mercury vacuum-pump, the platina wires *g* and *f* passing through. The burner is connected with a battery and variable-resistance coil while the vacuum is being made. The heat of the bobbin *d* is, in the course of one hour, brought gradually from the temperature of the air to vivid incandescence. When the vacuum is considered practically perfect the open end of the tube is melted and sealed. The platina wires passing through the glass are also sealed.

Thus I am enabled to obtain a nearly-perfect vacuum, which is permanent, and at the same time give the platinum wire a new and unknown property of great value in electric lighting, which is, that a platina wire which melts in the open air at a point where it emits a light equal to four candles will, when operated upon as described, emit a light equal to twenty-five candles without fusion. The reason why the melting-point of the metal is thus raised is, that in the act of making the vacuum with the metal under heat all the gases which are contained in its pores are withdrawn, and when the receptacle is sealed cannot re-enter when cold; hence unequal and sudden expansions cannot take place and the wire is never cracked, but if left uncovered becomes as bright as the most polished silver—an appearance which cannot be given it in any other way. On the other hand, it is known that the metals of the platinum group have, in a surprising degree, the peculiar power of absorbing within their pores many volumes of gas, and it is the sudden expansion of this gas upon a sudden accession of heat that disrupts the wire and produces cracks, which extend nearly to its center when the wire is brought to moderate incandescence in the open air. These cracks set up a great resistance to the passage of the current, and at these points become abnormally heated; hence the platina wire easily melts, where as no such cracks are noticed when the wire has been operated upon in the vacuum and all its gases pumped out.

e is a cylinder, of lime, with a small spool on its extremity, on which the wire is coiled. About thirty feet of platinum or iridium wire coated with magnesia oxide is coiled upon the spool.

The wire may be of any size; but I prefer to use wire .005 of an inch in diameter, which will give a resistance when incandescent of about seven hundred and fifty ohms. By the use of such high-resistant lamps I am enabled to place a great number in multiple arc without bringing the total resistance of all the lamps to such a low point as to require a large main conductor; but, on the contrary, I am enabled to use a main conductor of very moderate dimensions.

Another important point is gained by the use of lamps of high resistance, as the resistance of the wires leading from the main conductors may be of very moderate dimensions; hence can be 2726 placed in the pipes already used for gas, and at the same time effect a great saving in the cost of wire.

Still another point gained is, that the high resistance of the lamps allows all to be placed in multiple arc, which is the only method where the maximum economy is attainable, as the lamps, when connected to the circuit, draw from the central station just sufficient current to maintain it at the proper temperature, and if by accident or want of regularity in the main current the strength of the current should increase abnormally, the excess of heat sets the thermal regulator in motion and disconnects the lamp entirely from the circuit, thus stopping all further consumption of energy until the temperature of the lamp is reduced to its normal conditions. I will state that these changes are not perceptible to the eye; hence the lamp cannot consume any more energy than that required to cause it to emit a certain light.

No loss in economy occurs by using so large a resistance, because the loss of energy is proportionate to the radiating-surface exposed to the air and its temperature, and is independent of the resistance of the wire forming such surface.

m is a lime cup, into which the small end of the vacuum-burner is held. The platina wires pass under it to the binding-posts H K.

n is the thermal regulator, operated by the expansion of the air. When the temperature of the air between the bulbs becomes too great, the diaphragm bulges outward and the point *o* separates the spring *p* from R and disconnects the lamp from the circuit, where it remains until the temperature is reduced to the normal condition.

The spark upon the point is very small, as I employ constant field-magnets at the central station; hence the powerful sparks due to the secondary current set up by the weakening of the powerful field-magnet is avoided.

I will mention that the second globe *c* might be made entirely of glass, and the aneroid-diaphragm, provided with a platina tube, be sealed in the glass, or the aneroid itself be made of glass.

I am aware that an electric lamp has been made in which glass has been combined with other substances to form a case, and that efforts have been made to keep such case air-tight; but the changes of temperature have prevented the maintenance of a vacuum or the exclusion of the atmosphere. In my improvement the chamber containing the light is made entirely of glass, and I am able to obtain and maintain a vacuum, because there is no substance joined to the glass; hence the entire chamber can be hermetically sealed and the conductors of metal passing through the glass and around which the glass is melted are so small as not to injure the glass by their expansion.

I am also aware that carbon has been heated in the presence of both liquid and gaseous materials for changing its character and adapting it to an electric light. In my present invention the gaseous materials contained in metallic wire are driven off by the action of heat evolved by an electric current while the wire is in a vacuum, so that the pores of the metal are not filled with any extraneous substance; but, on the contrary, the metal is solidified by the removal of extraneous matter and the pores closed.

In my application No. 166 I have set forth an electric lamp formed of pyro-insulated metal. I do not, therefore, claim the same herein.

I claim as my invention—

1. In an electric lamp, the combination, with a hermetically-sealed vacuum-chamber made entirely of glass, of metallic conductors passing through the glass and around which the glass is melted, and an incandescent conductor placed in the electric circuit, substantially as set forth.

2. The method herein specified of treating metallic conductors for electric lamps, consisting in inclosing the conductor in a glass case, exhausting the atmosphere from such case, heating the conductor by an electric current, and then hermetically sealing such glass case, substantially as set forth.

3. The combination, in an electric lamp, of a hermetically-sealed

vacuum-case made entirely of glass, conducting-wires passing through the glass and around which the glass is melted, and an incandescent body formed of a pyro-insulated wire and an infusible core for the same, substantially as set forth.

4. The combination of a transparent vacuum-case, a continuous conductor forming an electric candle, and a second transparent case forming a closed chamber, for the purpose set forth.

5. The combination of the conductor *d*, forming an electric candle, the transparent sealed case B, the transparent case *c* inclosing the case B, and the thermostatic regulator *n o p* R, substantially as set forth.

Signed by me this 12th day of April, A. D. 1879.

THOMAS A. EDISON.

Witnesses:
S. L. GRIFFIN.
EDWIN M. FOX.

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(No Model.)

T. A. EDISON.

Manufacture of Carbons for Incandescent Electric Lamps.

No. 238,868. Patented March 15, 1881.

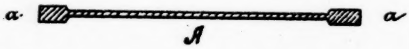


Fig. 1.

Fig. 2.

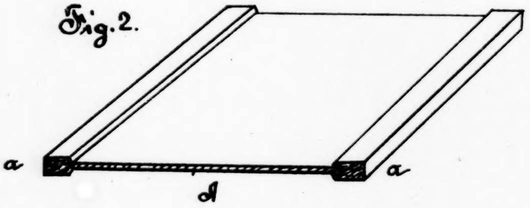
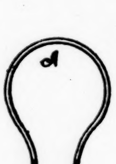


Fig. 3.



No. 286.
E. Light Co.
v.
McK Light Co. } p. 2728

Attest =

Saml. D. Mott,
James A. Payne.

Inventor =

T. A. Edison,
per Dyer & Wilber,
Attys.

2727 Consolidated E. L. Co.
vs.
McKeesport Co.

Complainant's Exhibit Edison Patent No. 238,868. April 6, 1889. H. C. M., S. E.

2729 United States Patent Office.

Thomas A. Edison, of Menlo Park, New Jersey.

Manufacture of Carbons for Incandescent Electric Lamps.

Specification forming part of Letters Patent No. 238,868, dated March 15, 1881. Application filed May 24, 1880. (No model.)

To all whom it may concern:

Be it known that I, Thomas A. Edison, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful method of manufacturing carbons for electric lamps; and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

In other applications for patents by me made has been set out the necessity, in electric lamps lighting by incandescence, of carbons of high resistance in small bulk, and of little or no tendency to disintegration upon being highly heated; and, further, that simple wood carbons of unchanged structural condition possess these qualities.

The invention in the present case relates to a method of manufacturing such carbons.

As is well known, I ordinarily use in my lamps an incandescent material of very small cross-section, often a mere filament. This necessitates a broadening or thickening at the ends, in order to 28 afford good contact with the clamps used. A block of wood is taken and cut or formed so that its center shall be a web, bounded at the sides by thicker portions. The grain of the wood is from side to side, and the thickness of the web is about the desired breadth of the carbon. From the block so fashioned pieces whose width approximates the desired thickness of the carbon are split, shaved, or cut off. These pieces are then sufficiently softened by moisture and heat so as to be bent into a circular or horseshoe or oval form, and they are retained in such shape in a proper carbonizing-flask and carbonized.

(Here follows diagram marked p. 2728.)

In the drawings, figure 2 represents a block formed as before described; Fig. 1, a piece split, cut, or shaved therefrom; and Fig. 3, the same after carbonization.

A is the web of the block, the center of the block being reduced in thickness, while the ends *a a* are left broad or thickened for fastening to the clamps. This block is split, cut, or shaved into pieces, like Fig. 2, which are then bent into shape shown in Fig. 3, or into any other desirable shape, and then carbonized while in such forms. The result is a carbon with broadened ends for clamping, unitary with itself, and which is porous, structurally unaltered, of high resistance, and with a minimum tendency to disintegration under high heat.

It is evident that the block shown in Fig. 2 could be made of disintegrated fiber, paper pulp, papier-maché, &c., by powerful pressure, and the individual carbons then cut off from such block; but in practice I so far prefer to make the block and resultant carbons of wood.

What I claim is—

1. The method of forming carbons for electric lamps, which consists in shaping a block of wood as described, then cutting, splitting, or shaving into straight pieces, adapted for simple carbons, then bending such pieces into the desired form and carbonizing in such form, substantially as described.

2. The block for the manufacture of carbons for electric lamps, consisting of the central web and thickened or broadened ends, substantially as described.

This specification signed and witnessed this 25th day of April, 1880.

THOMAS A. EDISON.

Witnesses:
WM. CARMAN.
Z. F. WILBER.

2730 CONSOLIDATED E. L. CO.
vs.
MCKEESPORT CO.

COMPLAINANT'- EXHIBIT EDISON PATENT NO. 248,417. April 6, 1889.
H. C. M., S. E.

2732 UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, of Menlo Park, New Jersey, assignor to the Edison Electric Light Company, of New York, N. Y.

Manufacturing Carbons for Electric Lights.

Specification forming part of Letters Patent No. 248,417, dated October 18, 1881. Application filed June 30, 1880. (No model.)

To all whom it may concern:

Be it known that I, Thomas A. Edison, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful method of manufacturing carbons for electric lamps; and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

This invention relates to the manufacture of carbons from wood for incandescing conductors in electric lamps.

As explained in previous applications by me made for patents for inventions relating to the same subject-matter, an incandescing conductor is needed which shall be exceedingly small—in fact, a mere filament in the light-giving portion—but with ends somewhat enlarged, so as to afford a good connection for the clamps which are to support the carbons and connect them to the conductors. These incandescing conductors are made as part of an oval, and are ordinarily designated "horseshoe carbons." In the present invention a block of wood is taken and cut in a machine or lathe for turning irregular forms until its shape is that of an elongated oval, of which about one-third, including an end, is cut upon somewhat larger axes than the remainder, in order to provide for the clamps. The interior is then reamed out in a suitable machine, so that the block then resembles a series of carbon horseshoes with closed ends piled upon each other. The length of the oval is with the grain of the wood. The block is then split or sawed into very thin layers or slips, each forming ultimately one horseshoe carbon. The slips are then carbonized, preferably in a nickel flask of a description shown in a prior application. After carbonization the greater portion of the broader end of the slip is cut off, leaving the horseshoe in shape for use. This broader end, which connects what are afterward the ends of the horseshoe, may, if desired, be cut off prior to carbonization; but as this broader connecting end tends to support and keep in shape the portions afterward forming the horseshoe, it is better to leave it on until after carbonization. Either before or after carbonization, (preferably before,) and before the slips are sawed or split from the block, small holes are made in the broad end, through which pass the clamp-screws.

(Here follows diagram marked p. 2731.)

In the drawings, figure 1 is a perspective view of the block partially turned in proper shape. Fig. 2 is a front view of a carbon after carbonization. Fig. 3 is a side view of a carbon properly secured in clamps.

A is a block of wood, which, in a proper machine, is turned so that its exterior shape is that of an oval, composed of two ovals, B, C, of different axes, thereby forming a broadened portion for the clamps, the interior being reamed out to present a uniform smooth surface, F. This block, so shaped, is then split or sawed into very thin layers or slips of a thickness sufficient for one carbon horseshoe, as seen in Figs. 2 and 3. These slips are then carbonized and a portion of C broken or cut off at *c c*, as shown in dotted lines in Fig. 2.

At some stage in the process, preferably while in the shape shown in Fig. 1, holes *d d* are drilled for the reception of the screws *e*, which fasten the clamps D to the carbon.

What I claim is—

The method of forming carbons for the incandescing conductors of electric lights, consisting in cutting or turning a block of wood into the shape of an oval having a broadened portion and reaming out the central portion of such oval, then slicing the block into layers, and then carbonizing the layers, a portion of the broadened part being removed before or after carbonization, substantially as set forth.

This specification signed and witnessed this 15th day of June, 1880.

THOS. A. EDISON.

Witnesses:
S. L. GRIFFIN.
WM. CARMAN.

(No Model.)

T. A. EDISON.

MANUFACTURING CARBONS FOR ELECTRIC LIGHTS.

No. 248,417. Patented Oct. 18, 1881.

No. 286.
C. E. Light Co v. McK Light Co } p. 2731

Fig. 1.

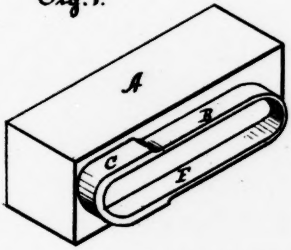


Fig. 2.

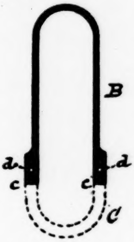
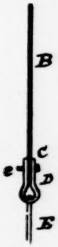


Fig. 3.



Attest:-

S. D. Mott
James A. Payne

Inventor:-

Thos. A. Edison
per Dyer and Wilber
Attys.

2733 CONSOLIDATED E. L. CO.
vs.
MCKEESPORT L. CO.

COMPLAINANT'S EXHIBIT LANE-FOX BRITISH PATENT 3988 OF 1878.
April 22, 1889. W. T. F., S. E.

(Fourth edition.)

[British coat of arms.]

A. D. 1878, 9th October. No. 3988.

Specification of St. George Lane Fox.

Electric lighting, &c.

London: Published and sold at the patent office sale branch, 38 Cursitor street, Chancery lane, E. C. 1884. Price, 6d.

(Fourth edition.)

2734 A. D. 1878, 9th October. No. 3988.

Electric Lighting, &c.

Letters patent to St. George Lane Fox, of Telegraph street, in the city of London, for an invention of "improvements in obtaining light by electricity and in conveying, distributing, measuring, and regulating the electric current for the same and in the means or apparatus employed therein."

Provisional Specification Left by the said St. George Lane Fox at the Office of the Commissioners of Patents on the 9th October 1878.

St. George Lane Fox, of Telegraph street, in the city of London. "Improvements in obtaining light by electricity and in conveying, distributing, measuring; and regulating the electric current for the same and in the means or apparatus employed therein."

My invention consists of improvements in obtaining light by electricity and in conveying, distributing, measuring and regulating the electric current for the same and in the means or apparatus employed therein.

In order to produce a light I pass the electric current through thin leaves or foil of some suitable material for which purpose I prefer to use platinum or an alloy of platinum and iridium.

The electric lamp in which the light is produced therefore consists of two conductors insulated from one another having this leaf or foil stretched between them and in contact with each. On each side of this leaf or foil I place a sheet of transparent mica or talc to prevent as much as possible radiation of heat from the surfaces and the cooling of the leaf or foil from atmospheric action. The sheets of mica or talc can be covered with glass plates.

Instead of stretching a strip of leaf or foil between two conductors as already described I sometimes coil a long strip of foil into a kind of spiral shape having a tube of talc, glass, fire lcay steatite
2735 or lime within the spiral and one of talc or glass just covering it outside. A fine platinum wire may be used instead of a strip of foil but the foil is preferable. A chief object I wish to attain in this lamp is to prevent as much as possible the dissipation of force in the form of heat and to concentrate and intensify it in the form of light.

An increase of light is attained by increasing the width or number of strips or by diminishing their length; in the first place more volume of light will be attained, in the second the light will be intensified.

Care should be taken that the length of the strips of foil is not too short and that they should not be too fine otherwise there is a risk of fusing them. Their length and width must be fixed according to the intensity and quantity of light required and of the electro-motive force used.

The way in which I work a number of these lamps from a single source of electricity is as follows:—From one pole or electrode of the electric generator or generators proceeds a large conductor from which branch out at various points where lights are desired, smaller conductors which again may have conductors branching off from them and so on. The other pole or electrode of each electric generator is connected with the earth so that the conductor and its branches and sub-branches will be perpetually in a state of electric tension tending to develop currents in every direction to the earth. One pole of the electric lamp is connected with the earth and this may be conveniently effected by means of gas or water pipes where such exist, so that wherever the circuit is complete between the earth and any one of these branches a current of electricity will pass through the thin leaf of metal rendering it incandescent and so produce light. The method by which I measure the amount of electricity used is as follows—I shunt off from any given length of the conductor (the amount of electricity passing through which is to be ascertained) a "derived" circuit having a voltameter joined up in it. The resistance of this circuit must be very much greater than that of the length of conductor from which it has been shunted. The resistance of both voltameter and conductor being fixed the quantity of electricity passing through the voltameter will consequently bear a fixed ratio to the amount passing through the conductor. In this matter with a graduated tube the height of a column of liquid can be measured and so the quantity of electricity passed can be ascertained.

The electromotive force of the electric conducting mains should be kept as nearly as possible constant at say 100 volts or British Association units of electromotive force.

A number of plantés (lead and sulphuric acid) cells joined together in series between the main and the earth will serve as a kind of reservoir for the electricity.

The electric current may be conducted through copper conductors

which can conveniently be laid inside the existing gas pipes having insulators of earthenware or other material around them to prevent their contact with the iron pipes. The conducting mains may be formed of a number of copper bands soldered together at the joints and insulated as just described. A very high degree of insulation can be obtained by filling the annular space between the copper conductors and the iron pipes with some insulating liquid preferably petroleum rock oil. In order to keep the electro-motive force in the electric mains constant it is desirable to have in the first place several generating machines, next, it is necessary to have some regulator such as that about to be described. In my regulator I make use of what is known as the quadrant electro-meter; in this instrument the position of the suspended needle will depend on the relative electro-motive force of the so-called quadrants. By connecting this instrument with the main and the earth in the ordinary way the electro-motive force of the main will determine the position of the suspended needle. If it increase or decrease the position of the needle will be altered accordingly. Now I fit this electro-meter with small pegs so that a slight deviation of the needle one way or the other will bring it in contact with one of the pegs and thus complete a circuit and set up the electric current which acting upon an electro-magnet sets a lever or other suitable
2736 device in action. The contact with each peg forms a separate circuit acting independently on two of these levers or other devices which are in connection with steam valves, one diminishing, the other increasing the supply of steam to the engine which works the electric generators. The electro-motive force can be regulated either in this manner or by otherwise effecting the action of the electric generators through the instrumentality of the currents set up by the pegs above described so as to increase or diminish the action of the generators.

Specification in pursuance of the conditions of the letters patent filed by the said St. George Lane Fox in the Great Seal Patent Office on the 9th April, 1879.

St. George Lane Fox, of Telegraph street, in the city of London. "Improvements in obtaining light by electricity and in conveying, distributing, measuring, and regulating the electric current for the same and in the means or apparatus employed therein."

My invention consists of improvements in obtaining light by electricity and in conveying, distributing, measuring and regulating the electric current for the same and in the means or apparatus employed therein.

In order to produce a light I pass the electric current through a thin strip or wire of some suitable material for which purpose I prefer to use an alloy of platinum and iridium. The electric lamp in which the light is produced therefore consists of two conductors insulated from one another having this strip or wire between them and in contact with each.

The material or alloy employed should be capable of standing as high a degree of temperature as possible without fusing, volatilizing or falling to pieces, it should also have a high specific resistance. The higher the temperature to which the material can be raised, the more economical will be the light produced, that is the light will be greater in proportion to the force or energy expended, inasmuch as the radiant energy proceeding from the surface of the material will be more and more luminous as the temperature increases. In order to prevent the deterioration of the material when incandescent, I sometimes surround it with an atmosphere of nitrogen gas. The quantity of light will be proportional to the extent of the luminous surface. The resistance of the luminous material and its extent of surface should therefore depend on the amount of light it is required to give and the electro-motive force used. Speaking broadly it may be said that the resistance of the luminous conductor should be so adjusted or fixed that the electro-motive force of the mains to which it is attached is just sufficient to develop within it the strength of current necessary to raise it to the right degree of incandescence.

In order that the electric force may be conveyed at a high tension, that is, having high electro-motive force, so that there may not be very great loss from the resistance of the conducting mains or conductors, I make the lamps when I use an alloy of platinum and
iridium of lengths of fine wires so that I may get a high re-
2737 sistance without having a large extent of luminous surface.
I generally suspend the wire as shewn in figures 1 and 2 of the annexed drawings as I find that at a high state of incandescence the alloy becomes soft and would not retain its shape if coiled or otherwise twisted.

(Here follows diagram marked p. 2740.)

In figure 1 *a* represents the wire of alloy of platinum and iridium; it is suspended between the two conductors *b b* which pass through the top *c* of the lamp. *d* is a cover of glass or other suitable material cemented or hermetically sealed to the top *c*. In figure 2 the wire *a* is shewn as passing several times over a bar or tube *e* of glass or other insulating material the ends of the wire being attached as before to the two conductors *b b*.

The way in which I distribute the electric energy so as to work a number of these lamps from a single source of electricity is represented in the diagrams figures 3 and 5 and is as follows:—From one pole or electrode of the electric generator or generators (situated at A, figure 3) proceed one or more large conductors from which branch out at various points where lights are desired, smaller conductors which again may have conductors branching off from them and so on. The other pole or electrode of each electric generator is connected with the earth so that the conductor and its branches and sub branches will be perpetually in a state of electric tension tending to develop currents in every direction to the earth.

One pole of the electric lamp is connected with the earth *e* and this may be conveniently effected by means of gas or water pipes

A.D. 1878. Oct. 9. No. 3988.
FOX'S SPECIFICATION
(4th Edition)

(1 SHEET)

FIG. 1.

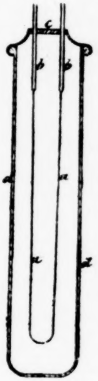
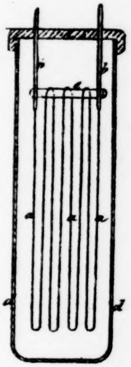


FIG. 2.



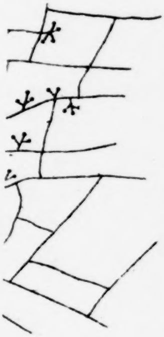
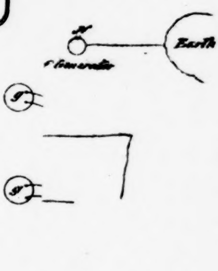


FIG. 5.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Generator
Earth
g
g'

No. 286
O.E. Light Co
v.
McK. Light Co
p. 2740

Malby & Sons, Photo-Litho

where such exist so that wherever the circuit is complete between the lamp and any one of these branches a current of electricity will pass through the thin strip or wire rendering it incandescent and so produce light.

The way in which I measure the quantity of electric force or energy used is as follows:—I shunt off from any given length or resistance of the conductor (the quantity of electricity passing through which it is desired to ascertain) a "derived circuit" having an electro magnetic voltameter joined up in it; the resistance of this electro magnetic voltameter should be much greater than the portion of the conductor from which it has been shunted.

Figure 4 represents the electro magnetic voltameter. $a\ a^1$ is a portion of the conductor. $b\ b^1\ b^{11}$ is a derived circuit in which is the coil of an electro magnet *c*. In conjunction with this electro magnet is an automatic make and break piece *k*. A voltameter *v* is joined between the set screw *l* and the hammer *h* or between the points where the contact is made and broken.

The action of the apparatus is as follows:—When a current passes through the conductor $a\ a^1$ there will necessarily be a difference of electro motive force between the points *a* and a^1, the result of which will be that an electric current will be made to circulate through the coil *c* and magnetize the soft iron core. The hammer *h* which is attached to a spring will thus be drawn out of its normal position and break the contact at *k* between the set screw *l* and the hammer *h*. The hammer will then no longer be attracted and will fall back to its original position and re-establish the contact and so on. The voltameter *v* is as already stated joined up between the points of contact. The extra current formed on breaking contact will pass through the voltameter and decompose the water it contains; the quantity of water decomposed will be approximately proportional to the quantity of electricity which has passed through the conductor $a\ a^1$.

The electro-motive force of the electric conducting mains should be kept as nearly as possible constant at say 100 volts or British Association units of electro motive force.

A number of secondary batteries such as Planté's (lead and sulphuric acid) or those formed with plates of copper in a solution of bicarbonate of soda, such batteries being joined together in series between the main and the earth will serve as a kind of reservoir for the electricity. The cells should have a very large conducting surface and there should be several batteries connected up at various points of the mains so that by increasing the electro motive force during the hours when not much electricity is being
2738 used, they will become charged and the electric force will be stored up in them so that a sufficient supply will be available when the electro motive force falls owing to the draft from the mains when the force is most used and needed. The number of cells in each of these batteries will depend on the electro motive force of the mains.

Figure 5 is a diagram representing a secondary battery joined up between the main and the earth for the purpose above described. E indicates earth and *l* lamps.

The electric current may be conveyed through copper conductors which can conveniently be laid inside the existing gas pipes with insulators of earthenware or other material of annular or other suitable form around them to prevent their contact with the iron pipes. The conducting mains may be formed of a number of copper bands soldered together at the joints and insulated as just described.

I sometimes fill the space between the copper conductor and the iron pipes with some insulating liquid preferably petroleum or rock oil, by which means a very high degree of insulation can be obtained. In order to keep the electro motive force in the electric mains constant, it is desirable to have in the first place several generating machines, also a number of reservoir batteries as before explained; next it is necessary to have some regulator such as that about to be described. In my regulator I make use of what is known as the quadrant electrometer; in this instrument the position of the suspended needle will depend on the relative electro motive force of the so-called quadrants. By connecting this instrument with the main and the earth in the ordinary way the electro motive force of the main will determine the position of the suspended needle. If it increase or decrease, the position of the needle will be altered accordingly. Now I fit this electrometer with small pegs so that a slight deviation of the needle one way or the other will bring it in contact with one of these pegs and thus complete a circuit and set up the electric current which acting upon an electro magnet sets a lever or other suitable device in action. The contact with each peg forms a separate circuit acting independently on two of these levers or other devices which are in connection with steam valves, one diminishing, the other increasing the supply of steam to the engine which works the electric generators. The electro motive force can be regulated either in this manner or by otherwise effecting the action of the electric generators through the instrumentality of the currents set up by the pegs above described, so as to increase or diminish the action of the generators.

Figure 6 represents a quadrant electrometer adapted to regulating the electro motive force in the mains as just described. *a a* are the quadrants and *b* the suspended needle. *c c* are pegs of platinum or other suitable material and *d d* are springs situated between the needle *b* and these pegs. *e* is the wire connecting with the main and *f* that connecting with the earth. *g g* represent electro magnets in connection with the respective pegs *c c*, the said magnets acting on levers or other devices for operating the steam valves as above described.

And having now described the nature of my said invention and in what manner the same is to be performed I declare that I claim as my "improvements in obtaining light by electricity and in conveying distributing measuring and regulating the electric current for the same and in the means or apparatus employed therein"—

First. The mode or system hereinbefore described of distributing the electric current by mains, branches and sub-branches with returns by "earth."

Second. In combination with the said mode or system of distributing the electric current by mains branches and sub-branches with returns by "earth," I claim the production of light by the incandescence of a continuous conductor as hereinbefore described.

Third. The means or apparatus substantially as hereinbefore described with reference to figure 4 for measuring the amount of electricity passed through conductors.

Fourth. The employment as described of secondary batteries as reservoirs of electricity in combination with a mode or system of distribution such as is hereinbefore explained.

2739 Fifth. The employment of petroleum or rock oil or other suitable insulating liquid in the space between the conductors and the pipes in which they are laid, as hereinbefore described.

Sixth. Constructing apparatus substantially as hereinbefore described and represented in figure 6 for regulating the electromotive force in the mains by which the electricity is conveyed.

Seventh. The combination of the means or apparatus hereinbefore described for obtaining light by electricity and conveying distributing regulating and measuring the electric current for the same.

Eighth. Obtaining light by the incandescence of a continuous conductor as hereinbefore described and as represented in figures 1 and 2 of the annexed drawings.

Ninth. Insulating the conductors for conveying electricity for lighting purposes by means of earthenware or other insulating supports in pipes as hereinbefore described.

In witness whereof I the said St. George Lane Fox have hereunto set my hand and seal this eighth day of April, one thousand eight hundred and seventy-nine.

ST. G. LANE FOX. [L. S.]

London: Printed by Eyre and Spottiswoode, printers to the Queen's most excellent majesty. For her majesty's stationery office.

(G 10.—100.—5 | 84.)

2741 CONSOLIDATED E. L. CO. vs. MCKEESPORT CO.

COMPLAINANT'S EXHIBIT LANE-FOX BRITISH PATENT NO. 4043 OF 1878. April 22, 1889. W. T. F., S. E.

(Third edition.)

[British coat of arms.]

A. D. 1878, 12th October. No. 4043.

Specification of St. George Lane Fox.

Applying electricity for lighting and heating.

Printed by order of the commissioners of patents for inventions. London: Published and sold at the commissioners of patents' sale department, 38, Cursitor street, Chancery lane, E. C. 1883. Price 6d.

2742 (Third edition.)

A. D. 1878, 12th October. No. 4043.

Applying Electricity for Lighting and Heating.

Letters patent to St. George Lane Fox, of Telegraph street, in the city of London, for an invention of "improvements in the application of electricity to lighting and heating purposes and in the means or apparatus employed therein."

Provisional Specification Left by the said St. George Lane Fox at the Office of the Commissioners of Patents on the 12th October, 1878.

St. George Lane Fox, of Telegraph street, in the city of London. "Improvements in the application of electricity to lighting and heating purposes and in the means or apparatus employed therein."

In a provisional specification lodged by me on the 9th day of October 1878 (No. 3988) I stated that a chief object to be attained in lighting by electricity is to prevent as much as possible the dissipation of force in the form of heat and to concentrate and intensify it in the form of light, and I described the use of spiral strips of metal foil or wire having a tube of talc, glass, fire clay, steatite or lime within the spiral and one of talc or glass outside, the two conductors being respectively connected with the two ends of the strips—In order to increase the retention of heat I now, according to my present improvements, cover the surface of the strips with some good non heat conducting material and I use for this purpose finely divided asbestos, fire clay, lime or steatite, or even some vitreous material or a mixture of the vitreous material with one or more of the other materials, the vitreous material in the latter case serving to hold the powdered asbestos or other material on the foil. The radiation of heat from the surface would thus to a great extent be prevented. I sometimes employ asbestos itself platinized or saturated with some conducting material. The asbestos may be woven or made up in the form of paper.

In order to apply electricity to heating purposes a coil of fine wire may be used which will be heated in a greater or less degree
2743 when the electric current passes through it. The intensity
of the heat is determined by the length and thickness of the wire or foil. Platinum is well suited to the purpose but iron will answer. For heating water the wire or foil is wound or otherwise arranged at the bottom of the receptacle in which the water is contained, such receptacle being made of earthenware or other suitable material; the water becomes heated by contact with the wire or foil. For atmospheric heating the wire may either be used plain and bare or in conjunction with asbestos, fire clay, lime, or steatite. Where very high temperatures are required, such as for melting metals for example, I construct a furnace of the best non heat conducting material available, and I shape it internally to correspond with the form of the crucible to be heated. I coil or apply the heating wires or strips round the inner surface of the furnace and pass them out through the sides or bottom. The wire or strip employed as the medium for the development of heat should be much thicker at the ends in order to prevent excessive heating at the point of exit from the furnace where it should go direct to some large body of conducting material to which it must be properly secured by some metallic connection. When the crucible is inserted the whole must be covered so that the heat will be retained.

In order to regulate the electric current so as to increase or diminish the supply of heat or light I join up in circuit an instrument composed of a hollow cylinder of glass or other suitable material fixed to a metallic base; the cylinder is partly filled with mercury or other suitable liquid in which dips an adjustable rod made by preference of copper or silver; this rod is pointed and is in metallic contact with a terminal—If a current pass from this terminal to the metal base (which is in metallic contact with the other terminal) its flow can be regulated by adjusting the height of the rod so as to increase or diminish the resistance; if the rod be lowered the resistance is diminished; if it be raised the resistance is increased. The ends of the conductors used for heating or lighting should have less resistance than any other part so as to prevent overheating at the point of junction with the terminals, and this is effected by making them thicker towards the ends, the ends being led directly to a large mass of some good conducting material.

When a number of Planté's (lead and sulphuric acid) cells or batteries joined together in "series" are employed as reservoirs for the electricity as described in my former provisional specification they should have a very large surface and there should be several of them connected up at various points of the mains so that by increasing the electro motive force during the hours when not much electricity is being used they will become charged and the electric force will be stored up in them so that a sufficient supply will be available when the electro motive force falls owing to the draft from the mains when the force is most used and needed.

Or I sometimes supply each of these reservoir batteries with commutators and with the means of working them so that it will not be necessary to increase the electro motive force in the mains in order to charge them, but by merely coupling two or more parts or the whole battery for "quantity" they can be charged with a low electro motive force and be capable of giving by an alteration of the commutators the full tension when required.

2744 Specification in pursuance of the conditions of the letters patent filed by the said St. George Lane Fox in the Great Seal Patent Office on the 12th April, 1879.

St. George Lane Fox, of Telegraph street, in the city of London. "Improvements in the application of electricity to lighting and heating purposes and in the means or apparatus employed therein."

In the specification of former letters patent granted to me and dated the 9th day of October 1878 No. 3988 I described that light might be produced by passing an electric current through a thin strip or wire of some suitable material, an alloy of platinum and iridium being preferred. According to the present invention I cover the surface of the strips or wires with some suitable refractory material and I use for this purpose finely divided asbestos, fire clay, lime, magnesia or steatite, or even some vitreous material or a mixture of the vitreous material with one or more of the other materials; the vitreous material in the latter case serving to hold the powdered asbestos or other material on the foil. The object of covering the wires or strips of metal with some earthy material such as lime, magnesia, steatite &c., is that at a given temperature they seem to radiate or give off more luminous rays in proportion to the dark or non-luminous rays than does the bright metallic surface of the platinum-iridium wire at the same temperature and consequently the production of light is in this manner to a certain extent economized. I sometimes employ asbestos or other suitable non conducting refractory material saturated or impregnated with some conducting refractory material such for example as carbon or iridium. The asbestos may be woven or made up in the form of paper.

(Here follows diagram marked p. 2747.)

Figures 1 and 2 of the annexed drawings represent an electric lamp in which the luminous surface which I will term the "bridge" is made of asbestos or similar non-conducting material saturated or impregnated with some refractory conducting material such as carbon or iridium. A is the bridge held by the metallic clips B B which are attached to the conductors C C. These conductors pass through the top D of the flask E which is hermetically sealed and is filled with nitrogen gas. The luminous portion a to a^1 of the bridge is of higher resistance than the rest.

In order to apply electricity to heating purposes a coil of fine wire may be used which will be heated in a greater or less degree when the electric current passes through it. The intensity of the heat is determined by the length and thickness of the wire or foil. Platinum is well suited to the purpose but iron will answer. Or I use a larger conductor of some bad conducting refractory material, such as carbon, (preferably in the form of graphite) which in conjunction with fire clay or similar material may be made to form an inner lining of the furnace.

For heating water the wire or foil is wound or otherwise arranged at the bottom of the receptacle in which the water is contained, such receptacle being made of earthenware or other suitable material, the water becomes heated by the wire or foil. The wire or foil should of course be enameled or otherwise insulated or it may be kept apart from the water or substance to be heated by a suitable diaphragm and immersed and surrounded by some insulating fluid such as oil.

For baking, heating rooms and other atmospheric heating the wire may either be used plain and bare or in conjunction with asbestos, fire clay, lime or steatite. Where very high temperatures are required, such as for melting metals for example, I construct a furnace of the best non-heat conducting material available and I shape it internally to correspond with the form of the crucible to be heated. I coil or apply the heating conductors round the inner surface of the furnace and pass them out through the sides or bottom.

Figures 3 and 4 are respectively a vertical section and a plan with the cover removed of a furnace constructed in accordance with my invention—*a* is the body of the furnace made say of fire clay. *b* is the space or chamber for the crucible (not shewn); *c* represents the wire or strip coiled round against the sides of the
2745 chamber; the ends of these wires pass through the furnace
sides. *d* is the cover. The wire or strip *c* should be much thicker at the ends in order to prevent excessive heating at the point of exit from the furnace where it should go direct to some large body of conducting material to which it must be properly secured by some metallic connection.

Figures 5 and 6 represent respectively in vertical section and in plan (with the cover removed) a similar furnace in which the heating conductor is made of a short bad conductor and the material I prefer to employ for this conductor is a combination of plumbago with some refractory earth such as fireclay, magnesia, lime &c. The proportions of plumbago and refractory earth are fixed according to what specific resistance the compound is required to give. *a* is the body of the furnace. *b* the space or chamber for the crucible. *c* is the bad refractory conductor forming a lining of the furnace. *d* is the cover or lid. *k* is part of the conductor of comparatively low resistance and is made preferably of pure plumbago. *m m* are metallic portions of the conductor to which are attached the conducting wires P and N. The electric current passes from one conductor round both sides of the furnace to the other conductor.

It will be seen that however expensive may be the source of heat in these furnaces, there will be a great economy in its development, inasmuch as the largest part of it will be utilized; there is not as in other furnaces a constant draught through it bringing in cold and letting off heat.

By an evident modification the apparatus represented in figures 3 and 4 may be used for roasting meat and other like purposes.

In order to regulate the electric current so as to increase or diminish the supply of light or heat, I join up in circuit an instrument constructed substantially as represented in figure 7 and which I will now describe. *a* is a hollow cylinder of glass or other suitable material fixed to a metallic base *b;* it is partly filled with mercury or other suitable liquid up to about the height marked *c*. *d* is a tapered or pointed rod made by preference of copper or silver and adjustable in the cover *e;* this rod is in metallic contact with the terminal *f*. *g* is the other terminal with which the base *b* is in metallic contact.

If a current pass from the terminal *f* to the base *b* its flow can be regulated by adjusting the height of the rod *d* so as to increase or diminish the resistance; if the rod be lowered the resistance will be diminished; if it be raised the resistance is increased. By making the rod twisted or spiral as shewn in the figure it offers a higher resistance than if straight.

When a number of secondary batteries joined together in series are employed as reservoirs for the electricity in a system of distributing currents by mains, branches and sub-branches with returns by earth as described in the specification of my said former letters patent, I sometimes supply each of these reservoir batteries with commutators and with the means of working them as will be well understood so that it will not be necessary to increase the electro motive force in the mains in order to charge them, but by merely coupling two or more parts or the whole battery for quantity, they can be charged with a low electro motive force and be capable of giving by an alteration of the commutators the full tension when required.

And having now described the nature of my said invention and in what manner the same is to be performed I declare that I claim as my "improvements in the application of electricity to lighting and heating purposes and in the means or apparatus employed therein"

First. The employment for obtaining light by electricity of strips or wires covered with earthy or vitreous material as hereinbefore described.

Second. The employment for obtaining light by electricity of a continuous conductor of asbestos or other non conducting refractory material impregnated with some refractory conducting material as hereinbefore described.

Third. The means and apparatus substantially as hereinbefore described for applying electricity to heating purposes.

2746 Fourth. The instrument or apparatus constructed substantially as hereinbefore described and represented in figure 7 for regulating electric currents used for lighting or heating purposes

Fifth. The providing or fitting of commutators as hereinbefore described to secondary batteries when such batteries are employed as reservoirs of electricity in a system of distributing electric currents by mains, branches and sub-branches with returns by "earth."

In witness whereof I the said St. George Lane Fox have hereunto set my hand and seal this eighth day of April, one thousand eight hundred and seventy-nine.

ST. G. LANE FOX. [L. S.]

London: Printed by George E. B. Eyre and William Spottiswoode, printers to the Queen's most excellent majesty. For her majesty's stationery office.
(389.—150.—4 | 83.)

2748 [British coat of arms.]

A. D. 1878, 14th November. No. 4626.

Specification of St. George Lane Fox.

Electric lighting, &c.

Printed by order of the commissioners of patents for inventions.
London: Published and sold at the commissioners of patents' sale department, 38 Cursitor street, Chancery Lane, E. C. 1879. Price 8d.

2749 [British coat of arms.]

A. D. 1878, 14th November. No. 4626.

Electric Lighting, &c.

Letters patent to St. George Lane Fox, of Telegraph street, in the city of London, for the invention of "improvements in the means or apparatus for obtaining light by electricity and distributing, regulating, and measuring the electric currents for the same."

Sealed the 24th January 1879, and dated the 14th November 1878.

Provisional Specification Left by the said St. George Lane Fox at the Office of the Commissioners of Patents on the 14th November, 1878.

St. George Lane Fox, of Telegraph street, in the city of London. "Improvements in the means or apparatus for obtaining light by electricity and distributing, regulating, and measuring the electric currents for the same."

My invention has reference to the application of electricity to lighting purposes.

In order to obtain light from an electric current I make use of a sheet of platinized or iridized or carbonized asbestos or other suitable material supported between two conducting terminals of platinum or other suitable material; and in order to preserve the incandescent substance in a good condition and to prevent its deterioration I enclose the whole in a glass or other suitable transparent vessel or cover through which the platinum supports are fused. This vessel or cover is then exhausted of air by means of a small tube leading from it, and it may then, if thought desirable, be filled with some gas or vapor which has no action on the material used for producing the light.

When platinum, iridium, iron, or other metal is used either pure or alloyed, with some other material or materials, and either plain or covered with some suitable material, such as powdered asbestos, magnesia, or a vitreous substance, I prefer to coil a long strip or

wire into the form of a spiral, and to attach the two ends to
2750 platinum wires fixed side by side by fusing into a piece of glass or otherwise so that they run parallel to one another, one wire carrying the top of the spiral and the other the lower end. The length and thickness of the spiral will depend on the intensity of the light required and the electro-motive force available. The ends of the spiral should be united to these wires with some hard solder. This spiral is then enclosed in a globular or flask shaped glass vessel whose neck is sufficiently large to admit it; and the neck should then be closed up around the two supporting wires so as to seal them in and make the whole vessel air tight. A small tube projecting from some part of the neck is then connected with a Sprengel air pump or other exhausting apparatus, and the air is then removed as completely as possible and the tube sealed up, some gas being previously admitted, if desired, into the vessel, as before described. The neck of the vessel may be fixed to some suitable holder or support, and the projecting platinum wires should be connected to proper terminals.

According to another method or arrangement for obtaining light by the incandescence of carbon or other suitable material the said material is enclosed, as before described, in a glass vessel from which the air is exhausted or which is filled with any suitable gas, and the terminals are, as before described, fused into the glass at the lower end of the neck where it is sealed up; or the glass vessel may be made in any way by which it can be readily opened when desired, and be again hermetically sealed; one of the terminals leads by a proper conductor to a small piece of hard coke, graphite, or other suitable material, and is fixed thereto so as to be in good electrical contact with it; this piece of carbon or material may be spherical or of other desired shape. The other terminal leads to the bottom of a long cylindrical vessel containing mercury; in the mercury is a float of some conducting material capable of vertical movement and attached to a metallic wire or rod passing through and fitting into an aperture or guide at the top of the cylindrical vessel; to this wire or guide is fixed a long pencil of carbon, about $\frac{1}{16}$th of an inch thick. This carbon being fixed to the rod of the float is pressed upwards by the buoyant action of the mercury, and the upper end of the pencil is thus pressed lightly against the lower surface of the piece of coke or other carbon or material above mentioned, so that by passing an electric current through the two terminals a brilliant light is emitted at the point of contact of the two carbons or materials. If the pencil wears away it is by virtue of the float and guide retained in the proper position, and presses with an equal pressure against the carbon or material above.

In laying on electricity to a building, district, or town for lighting purposes I arrange the conductors for the conveyance of the electricity in a manner somewhat similar to that adopted for the supply of gas, so that from the point or station where the electric currents are developed I lead a main conductor or a number of main conductors whose size should be as large as practicable in order to prevent great inequality of tension or electro-motive force

in different parts. From these main conductors branch off at different points sub-mains whose size should depend on the amount of electricity to be conveyed. One of the poles or electrodes of the electric generator or generators, and of the reservoir batteries (herein-after referred to), should be connected with the mains or branches and the opposite poles to the earth by means of gas or water pipes or otherwise. In order to prevent a great inequality in the tension or electro-motive force in different parts of the area supplied in case the main conductors are not sufficiently large, I insert at the point of junction between each branch and the main conductor a regulator, hereinafter described, whose object is to increase the resistance at the point of junction as the electro-motive force in the branch conductors rises, and so to prevent too large a current passing through those branches joining the main at points where the electro motive force is temporarily high, and to decrease the resistance when the electro motive force falls, and so to allow a constant flow in that direction. By this means although the electro-motive force in the main conductors will necessarily be
2751 & 2752 continually altering owing to the alteration of draft in different directions the electro-motive force in the branches themselves will be maintained very nearly constant. Smaller regulators may be used at the points where sub branches are led off from the main branches, and so on for the smaller branches. By this means it will be seen that by connecting the various sub branches or smaller branches at any required points with lamps an amount of electricity will pass through them according to the resistance they present to its passage.

The further control and regulation of the electro motive force can be conveniently effected by placing in conjunction with the numerous branches or different parts of the main an arrangement of secondary batteries, for which purpose I prefer to use those made with lead and sulphuric acid. In these batteries large quantities of electricity may be stored up during the time when the demand is small so as to be available for use when the demand is great. The regulator hereinbefore referred to consists of a magneto electric arrangement in which a coil of wire is placed in circuit between the branch conductor and the earth, so that more or less electricity will flow through it according as the electro motive force in the conductor is great or small. A soft iron core in the centre of this coil will consequently be magnetized in a degree proportionate to and varying with the electro motive force of the conductor at the point where the wire of the coil is connected. A spring armature working an arrangement of levers approaches or recedes from the core as the strength of its magnetism varies, so that a pointed, tapered, or conical shaped body, fixed to the end of a lever is immersed point downwards to a greater or less degree in some conducting fluid, preferably mercury, and so will alter the amount of resistance between the said pointed body and the conducting fluid; if therefore the branch through which the flow of electricity is to be regulated is connected to this mercury and the pointed body with the main, or *vice versâ*, the resistance interposed between the main and the branch conductor will be increased when the electro motive force in the branch conductor rises and diminished when it falls. The electrometer arrangement described in a provisional specification lodged by me on the 9th October, 1878, No. 3988, combined with a pointed body and conducting fluid, may be substituted for the electro magnetic arrangement just described. A similar electromagnetic arrangement may be substituted for the said electrometer apparatus, as described in my said provisional specification, for the purpose of regulating the supply of electricity according to the electro motive force, or for moving the commutator of the secondary batteries as the height of the tension requires. In the present improved arrangement the spring armature works by an arrangement of levers, an indicator moving along a scale, its position depending upon the attractive force of the electro magnet, and consequently if it be connected with the main at any point it will indicate the amount of electro motive force at that point. A sliding piece with contact pegs will allow the working of levers in connection with the commutators of the secondary batteries, or with the steam valves of the engine, which works the electric generators, as described in my said provisional specification.

For the purpose of measuring the electric current which passes through any given conductor I use an apparatus which consists chiefly of an electro magnet, the coil of which forms part of the circuit of the conductor, the amount of electricity passing through which it is desired to ascertain. In conjunction with this electro magnet is an armature attached to a spring in connection with a cone or wedge-shaped body working in a suitably shaped orifice. This orifice leads by means of a pipe to an ordinary gas meter, and thence to a reservoir or air chamber kept constantly at a certain pressure, either above or below that of the atmosphere, by means of a water air pump, a small electric pump, or other suitable means. This chamber is provided with a valve which opens when the pressure increases or decreases from a certain point. In this manner the meter has on one side a constant pressure, and on the other an inlet or outlet whose extent will depend on the position of the cone shaped body, and consequently on the distance of the
2753 armature from the magnet; when no current is passing this
valve will be completely closed; a current of a greater or less strength will cause an opening of corresponding extent, and therefore a corresponding flow of air through the meter.

Instead of a meter and air chamber arranged as before described, I sometimes employ a gas holder, so that there is a constant pressure within it. The height of the gas holder, determined by a scale at its side, will represent the amount of electricity passed.

The whole apparatus may be worked either by pressure or vacuum, and the gas meter registering the amount of air passing through it should bear a constant ratio to the amount of electricity passing round the coils of the electro-magnet.

The adjustment of this apparatus can be conveniently effected by varying the shape of the cone or wedge shaped body, or by altering the tension of the armature spring.

It may sometimes be advisable to use a shunted portion of the circuit to work this meter, so that the whole current need not pass through the coil of the electro-magnet, but a portion which bears a fixed ratio to the whole.

Although I prefer to use a gas meter so as to measure the volume of air passed through the valve, water may, if desired, be used instead of air, and the amount of water passed through the valve be made to represent the consumption of electricity in the same way as in the other case it is represented by the passage of a given quantity of air.

2754 Specification in pursuance of the conditions of the letters patent filed by the said St. George Lane Fox in the Great Seal Patent Office on the 14th May, 1879.

St. George Lane Fox, of Telegraph street, in the city of London. "Improvements in the means or apparatus for obtaining light by electricity and distributing, regulating, and measuring the electric currents for the same."

My invention has reference to the application of electricity to lighting purposes.

In order to obtain light by electricity I cause a current to pass through a resisting medium composed of some refractory material so as to render it incandescent. For this purpose I sometimes make use of some difficultly fusible metallic body such as platinum-iridium alloy in the form of a strip of wire. I prefer however to use the compound material mentioned in the specification of my patent, dated October 12th, 1878, No. 4043, and which as therein described is composed of asbestos or other suitable non-conducting refractory material such as lime, magnesia, or steatite, impregnated with or covering the surface of some refractory conducting material such as carbon, platinum, or iridium. In order to prevent the deterioration of the material it is sometimes necessary to enclose it in a glass cover filled with some gas or vapor which has no action on the incandescent material.

In laying on electricity to a building, district, or town for lighting purposes I arrange the conductors for the conveyance of the electricity as described in the specification of my patent dated October 9th, 1878, No. 3988, that is to say, in a manner somewhat similar to that adopted for the supply of gas, so that from the point or station where the electric currents are developed I lead a main conductor or a number of main conductors whose size should be as large as practicable, in order to prevent great inequality of tension or electro motive force in different parts. From these main conductors branch off at different points sub-mains, whose size should depend on the amount of electricity to be conveyed. One of the poles or electrodes of the electric generator or generators, and of the reservoir or secondary batteries (described in the specification of my said patent of 9th October 1878), should be connected with the mains or branches and the opposite poles to the earth by means of gas or water pipes or otherwise. In order to prevent a great inequality in the tension or electro motive force in different parts of the area supplied, in case the main conductors are not sufficiently large I insert at the point of junction between each branch and the main conductor (or between any two parts of the main) a regulator hereinafter described, whose object is to increase the resistance at the point of junction, as the electro motive force in the branch conductors rises, and so to prevent too large a current passing through those branches joining the main at points where the electro motive force is temporarily high, and to decrease the resistance when the electro motive force falls, and so to equalize the electro motive force in that direction. By this means, although the electro motive force in the main conductors may be continually altering, owing to the alteration of draft in different directions, the electro motive force in the branches themselves will be maintained very nearly constant.

Smaller regulators may be used at the points where sub-branches are led off from the main branches and so on for the smaller branches. By this means it will be seen that by connecting the various sub-branches or smaller branches at any required points with lamps a constant amount of electricity will pass through them according to the resistance they present to its passage.

(Here follow diagrams marked pp. 2759 & 2760.)

The regulator hereinbefore referred to should be such as that represented in figure 1. It consists of a magneto electric arrange-
2755 ment in which a coil of wire *a* is placed in circuit between the
branch conductor *b* and the earth so that more or less electricity will flow through it, according as the electro motive force in the conductor is great or small. A soft iron core in the centre of this coil *a* will consequently be magnetised in a degree proportionate to and varying with the electro motive force of the conductor at the point where the wire of the coil is connected. An armature *c*, fitted with a weight *d*, or a spring, approaches or recedes from the core as the strength of its magnetism varies so that a rheostat in connection with the armature may be made to interpose more or less resistance to the passage of the current into that part of the branch (or main) where it is desired to preserve a constant electro motive force. The rheostat is composed of a vessel *e*, containing a conducting fluid, preferably mercury, and is fixed either as shown directly to the end of the armature or with a suitable arrangement of levers between them; *f* is a resistance coil, the plates *g* of which dip into the mercury vessel *e*. It will be seen that as the mercury rises or falls with armature *c* as the electro motive force varies, there will be more or less layers of the resistance coil in circuit, thus the resistance interposed between the main and the branch conductor will be increased when the electro motive force in the branch conductor rises, and diminished when it falls. The weight *d* is carried by a bell crank centered at d^1, whose shorter arm may be made adjustable in any suitable manner.

A somewhat similar electro magnetic arrangement may be substituted for the electro-meter described in the specification of my said patent of 9th October, 1878, for the purpose of regulating the supply of electricity, according to the electro motive force or for moving the commutator of the secondary batteries as the height of the tension requires. In the present arrangement, which is represented in figure 2, the weighted or spring armature *c* works an indicator *h* moving along a scale *i*, its position depending upon the attractive force of the electro magnet *a*, and consequently if it be connected with the main at any point it will indicate the amount of electro motive force at that point. A sliding piece *k*, with platinum or other suitable contact pegs *l*, *l*, will allow or control the working through the intermediation of electro magnets *m*, *m*, of levers in connection with the commutators of the secondary batteries or with the steam valve of the engine which works the electric generators.

For the purpose of measuring the electric current which passes through any given conductor I use an apparatus which consists chiefly of an electro-magnet, the coil of which forms part of the circuit of the conductor the amount of electricity passing through which it is desired to ascertain. In conjunction with this electro magnet is an armature attached to a weight or spring in connection with a cone or wedge shaped body working in a suitably shaped orifice. This orifice leads by means of a pipe to an ordinary gas meter, and thence to a reservoir or air chamber kept constantly at a certain pressure either above or below that of the atmosphere by means of a water air pump, a small electric pump, or other suitable means. In this manner the meter has on one side a constant pressure and on the other an inlet or outlet whose extent will depend on the position of the cone shaped body, and consequently on the distance of the armature from the magnet. When no current is passing this valve will be completely closed. A current of a greater or less strength will cause an opening of corresponding extent, and therefore a corresponding flow of air through the meter.

Instead of a meter and air chamber arranged as before described I sometimes employ a gas holder having a constant pressure within it. The height of the gas holder, determined by a scale at its side, will represent the amount of electricity passed.

The whole apparatus may be worked either by pressure or vacuum, and the amount of air registered as passing through the meter should bear a constant ratio to the amount of electricity passing round the coils of the electro magnet.

The adjustment of this apparatus can be conveniently ef-
2756 fected by varying the shape of the cone or wedge shaped
body, or by altering the weight attached to the armature or
the tension of its spring.

It may sometimes be advisable to use a shunted portion of the circuit to work this meter so that the whole current need not pass through the coil of the electro magnet, but a portion which bears a fixed ratio to the whole.

Although I prefer to use a gas meter so as to measure the volume of air passed through the valve, water may if desired be used instead of air, and the amount of water passed through the valve be made to represent the consumption of electricity in the same way as in the other case it is represented by the passage of a given quantity of air.

Figure 3 represents an apparatus constructed according to my invention for measuring the electric current which passes through any given conductor. *a* is an electro magnet, the coil of which forms part of the circuit of the conductor; *b*, the amount of electricity passing through which for the supply of say a house at X it is desired to ascertain. C is an armature attached to a spring *d;* instead of this spring however I prefer to employ a weight, as in the modification shown in figures 4 and 5, and herein-after described, as I consider a weight more reliable. This armature carries a cone or wedge shaped body *e* working in an orifice *f*. This orifice leads by a pipe *g* to a meter *h* like an ordinary gas meter, and thence by a pipe *i* to an air chamber *k*. The air in this chamber is kept constantly at a certain pressure, and this may be conveniently effected by means of a water air pump, as shown, that is to say, water from a reservoir *l* in descending by the pipe *m* draws in air by the inlet *n* and carries it with it into the chamber *k; o* is the water outlet pipe; *p* is a valve to the chamber *k*, which valve opens when the pressure increases beyond a certain point. Thus the meter *h* has on one side a constant pressure and on the other side an outlet at *f* whose extent depends upon the position of the cone *c*, and therefore upon the distance of the armature *c* from the magnet *a*. As has been before explained, when no current is passing the cone *e* closes the orifice *f*, and when a current of a greater or less strength is passing the orifice *f* is opened to a corresponding extent, and consequently air to a like corresponding extent flows through the meter *h*. Figure 3, which I have just described, is only a diagram of the apparatus; its construction will be fully understood on reference to figures 4 and 5, which represent in front and side elevations respectively (figure 5 being partly in section) a modified arrangement of the apparatus in which the air chamber is kept charged by means of an electric air pump, and in which a governor is interposed between the meter and the outlet valve or orifice. In figures 4 and 5 *a* is the electro magnet whose coil forms part of the conductor *b*, the amount of electricity passed through which it is desired to ascertain. *c* is the armature fitted with a weight *d*. This weight is carried on one arm of a bell crank d^1 d^1, centred at d^2, and the other arm of the bell crank is connected by a link d^3 to the armature. *e* is the cone or valve, which may either be attached to the armature or simply rest thereon. *f* is the orifice in which the valve or cone *e* works. This orifice leads by a pipe *g* to a governor *p*, which I prefer to be what is known as a double dry gas governor, thence by a pipe *q* to the meter *h*, and from the meter by a pipe *i* to an air chamber *k*. This air chamber is kept charged by means of an electric air pump, and this is effected as follows:—*r* is an electro magnet, and *s* its armature, which is carried by a lever *t* centered at *u*. When the armature *s* is attracted by the magnet the outer end of the lever *t* presses upon and pushes down a rod *v* which

is attached to a plunger in a mercury vessel w, the result of which movement is that the mercury is forced up in a vessel x which is in communication with the vessel w. This vessel x is closed except to an air inlet pipe y, and to an air outlet pipe z which communicates with ths air chamber k. The rising of the mercury in the vessel x as above stated drives a corresponding volume of air up the pipe z to the air chamber, and the return of air from the chamber is prevented by a suitable valve fitted in the pipe z. When the armature s ceases to be attracted by the magnet the mercury which has been previously forced from the vessel w to the vessel x returns, air
2757 entering the vessel x by the pipe y which has a valve opening inwards, and the plunger in the vessel w therefore rises and lifts the armature s until it is again attracted by its magnet; a pumping action is thus kept up. Instead of having mercury in the vessel w and a plunger to act upon it, the vessel w may simply contain air, and the rod v be made to act upon a flexible diaphragm in the vessel so as to compress the air below such diaphragm, and the rod v is in this case lifted by a suitable spring. The air chamber k contains a given quantity of paraffin oil or other suitable liquid into which a pipe k^1 from an upper chamber k^2 dips, so that as the air is more or less compressed in the chamber k, the liquid is more or less forced up the pipe k^1 into the chamber k^2 which has an aperture at the top for the admission and exit of air as necessary. In order to break the contact when the pressure in the chamber k reaches a certain point I fit to this chamber a syphon k^3 made of metal, but with a glass piece k^4 interposed. The bend of the syphon contains mercury at such a level that it makes contact between the two metal portions of the syphon except when the pressure is sufficient to force its level down into the glass portion k^4; the contact is then broken. The manner in which contact is alternately made and broken so as to enable the magnet r to alternately attract and free its armature s, and thus effect the pumping action before explained is as follows:—From the tail of the lever t is suspended by a rod t^1 a plate or piece of lead t^2 which dips in sulphuric acid or other liquid in a trough t^3. The contact of the lead t^2 with the liquid in the trough t^3 completes the electric circuit in which are the coils of the magnet r so that the armature is attracted. As the armature descends the lead t^2 is gradually lifted out of the liquid, and as soon as it is quite out of contact therewith the circuit is broken.

Although I prefer that the measuring of the electric current should be effected by causing the movement or position of the armature c of the electro magnet a to control the flow of air through a meter in the manner hereinbefore explained, the same result can be obtained by causing the movement or position of the said armature c to control a meter by mechanical means. This may be effected in the manner shown in figure 6. a is the electro magnet, as in figures 3, 4, and 5; b the conductor; c, the armature with its weight d. The lever which carries the armature c bears at its outer end upon a spindle A which is free to move vertically in a guide B, and forms a pivot for a spindle A^1 which is supported by a spring

C to keep the spindle A in contact with the armature lever. On the spindle A^1 is a disc D which is in fractional contact with another disc E, this disc E is driven by clockwork at F, and is kept against the disc D by a spring. On the spindle A^1 is also a long pinion G in gear with a wheel H, and this wheel actuates the train of wheels which constitute the meter or counting apparatus. When no current is passing through the conductor b and the armature therefore is not attracted by the magnet a, and is consequently in its highest position the disc D is exactly in the centre of the disc E, and therefore not driven thereby; but as when a current is passing through the conductor b the armature c is more or less attracted by the magnet a, the spindle A with the disc D is more or less forced down, and the disc D being thus pushed more or less from the centre of the disc E is driven at a proportionate speed and a corresponding motion is given to the wheel H and to the meter; the extent to which the meter is acted upon will thus depend upon the time the current is passing through the conductor b and to the amount of current passed during such time.

And having now described the nature of my said invention, and in what manner the same is to be performed, I declare that I claim as my "improvements in the means or apparatus for obtaining light by electricity, and distributing, regulating, and measuring the electric currents for the same,"—

First. Constructing apparatus substantially as hereinbefore described, and represented in figure 1 of the annexed drawings, for regulating the distribution of the electric currents.

2758 Second. The improved electrometer or apparatus hereinbefore described, and represented in figure 2, arranged and acting as and for the purposes explained.

Third. The construction of apparatus for measuring the electric currents passing through a conductor when such apparatus comprises an electro magnet whose coil forms part of the circuit of the conductor or a shunted portion of the circuit, and when the movement or position of the armature of such electro magnet controls the working of a meter or counting apparatus, substantially in the manner hereinbefore explained.

Lastly. I claim specially the measuring apparatus constructed and acting substantially as hereinbefore described with reference respectively to figure 3, and figures 4 and 5 of the annexed drawings.

In witness whereof, I, the said St. George Lane Fox, have hereunto set my hand and seal, this fourteenth day of May, one thousand eight hundred and seventy-nine.

ST. G. LANE FOX. [L. S.]

London: Printed by George Edward Eyre and William Spottiswoode, printers to the Queen's most excellent majesty. For her majesty's stationery office. 1879.

2761 Duplicate.

CONSOLIDATED E. L. CO.
vs.
MCKEESPORT CO.

COMPLAINANT'S EXHIBIT LANE-FOX BRITISH PATENT NO. 1122 of 1879. W. T. F., S. E.

(Third edition.)

[British coat of arms.]

A. D. 1879, 20th March. No. 1122.

Specification of St. George Lane Fox.

Electric light.

London: Published and sold at the patent office sale branch, 38 Cursitor street, Chancery Lane, E. C. 1884. Price, 2d.

2762 (Third edition.)

A. D. 1879, 20th March. No. 1122.

Electric Light.

(This invention received provisional protection only.)

Provisional specification left by St. George Lane Fox at the office of the commissioners of patents on the 20th March, 1879.

St. George Lane Fox, of Telegraph street, in the city of London. "Improvements in the means or apparatus for obtaining light by electricity and in the manufacture of materials to be employed therein."

My invention has reference to obtaining light by the incandescence of a portion of a continuous conductor through which a current of electricity is made to pass and the improvements chiefly relate to the manufacture of the material of which such portion of the conductor as is made incandescent is composed. For the manufacture of this material I employ two highly refractory materials one of which is a conducting material such for example as plumbago and the other a non-conducting or bad conducting material such for example as magnesia, zirconia lime, steatite or earthy matter. I mix or combine these materials in such proportions as to make the whole give a specific resistance in accordance with the electro motive force employed for producing the light. Where an electro motive force of 140 volts is employed in order to produce a light somewhat equal in power to an ordinary gas jet the portion of the continuous conductor which is made incandescent and which portion I will call the "luminous bridge" should have a resistance of about 300 ohms or British Association units. To attain this high resistance and keep the bridge of small size the quantity of non-conducting material would have to be considerably in excess of the conducting material. If however a smaller electro motive force is employed the conducting power and consequently the proportion of the conducting material will have to be increased.

The manner in which I prefer to manufacture the luminous bridge is as follows:—I grind or reduce the materials to impalpable or very fine powder and then with the aid of a little moisture I unite them into a compact piece of the required form by means of powerful pressure. Sometimes I add a trace of a silicate or other fusible material for the purpose of assisting in the hardening or increasing the toughness of the combined material. Sometimes also I produce on the surface a very hard film of carbon and this I effect after the bridge has been made by treating it at a high temperature with a hydrocarbon, for example by raising it to an incandescent state by sending a current through it while immersed in a dense hydrocarbon. In order that the temperature of the luminous bridge may be as much as possible equal throughout I
2763 make it narrower at and near the ends than in the middle.

I connect or fit each of the ends to a piece of plumbago or other conducting material, and union to these pieces may be made at the time of moulding the luminous bridge by placing powdered plumbago in parts of the mould contiguous to the parts which receive the mixture for forming the bridge. The bridge and plumbago pieces form what I may call an electric candle and are held in any suitable holder or holders. According to one method the plumbago pieces are held by iron or other metallic clips to which fine conducting wires are connected; according to another method the said pieces are held loosely in metallic supports having sufficient elasticity to allow of the insertion of the candle between them, electrical contact being formed by the pressure between the plumbago pieces and the metallic supports, due to the weight of the candle. According to a third method the said pieces enter passages in a block of steatite, adamant or other suitable material in which they are connected with the wires of the continuous conductor; and in order to increase the conductivity and to enable the plumbago to be soldered to the conducting wires it may be coated with copper or other metal.

The parts before described are hermetically enclosed within a globe or other form of glass or other suitable material through one portion of which the conducting wires are hermetically carried. From this globe all trace of oxygen, carbonic acid gas, water and any gas or vapor capable of attacking or affecting the material of the luminous bridge when at a high temperature must be removed.

London: Printed by Eyre and Spottiswoode, printers to the Queen's most excellent majesty. For her majesty's stationery office.
(16819.—25.—12—84.)

2766

CONSOLIDATED
vs.
MCKEESPORT.

COMPLAINANT'S EXHIBIT SOAPSTONE SWITCH PATENT. W. T. F., S. E. March 28, 1889.

UNITED STATES PATENT OFFICE.

WILLIAM E. SAWYER, of New York, and ALBON MAN, of Brooklyn, N. Y., assignors to Electro Dynamic Light Company.

Electric Switch.

Specification forming part of Letters Patent No. 229,476, dated June 29, 1880. Application filed December 5, 1878.

To all whom it may concern:

Be it known that we, William Edward Sawyer, of the city, county, and State of New York, and Albon Man, of Brooklyn, county of Kings, and State aforesaid, have jointly invented certain new and useful improvements in electric switches for dividing and regulating the application of electric currents to electric lamps; and we do hereby declare the following to be a description of our invention, and of the manner and process of making, constructing, and using the same, in such full, clear, concise, and exact terms as to enable any person skilled in the art or science to which it appertains, or with which it is most nearly connected, to make, construct, and use the same, reference being had to the accompanying drawings, making part of this specification, and to the figures and letters of reference marked thereon, and also to letters patent allowed to us for switches for electric lights, November 15, 1878.

In this switch the mode of operation in its relation to the lamp is substantially the same as that of the letters patent allowed to us as aforesaid; but this switch differs from that in its mechanical construction and in the material of which it is constructed, by which all danger or inconvenience arising from the heat of the current is avoided.

The frame of this switch is composed of soapstone or other non-conductor of heat that can be readily worked in the desired form, and instead of resistances formed of metallic conductors, as in the patent above referred to, we employ either broken or powdered carbon or carbon rods packed in tubes formed or set in the frame of the switch.

(Here follow diagrams marked pp. 2764 & 2765.)

Reference being had to the drawings, A is a disk of plaster-of-paris, soapstone, or other heat-resisting material, perforated, as shown in Fig. 6, the black circles being those which are filled with carbon, the others being for the rods and connections by which the several parts are clamped together.

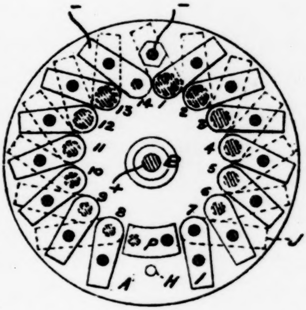
No. 268
E Light Co
v.
MCK. Light Co } p. 2764.

2 Sheets—Sheet 1.

W. E. SAWYER & A. MAN.
Electric Switch.

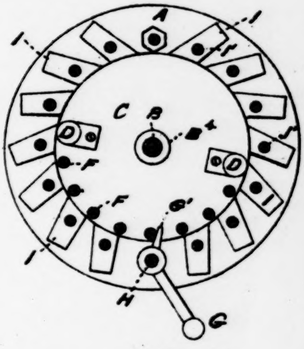
No. 229,476. Patented June 29, 1880.

FIG. 1.



−
−
14
1
2
3
4
5
6
7
8
9
10
11
12
13
B
+
P
A
H
I
J

FIG. 2.



A
I
I
C
B
B4
D
D
F
F
G'
I
H
G
J
I

FIG. 3.

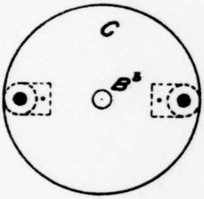
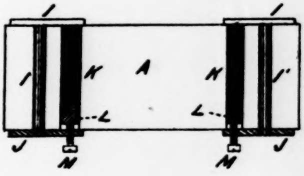
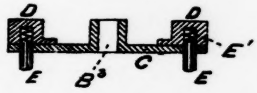


FIG. 4.



I
I
I
K
A
K
I'
L
L
J
J
M
M

FIG. 5.



WITNESSES.

F. S. Miller Jr

Wm. H. Broadnax

INVENTORS.

William E. Sawyer

Albon Man By

Amos Broadnax

Atty

No. 286
E. Light Co.
v.
McK Light Co. } p. 2765

2 Sheets—Sheet 2.

W. E SAWYER & A. MAN.
Electric Switch.

No. 229,476. Patented June 29, 1880.

FIG. 6.

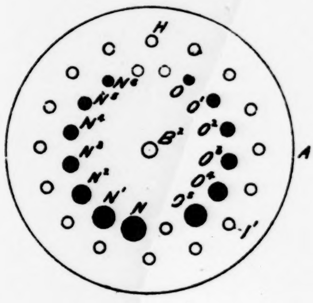
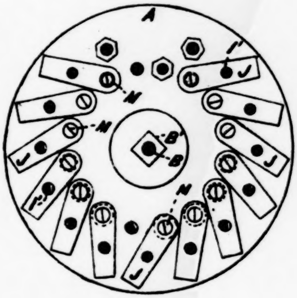

H
N²
N²
N²
N²
N²
N'
N
O
O'
O²
O²
O²
O²
B²
A
I'

FIG. 7.


A
I'
J
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M
J
B'
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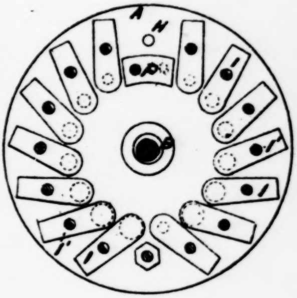
J
N
I'
J

FIG. 8.



WITNESSES.

J. S. Miller Jr
William H. Broadnax

INVENTORS.

William E. Sawyer
Albon Man By
Amos Broadnax Atty

On the top side of the disk are set fourteen metallic pieces, I, and on the bottom side thirteen similar pieces, J. These pieces are arranged as shown, and drawn firmly together and down upon the disk A by screw-rods I′, the position they hold with respect to each other being clearly shown in Fig. 1, wherein the full lines represent the pieces I upon the top of the disk and the dotted lines the pieces J upon the under side of the disk. The enlarged ends of the pieces I J cover the holes N O through the disk, the pieces I acting as a stopper to the upper end of the hole. The hole being packed with carbon K, Fig. 4, the plunger L is put into the lower end, and by means of screw M in pieces J the plunger L is caused to exert any required pressure upon the carbon, thus making perfect connection with the carbon and enabling its resistance to be changed, if desired.

Through hole B^2 passes a stud, B, drawn down upon the disk A by nut B′ on the under side of the disk, and turning upon this stud is a metallic disk, C, Figs. 2 and 3, through the hole B^3 of which the stud passes, the disk C being secured in place by nut B^4, Fig. 2, on the upper end of stud B.

On the disk C are two brackets, D D, drilled partly through from the under side of the disk. In the circular cavities thus made, actuated by spiral springs E′, work the two plungers E, which, as the disk is turned, make connection with the faces of the pieces I. The disk is further provided with eight pins, F, in which the pin G′ of crank-key G, working on stud H, engages, precisely the same as in the letters patent referred to. Referring to those letters patent, the current, as shown in Fig. 1, enters from the + side at the stud B, and thence through disk C and its plunger E, and when the lamp is not in circuit it passes outward by way of piece I (numbered 1) and the carbon resistance N, which has the same resistance as that of the lamp. When the lamp is fully lighted the current passes outward by way of piece I, (numbered 14,) and through the lamp.

The object of the piece P is merely to keep the plungers E from dropping out of place. Supposing the resistance of the lamp is .95 ohm, the resistance N, Fig. 6, corresponding to piece I, No. 1, of Fig. 1, is .95 ohm. When the lamp is completely out of the circuit one of the studs E is bearing upon piece I, No. 1, and the other stud E is bearing upon the blank piece P, with which there
2767 is no connection. A single turn of the crank brings the studs
upon pieces I, Nos. 2 and 8, and the current divides, three-fourths of it flowing, by way of pieces 2, carbon resistance N′, of $.31\frac{2}{3}$ ohm, piece J, and bolt I′, to piece I, No. 1, and resistance N, of .95 ohm, outward, and one-fourth of it flowing, by way of piece 8, carbon resistance O, of 1.9 ohm, and thence by piece J and bolt I′ to piece 9; thence through carbon resistance O′, of .38 ohm, and so on through carbon resistances O^2, of $.25\frac{1}{3}$ ohm, O^3, of $.18\frac{2}{21}$ ohm, O^4, of $.07\frac{5}{21}$ ohm, and O^5, of $.06\frac{1}{3}$ ohm, and thence, through piece J and bolt I′, to piece 14 and the lamp. The total resistance of the first or shunt circuit is therefore $1.26\frac{2}{3}$ ohm, and that of the lamp-circuit, including the lamp, is 3.8 ohms, making the joint resistance .95 ohm. The resistance of N^2 is $.63\frac{1}{3}$ ohm, N^3 $.63\frac{1}{3}$ ohm, N^4 $1.26\frac{2}{3}$ ohm,

N^5 3.8 ohms, and N^6 7.6 ohms, making a sum total of resistances on the shunt side of 15.2 ohms.

Without following out the various changes, which are fully set forth in the letters patent referred to, suffice it to say that when one plunger E is bearing upon piece I, No. 1, the other plunger is bearing upon blank piece P, and that the plungers thereafter take position as follows: upon 2 and 8, 3 and 9, 4 and 10, 5 and 11, 6 and 12, 7 and 13, and lastly blank piece P and 14, when the entire current is directed through the lamp.

Having thus fully described our invention, we claim and desire to secure by letters patent—

1. An electric switch consisting of a frame composed of soapstone or plaster, or other insulating material, also suitable to resist the transmission of heat, fitted with carbon resistances and combined with metal contact-joints and conductors arranged in relation to each other to regulate the application and division of the current to the lamp, as set forth, and at the same time avoid danger or inconvenience from the heat of the current.

2. A circular disk, A, fitted with packed carbon resistances, as set forth.

3. A disk, A, fitted with pieces I and J, clamped to the disk, as set forth.

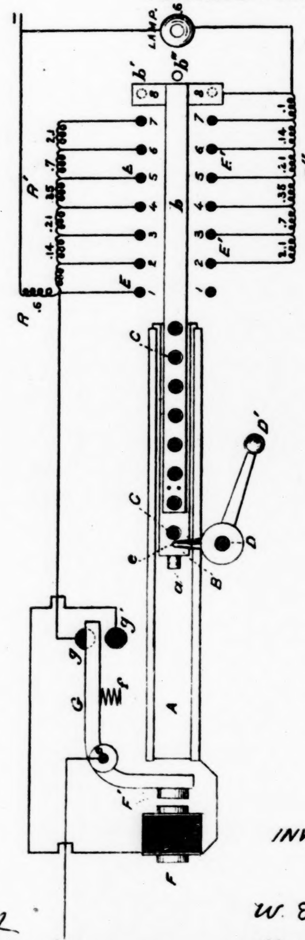
WILLIAM EDWARD SAWYER.
ALBON MAN.

Witnesses:
THOS. CROCKER.
GEO. W. SAWYER.

No. 286
C.E. Light Co
v.
McK. Light Co } p. 2768

W. E. SAWYER & A. MAN.
Switch for Electric-Light.

No. 210,152. **Patented Nov. 19, 1878.**



-
LAMP.
.6
b'
b''
b
8
7
6
5
4
3
2
1
R
.6
R'
.14
.21
.35
.7
2.1
R''
.1
.14
.21
.35
.7
2.1
E
E'
E''
C
C
c
a
B
D
D'
g
g'
G
f
A
F'
F
+

FIG. 1

WITNESSES.

Thomas Leach
Amos Broadnax

INVENTOR.

W. E. Sawyer
Albon Man

2769 CONSOLIDATED E. L. CO.
vs.
MCKEESPORT CO.

COMPLAINANT'S EXHIBIT SAWYER-MAN SWITCH PATENT. W. T. F., Sp'l Ex'r. Mar. 28, 1889.

UNITED STATES PATENT OFFICE.

WILLIAM E. SAWYER, of New York, and ALBION MAN, of Brooklyn, N. Y.

Improvement in Switches for Electric Lights.

Specification forming part of Letters Patent No. 210,152, dated November 19, 1878; application filed October 19, 1878.

To all whom it may concern:

Be it known that we, William Edward Sawyer, of the city, county, and State of New York, and Albon Man, of the city of Brooklyn, in the county of Kings and State aforesaid, have jointly invented certain new and useful improvements in electrical lighting apparatus and circuits; and we do hereby declare the following to be a description of the same, and of the manner and process of making, constructing, and using them, in such full, clear, concise, and exact terms as to enable any person skilled in the art or science to which it appertains, or with which it is most nearly connected, to make, construct, and use the same, reference being had to the accompanying drawing, making part of this specification, and to certain letters patent of the United States heretofore granted to us for certain inventions hereunto appertaining, and to which especial reference will hereinafter be made.

In letters patent of the United States No. 205,303 we have shown and described an electric-lamp-lighting switch, which not only turns the current onto and off from the lamp gradually, but admits of regulating the light proceeding from the lamp to any desired intensity; and in the same letters patent we have described a distributing system, by means of which the current from a single generator may be divided among any number of lamps.

Our present invention comprises a new lamp-lighting switch which not only accomplishes the purpose of the switch above referred to, but is provided also with a safety device, the nature of which will be explained in detail hereinafter.

(Here follows diagram marked p. 2768.)

In the drawing accompanying and forming a part of this specification, figure 1 illustrates our electric-lamp-lighting switch.

Reference being had to Fig. 1, it consists of a suitable metallic holder, A, grooved so as to keep a sliding piece, B, in place. To the sliding piece B is fixed a flat spring, *b*, carrying at one end a cross-piece, *b′*, which, as the slide is moved, makes contact with the sixteen pins E E and E′ E′, arranged eight on each side of the spring.

The movement of the slide B backward and forward is accomplished by turning the crank D and D′, which works upon the stud *d*. At each revolution of the crank the pin *c*, fixed in the hub of the crank, engages with a tooth, C, and moves the slide forward one tooth, until it has acted upon the last tooth, when further movement is prevented by the contact of the cross-piece *b′* with the stop-pin *b″*. Turning the crank in the opposite direction in like manner moves the slide backward until its movement is arrested by the contact of the pin *a* with the armature-lever G.

In lighting a lamp such as that shown and described in letters patent No. 205,144, granted to us as aforesaid, we have found it important to turn on the current gradually, otherwise fractures of the carbon may ensue. It is possible that at times, when the current is fully turned on the lamp, there may occur an interruption in the supply. Extinguishment of the light follows, and the carbon grows cool. Suppose, now, that the circuit of the lamp not having been destroyed, but being set for the full force of the current, the supply is suddenly renewed, instantly the carbon is heated from a low to an extremely high temperature, and its fracture may be expected. The electro-magnet F attached to the switch effectually guards against this danger. Unless the current is circulating in its coils the lamp cannot be lighted ; and if there is an interruption in the supply the current cannot circulate in its coils, although the supply may be renewed, until the lamp shall first have been taken out of the circuit.

The armature F′ is fixed to the bent lever G, (pivoted at *e*,) one extremity of which plays between the studs *g* and *g′*, according as the magnet is or is not actuated by the current.

The spring *f* acts to force the armature away from the magnet and establish a connection between the lever G and stud *g*.

The current from the + side of the generator enters the lever G, and when the circuit is in its normal condition passes, by way of the stud *g′*, through the coils of magnet F to the holder A, then by way of slide B, spring *b*, cross-piece *b′*, and the eight pins E′, to the lamp and outward at the point. A sudden interruption
2770 occurs instantly the armature is forced away from the magnet by the spring *f*, and contact of the lever G with the stud *g* is established. The lamp is now entirely out of the circuit, and the current flows solely from the lever through stud *g* and resistance R outward at the — point. It is in this position we have shown the switch, nor can the lamp ever be relighted unless the slide B be moved back until the cross-piece *b′* makes connection with 1′ E, when the pin *a* strikes the lever G, and forces the armature within the grasp of the magnet, at the same time establishing a connection between G and *g′*. Then, if there be a supply of current, the lamp may be lighted by moving the slide B forward ; but if there be no supply, moving the slide forward will simply release the armature, and the lever G will again move to the stud *g*.

By this device even carelessness is rendered harmless, and inasmuch as seven turns of the crank are required to fully light the lamp the current is not likely ever to be turned on very rapidly.

We have found that the internal resistance of a lamp such as that of letters patent No. 205,144 is not far from six-tenths of an ohm. It is clearly important, to the end that other lamps in the circuit may not be affected, that the resistance of the circuit from + to the — points shall be constant, whether the lamp be in or out of the circuit, or whether it be lighted feebly or at its full head. Therefore when the lamp is out of the circuit—*i. e.*, the cross-piece *b′* resting upon the pins 1 1—the current flows by way of pin 1 E through the .6 ohm resistance R and outward at the — point. Thus when the lamp is entirely cut out the resistance of the circuit is precisely the same as when the lamp is fully lighted. The pins 1 E′ and 8 E serve no useful purpose other than to keep the cross-piece *b′* in position. Assuming, now, that it is desired to light the lamp, the current is let on by sevenths, but any other small fraction may be substituted. A single turn of the crank advances the cross-piece *b′* upon the two pins 2 2. The current divides, six-sevenths of it passing through resistance R′ of .1 ohm and resistance R of .6 ohm outward at the — point, the other seventh passing through the several resistance B^2, amounting altogether to 3.6 ohms, and through the lamp of .6 ohm outward at the — point. The resistance of the first circuit, which we will call the "shunt," is therefore .7 ohm, and that of the lamp is 4.2 ohms, making the resistance from the + point to the — points .6 ohm. At the next turn of the crank the cross-piece *b′* bears upon pins 3 3, and the resistance is as follows: In the shunt-circuit .84 ohm, in the lamp-circuit 2.1 = .6 ohm. Upon pins 4 4 the resistance is in the shunt-circuit 1.05, in the lamp-circuit 1.4 = .6 ohm. Upon pins 5 5 the resistance is in the shunt-circuit 1.4, in the lamp-circuit 1.5 = .6 ohm. Upon pins 6 6 the resistance is in the shunt-circuit 2.1, in the lamp-circuit .84 = .6 ohm. Upon pins 7 7 the resistance is in the shunt-circuit 4.2, in the lamp-circuit .7 = .6 ohm. Upon pins 8 8 the current no longer flows through the shunt-circuit, but is solely through the lamp, the resistance of which is .6 ohm.

By what we have written it will be seen that we not only succeed in gradually lighting the lamp to any desired degree of intensity within the scope of the current of electricity, but maintain an absolutely constant resistance in the circuit, whereby other lamps in the circuit or in other circuits are absolutely unaffected.

In the letters patent granted to us, hereinbefore referred to, we have fully set forth and claimed these important features; but we consider the switch above described an improvement upon the methods set forth in said letters patent, though we do not intend to limit our patent, of which this is a specification, to any particular form of apparatus or special application of the invention, but intend to claim all forms and applications of the invention that fall within the substance of its scope.

For distributing the current from a single generator to two or more electric lamps, engines, or other apparatus, we have recourse to a commutator in connection with the generator, which, when there are two circuits from the generator, transmits the electric impulses alternately into each, and when there are more than two circuits transmits these impulses seriatim into the several circuits. This commutator and system of distribution we intend to make the subject-matter of a separate patent.

Having thus fully described our invention, we claim and desire to secure by letters patent—

1. The combination, with an electric-lamp-lighting switch, of an apparatus which operates to prevent the completion of the lamp-circuit when there is no current to energize the lamp.

2. The combination, with an electric-lamp-lighting switch, of an apparatus energized by the current which actuates the lamp, and that operates, when there is an interruption in the flow of the current, to close the circuit of the lamp against a sudden recurrence of such flow.

3. The combination, with an electric lamp and a lamp-lighting switch, of two electrical circuits connected therewith, the switch operating to reduce the resistance of one circuit and increase the resistance of the other in such manner that at each reduction in the resistance of one circuit there will be an increase in the resistance of the other.

4. The combination of an electric lamp and a lamp-lighting switch, of electrical circuits so arranged that as the resistance in the circuit of the lamp is lessened, and consequently more current caused to flow through the lamp, the resistance of an extraneous channel or channels is increased, each reduction in the lamp-circuit being accompanied by such increase in the resistance of the
2771 extraneous channel or channels that the resistance of the main or branch circuit which contains the circuit of the lamp, and the extraneous channel or channels is maintained constant, or nearly so.

5. An electric-lamp-lighting switch or apparatus, which, after an interruption in the flow of current, operates to prevent the lighting of the lamp until it shall have first been brought into the position which it occupies when the lamp is not lighted.

WILLIAM EDWARD SAWYER.
ALBON MAN.

Witnesses:
AMOS BROADNAX.
THOMAS SAULT.

4 Sheets—Sheet 4.

W. E. SAWYER & A. MAN,

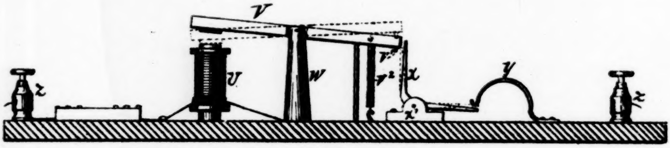
Assignors to THE ELECTRO DYNAMIC LIGHT COMPANY.

ELECTRIC LIGHTING SYSTEM.

No. 10,134. Reissued June 6, 1882.

No. 286.
C.E. Light Co
v.
McK. Light Co
} p. 2775

Fig. 7.



Witnesses:
J. Edgar Bull
Saml R. Taylor

Inventors:
W. E. Sawyer
Albon Man.
By Amos Broadnax
Attorney

No. 286.
C.E. Light Co
v.
McK. Light Co. } p. 2774

4 Sheets—Sheet 3.

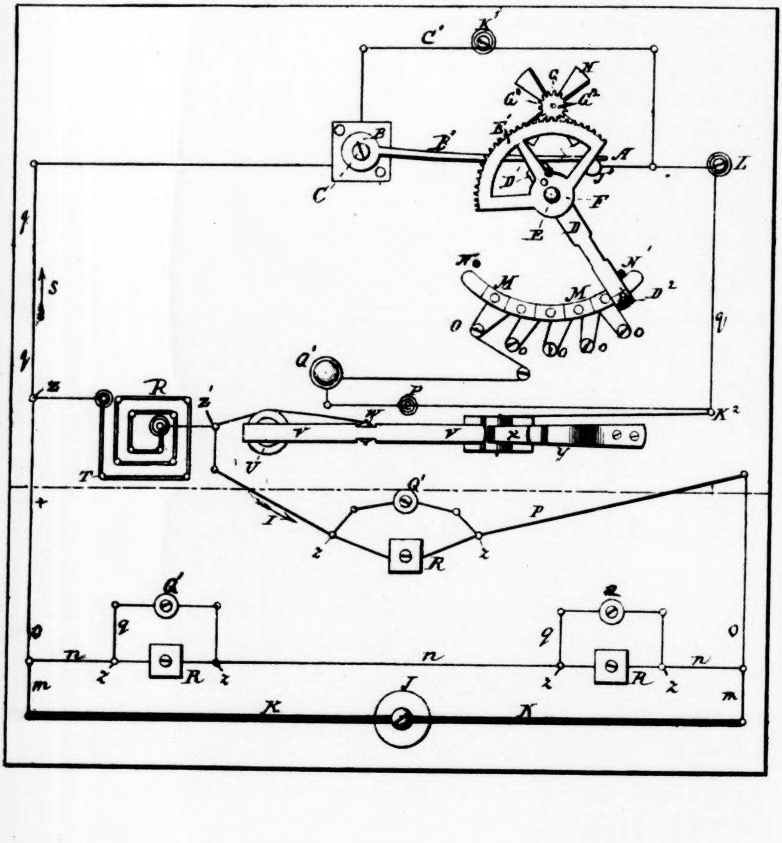
W. E. SAWYER & A. MAN,

Assignors to THE ELECTRO DYNAMIC LIGHT COMPANY.

ELECTRIC LIGHTING SYSTEM.

No. 10,134. **Reissued June 6, 1882.**

Fig. 6.


C'
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Witnesses:
J. Edgar Bull
Saml R. Taylor

Inventor.
W. E. Sawyer
Albon Man By
Amos Broadnax
Attorney

W. E. SAWYER & A. MAN, 4 Sheets—Sheet 2

Assignors to The Electro Dynamic Light Company.

ELECTRIC LIGHTING SYSTEM.

No. 10,134 Reissued June 6, 1882.

No. 286
C.E. Light Co
McK. Light Co } p. 2773

Fig. 2

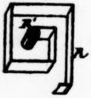


Fig. 3.

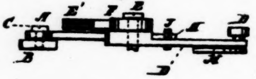

C
A
E'
F
E
J
a
B
B
D
H

Fig. 4.

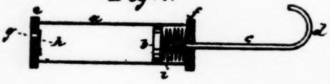
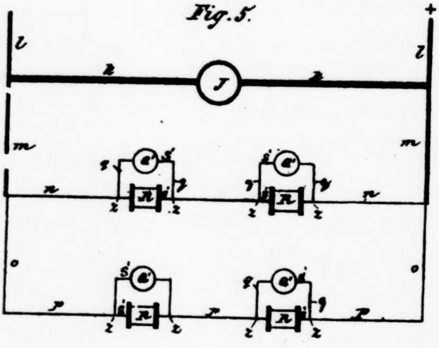


Fig. 5.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WITNESSES:
J. Egar Bull
Saml R. Taylor

INVENTOR:
W. E. Sawyer
Albon Man
BY Amos Broadnax

ATTORNEY.

3

W. E. SAWYER & A. MAN, 4 Sheets—Sheet 1.

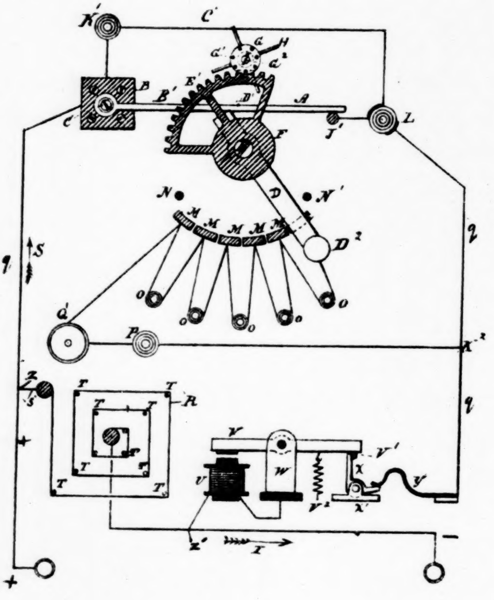
Assignors to THE ELECTRO DYNAMIC LIGHT COMPANY.

ELECTRIC LIGHTING SYSTEM.

No. 10,134. Reissued June 6, 1882.

No. 286
E. Light Co
v.
McK. Light Co } p. 2772

Fig. 1.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WITNESSES:

J. Edgar Bull

Saml R. Taylor

INVENTORS

W. E. Sawyer

Albon Man

BY Amos Broadnax

ATTORNEY.

2776 CONSOLIDATED E. L. CO.
vs.
MCKEESPORT CO.

COMPLAINANT'S EXHIBIT REISSUE 10134. W. T. F., Sp'l Ex'r. March 28, 1889.

UNITED STATES PATENT OFFICE.

WILLIAM E. SAWYER, of New York, and ALBON MAN, of Brooklyn, assignors to the Electro Dynamic Light Company, of New York, N. Y.

Electric Lighting System.

Specification forming part of Reissued Letters Patent No. 10134, dated June 6, 1882. Original No. 205,303, dated June 25, 1878. Application for reissue filed May 14, 1881.

To all whom it may concern:

Be it known that we, William Edward Sawyer, of the city, county, and State of New York, and Albon Man, of Brooklyn, in the county of Kings and State aforesaid, have jointly invented certain new and useful improvements in the application of electricity to electric lighting, of which the following is a description in such full, clear, concise, and exact terms as to enable any one skilled in the arts to which our invention appertains or with which it is most nearly connected to construct and practice the same, reference being had to the accompanying drawings, making part of this specification, and to the figures and letters of reference marked thereon.

(Here follow diagrams marked pp. 2772, 2773, 2774, & 2775.)

By figure 1 of the drawings is shown a general plan of the invention in its application to each lamp, including a top view of a lamp-lighter and a side view of a safety-switch. Figs. 2 and 3 are detail parts of Fig. 1. Fig. 4 is an outline of a device that may be made part of the lamp-lighter. Fig. 5 is a diagram of circuits combining several sets of apparatus shown by Fig. 1. Fig. 6 is another view of the arrangements illustrated by Fig. 1, showing its connection to a number of lamps in circuit. Fig. 7 is a side view of the cut-off or safety-switch, a top view of which is included in Fig. 6.

The operation of our invention, its object, and use are described as follows:

Referring first, for convenience of description, to Fig. 5 of the drawings, J is a generator of electricity, supplying the outletting conduits or conductors *k k*, which branch into conductors *l l* and *m m*, the continuations of which are shown only in the case of the conductors *m m*, the circuits of conductors *l l* being merely indicated in Fig. 5 by the + and — signs. There may be any number of branches *l l* and *m m* leading from the outletting-conductors, according to the volume of current supplied by the generator J. The outletting-conductors *k k*, as indicated by the thickness of the lines, are large, in order to conduct, without heating and consequent waste, the greatest quantity of current supplied.

It is clear that all of the conductors may be of uniform size; but the expense of such against conductors diminishing in transverse mass as they extend onward is so considerable that we have adopted the latter plan. Therefore we make the first section, *m m*, of the circuits smaller than the outletting-conduits, and the next sections, *o o*, Fig. 5, still smaller, and so on indefinitely. This arrangement of the conductors is the first step in the construction of the system of conductors making part of our invention; but, though desirable, it is not a necessary part of the system.

The next step is to divide and subdivide the conductors in which the lamps are placed at the point or points where the current is to be made available for lighting. This is done by making a closed offset or division in the conductor, the lamp and its machinery being placed in one side of the offset or division and a resistance in the other.

In the drawings we have shown the lamp, the lamp-lighter, and the safety-switch or cut-off of our invention placed in the offset or division *q*, the resistance R being placed in the opposite division of the branch conductors *n* and *p* between the points of division and reunion in the conductors. By these means we obtain two paths for the current in the conductor, one around and the other through the lamp and its machinery, all indicated by Q′, Fig. 5.

The next step is the arrangement of the lamp and its machinery in the divided circuit or offset *q*. This is done as follows, reference being had to Figs. 1 and 6, in which Q′ is the lamp; A D M, the lamp-lighter; U V *x y*, the safety-switch or cut-off, and R the resistance indicated in the diagram.

The letters *z z*, Figs. 5 and 6, indicate the points at which the lighting-circuits leave the branches *n* and *p* to enter the lamp and its machinery. The machinery of the lamp consists of the conductors to and about it, the lamp-lighter, by which the current is governed, and the safety-switch or cut-off, by which, in certain contingencies, the lamp is automatically cut out of circuit.

2777 The lamp-lighter consists of a flat metallic spring-lever, A, fixed to a holder, B, by means of a screw, C. This lever makes connection with the contact-point J′ when the lamp Q′ is not in circuit, and also of a lever, D, working around a pivot or stud, E, and provided with a finger-piece, D². This lever D has a cam-projection, D′, on its upper end for the purpose of lifting the spring A from contact with the point J′. The said lever has also fixed upon its short end a cogged sector, E′, the teeth of which mesh into the cog-pins G′ of pinion G, supported upon a stud, G². The object of this cogged sector and pinion is to steady the motion of the lever D by the inertia of the counter-balance or some resisting force to guard against the danger of turning the current into the lamp too rapidly. To this end the fans or arms H are fixed in the pinion to retard its motion and increase the force necessary to move the lever D. Any other means of insuring a gradual movement of the machinery will answer the purpose, and as an example we have indicated by Fig. 4 a modification that may be made in this apparatus, *a* being a tube of glass or metal, in which travels a plunger, *b*, on piston-rod *c*, provided with finger-hook *d*. The piston-rod works loosely in the tube-head *f*, and the plunger is pressed toward tube-head *e* by coil-spring *i*. In the head *e* is an opening, *g*, provided with a valve, *h*. This device may be attached to the apparatus of Fig. 1, so that, for instance, when the plunger is drawn into the position shown a catch shall take hold of the lever D, and the piston-rod being released and the valve *h* closing, the slow escape of the air as the plunger is followed by spring *i* will cause the piston-rod to slowly move the lever D and light the lamp. This piston-rod disengaging when the lamp is lighted, all that is necessary in order to put out the light is to move the lever D back to the position it occupies in Fig. 1, and this may be accomplished by a second catch upon the piston-rod *c* and the same movement of the rod as that which takes place upon lighting the lamp; but since, as before observed, any retarding device will answer the same purpose, we have not deemed it necessary to enter into details of modifications, which would only needlessly incumber our specifications; and said lamp-lighter consists also of the contact points or pieces M M M M and resistances K′, L, and O, all of which are more or less affected by the motion of the lever D.

K′ and L are resistances of, say, fifteen ohms each. P is a resistance of, say, ten ohms, and O O are five resistances of, say, two ohms each. N and N′ are stops for lever D, and M M are six metallic contact-pieces, with which the lever D makes connection as it is moved, which contact-pieces are connected, as shown, with five resistances, O O. All of these resistances may be of the character of resistance R, which, as is better shown in Fig. 2, is a flat wire or ribbon of metal. This ribbon is wound over pins T, fixed to any suitable insulating-base. The conductor of which the resistance R is made may be of any desirable form. Being in the shape of a ribbon, the conductor constituting the resistance has a large radiating-surface, and a space being left between each layer to permit of free access of air, any heat which may be evolved is rapidly dissipated.

The resistance R, Figs. 5 and 6, as it is great or small, operates to divert more or less of the current from the conductors into the set-off or division of the conductor in which the lamp and its machinery are placed.

The safety-switch is of the simplest construction. It consists of an ordinary electro-magnet, U, an ordinary armature-lever, V, a standard, W, in which the armature-lever is pivoted, and a retractile spring, V², by which the armature is held off of the magnet.

The pin V′, fixed to the lever V, serves to hold the bent lever *x*, working in the bearing *x*′, in the position shown in the drawings, Fig. 1. When, however, the lever V is attracted by magnet U, the pin V' is lifted, and the lever x, actuated by spring y, escapes from its imprisonment, as in Fig. 7.

In place of the safety-switch, we may interpose in the circuit a section of a conductor more readily fused than the conductors constituting the rest of the circuit, so that when there is too much current this section will be instantly melted and the continuity of the current destroyed.

The operation of our apparatus is as follows, reference being had to Figs. 1 and 6 of the drawings:

The current enters from the point x and divides at the point z, the required portion entering the lighting-circuit q of any one lamp, the remaining portion going through the resistance to the other lamps in circuit.

To illustrate better the operation in detail, we will follow first that portion of the current represented by the arrows S and I, Figs. 1 and 6. Assuming the lever D to be in the position shown by the drawings, the current passes from the point z, through the spring-lever A, contact-point J', resistance L, of fifteen ohms, and thence through spring y, levers x and V, standard W, and magnet U, to point z'. In this position of the lever D the lamp is not in operation, and the resistance of the circuit is fifteen ohms, disregarding everything excepting the resistance L.

To light the lamp the lever D is moved to the left, and while it is still in connection with the first contact-point, M, its end D' makes connection with spring-lever A, breaking connection between A and J', and at the same time, without breaking the current, divides it into two sub-circuits, one of which is from z to resistance K', of fifteen ohms, resistance L, of fifteen ohms, and the safety-switch to point z'; total resistance of this sub-circuit, thirty ohms. The other sub-circuit is from point z, by way of spring A, lever D, contact-point M, the five resistances O O O O O, of two ohms each, the lamp of ten ohms, and the resistance P, of ten ohms, to the point z'; total resistance of the lamp-circuit, thirty ohms. The 2778 lighting-circuit being now divided in two sub-circuits of thirty ohms resistance each, the resistance of the circuit is still fifteen ohms; but the lamp is not yet illuminated. Now, to bring the lamp up to its proper luminosity, the necessary portion of the current of the lamp-circuit must be turned into the illuminating-conductor of the lamp. This is done by turning the lever D to the left, cutting out the resistances O O O O O until the desired degree of luminosity is reached.

It will thus be seen that the lamp-lighter of our invention not only prevents the too sudden heating of the carbons, but practically obviates the disturbing influence of great changes in resistance which have heretofore accompanied the lighting or extinguishing of a lamp; and it will also appear that, inasmuch as the sub-circuits unite at K^2, the united current passes through the safety-switch to the point z' by way of the spring y, lever V, standard W, and magnet U, so that in case of an excess of current in the lamp-circuit the magnet U will be unduly energized and attract the armature, by which the lever x will be released and the circuit broken, thus cutting the lamp out of circuit; and it will be observed, also, that there is a constantly-closed shunt-circuit, c', around the lamp, so that in case the lamp-circuit be broken, or in case of an abnormally-great electrical resistance in the lamp, its machinery, or circuit, the current will be increased in the shunt c' around the lamp, leaving that particular lamp out of circuit, or to go out, without materially affecting any of the other lamps in circuit, the current being automatically transferred from the circuit B' to the shunt c' without interruption, the resistance in the shunt c' being at least equal to the resistance in the lamp-circuit B'.

It will of course be understood that to prevent the lamp from being cut out of circuit by the safety-switch U V W x y, unless the current becomes abnormally great, the retractile strength of the spring V^2 must be made equal to the attracting force of the magnet when the lamp has all the current it will bear with safety. It will also be understood that the shunt-circuit c' and the circuit B' are both closed, whether the lamp is illuminated or not, so that in case there is the least obstruction in the circuit of the lamp the current will be correspondingly increased in the shunt, leaving the circuit constant in all the other lamps. Again, if there is an excess of current it will be divided, a portion going through all the shunts and a portion through all the lamps in circuit.

In the lamp of our invention described in letters patent of the United States No. 205,144 a small piece of carbon is heated to incandescence in an atmosphere with which it will not chemically combine.

Other attempts to produce such a lamp have been made; but, among other things, it has been found almost impossible to prevent fracture of the carbon. The fracturing of the carbon is mainly due to sudden changes of temperature. While it becomes soft and pliable under the great heat of the current, at ordinary temperature it is extremely brittle, and instantaneously heating it from its normal condition to a very high temperature tends to disrupt the particles and establish the voltaic arc, by which in a moment the carbon is destroyed. Our lamp-lighter also avoids this difficulty.

To avoid undue electrical heating from accidental or other cause in the conductors, and the great resistance occasioned by the heating of a conductor, especially in the form of rheostats, we construct our artificial circuits, rheostats, or resistances R of flat or ribbon wire, in order that they may present considerable radiating-surface, and thereby keep cool when otherwise they might be melted by excessive heat.

The application of the lamp-lighter and cut-off or safety-switch to electric lamps in which the light is produced by the voltaic arc by removing resistances from the circuit or cutting lamps out of circuit in proportion as the carbons separate or the resistance becomes too great will be comprehended without further explanation.

Recurring now to Fig. 5, in which we have shown more than one branch from a single source of electricity and more than one lamp in each branch, we are aware that it is not new to place a number of lamps in series in the circuit of a generator, or to divide the current among several conductors each containing a single lamp, or to divide the current among several cross-branches each containing a single lamp. But besides other points of novelty described in this specification, it is new with us to divide the current among several conductors or several cross-branches each containing two or more lamps, as it is also new to associate each lamp with two constantly-closed circuits having an electrical resistance at least equal to the lamp or group of lamps; and it is also new to associate an automatic safety-switch or cut-off with the shunt around each lamp or group of lamps, to cut it out of circuit automatically in case of accident to the lamp or group of lamps without sensibly affecting any other lamp or group of lamps in the system, excepting that lamp or group of lamps with which the safety-switch is associated in the shunt embracing it or them; and, lest one of the principal features of our arrangement may not be apparent, we will proceed to explain the same more in detail.

It is well understood, first, that to produce a good electric light a current of electricity combining considerable quantity with considerable intensity is indispensable; second, in dividing the electric current among a large number of lamps, if there is a conductor from the generator to each lamp or a cross-branch to each lamp, the quantity of current supplied must be very great, and in the event of a short-circuit occurring in any lamps the result 2779 would be disastrous to the lamp, if it would not extinguish all the other lamps; third, in placing a large number of lamps in series, each lamp having a considerable resistance, the intensity of the current, in order to overcome the combined resistance, must be very great, and to obtain the proper intensity of current in each case is far more expensive than it is to obtain a current of great quantity with less intensity, as in the case of our invention.

To illustrate the disadvantage attending the placing of very many lamps in series, let it be assumed that there are one hundred lamps in circuit, and that the resistance of each lamp is ten ohms, then the combined resistance of all the lamps is one thousand ohms, which, in the service of current for electric lighting, is inconvenient, if not impracticable; and, moreover, if the circuit is broken in one of the lamps, the effect is to extinguish all the rest. Now, instead of placing the one hundred lamps in series, assume that there are one hundred conductors, and that in each conductor there is placed one lamp of ten ohms resistance. Then the joint resistance of the one hundred lamps will be but one-tenth of an ohm, not to mention the wear and tear upon the generator of so slight a resistance; and in case the lamp in any one of the conductors is short-circuited, so as to cut out the resistance of the lamp and its machinery, the resistance of that conductor will be *nil*, while the resistance of the other conductors having their lamps intact will remain constant. The current will then flow through the conductor of least resistance, the effect of which will be to extinguish all the other lamps in the remaining ninety-nine conductors. If to avoid this we increase the resistance of the conductors artificially or otherwise outside of the lamps, we simply waste current in overcoming the added or artificial resistance. Adopting, finally, our plans, let it be supposed that there are ten conductors or cross-branches leading from the generator, each containing ten lamps of ten ohms resistance each. The combined and joint resistance of the circuit of the generator is ten ohms, $\frac{10 \times 10}{10} = 10$. This resistance of the circuit is better suited to the generator, and should a lamp short-circuit the result would not be disastrous; on the contrary, it could hardly be detected. The very slight proportion of current taken from ninety lamps in the nine perfect conductors and the very slight proportion of current added to nine lamps in the conductor containing the short-circuiting lamp would have no appreciable effect upon either the ninety or the nine.

Referring again to the lamp-lighter, it is apparent, first, that there may be any number of resistances O in each lighter of any number of ohms or parts of ohms resistance each; second, that a portion of the current is turned out of circuit c' by turning the lever D to the extreme right; third, that in transferring the current into the circuit of the lamp the resistance of the conductor to the lamp will decrease, while the resistance in the shunt-circuit remains constant, the resistance K' becoming operative as the circuit is turned into the lamp; fourth, that everything in the lamp-lighter, excepting the bar A, lever D, resistances O O O O O, and lamp Q', may be omitted and still have an operative apparatus, since the resistances O may be increased to any extent, so that when they are all in circuit the current will be too weak to heat the carbons, while by turning them out the lamp can be illuminated to any degree of luminosity.

By Fig. 6 of the drawings is fully shown the relation and connection of the lamp-lighter, the automatic cut-off or safety-switch, the combination of conductors and circuits, and the several lamps in the circuits; and by the foregoing specification, taken in connection with the accompanying drawings, the arrangement and combination of the circuits, the construction and operation of the lamp-lighter and the automatic cut-off or safety-switch, of themselves and in relation to each other and to the circuit and lamps, will be readily understood, and by said description and drawings it will appear to any one skilled in the art or science of electricity that our invention embraces and includes the following new and useful features, parts, and combinations of parts, all of which and the object of which are described or suggested in the following claims—that is to say,

We claim—

1. In an electric lighting system, the combination of a generator of electricity which is the common source of supply for the system, two or more conductors, and two or more electric lamps in each of said conductors, or in circuits derived therefrom, substantially as described, for the purpose specified.

2. In an electric lighting system, the combination with the circuit of resistance consisting of wire having great radiating surface and having the several coils or convolutions composing the same held

apart to facilitate the access of the air and the escape of the heat, substantially as described.

3. In an electric lighting system composed of a number of lamps connected in circuit, an automatic electric safety-switch combined in the lighting-circuit of each lamp, and through which the current of said circuit flows to the other lamps in circuit, said safety-switch being connected to its own lamp and to the other lamps in circuit to disrupt the circuit of its particular lamp in case of an excess of current therein, leaving the circuit of the remaining lamps intact.

4. With each lamp-circuit B′ of an electric lighting system, the combination of a shunt, c', and an electric safety-switch, the shunt and lamp-circuit each providing a closed path for the current at the same time, one through and one around the lamp, and the safety-switch operating to cut the lamp out of circuit in case of an excess of current either in the lamp or in its shunt-circuit.

5. With the lamp-circuit, the combination of a closed shunt-
2780 circuit containing a resistance at least equal to the resistance
of the lamp, and an automatic electric safety-switch with each lamp, the shunt to furnish a path for the current in case of an abnormal resistance in the lamp, the resistance to keep the current in the lamp when the flow is normal, and the safety-switch to cut the lamp out of circuit in case of an excess of current therein.

6. In combination with a constantly-closed lamp-circuit, B′, having resistances O combined therewith, a constantly-closed shunt-circuit, c', having resistances K L, and a lighting-switch, A D, the switch coacting with the two closed circuits and the resistances thereof to gradually transfer the current from one closed circuit to the other for the purpose of gradually illuminating and extinguishing the lamp, substantially as described.

7. In an electric lighting system, a lighting-circuit conductor, n, divided at $z\ z$, between which points of divisions the lamps are placed, one branch of said divisions provided with a resistance, R, to divert the necessary current into the other divisions forming the lighting-circuit, said lighting-circuit consisting of a lamp-circuit, B′, and a shunt-circuit, c', containing a resistance at least equal to the resistance of the lamp-circuit, and combined with a lighting-switch, substantially as described.

8. In an electric lighting system, an electric lamp and a lamp-lighting switch combined in a divided conductor, forming two closed circuits, q and n or q and p, for the current at the same time, one through and one around the lamp, the lamp-circuit B′ being also provided with a shunt-circuit, c', and combined with an electric safety-switch energized by a part of the current in the system, and that cuts the lamp out when from any cause there is an excess of current in the lamp or shunt-circuit, or in both.

9. In an electric lighting system, the combination, with a main-circuit conductor, n or p, of a shunt-circuit, q, divided in two sub-circuits, B′ and c', both of which are provided with resistances, and are constantly closed for the passage of current, and with one of which the lamp is also combined.

10. In an electric lighting system, the means substantially herein

described of cutting the lamp out of circuit when from any cause there is diverted from the lighting-circuit *n* or *p* an abnormally-great current in the shunt-circuit *q*, which means consist of an electric safety-switch combined with each shunt *q* and each lamp Q′, and which is called into action to cut the lamp out of circuit by any excess of current in the shunt-circuit sufficient to increase the attracting powers of the magnet of the switch until it overcomes a given counteracting force on the armature.

11. In an electric lighting system, a lighting-circuit, *n* or *p*, in which are combined a resistance, R, and a divided shunt-circuit, B′ and *c*′, having equal resistances, and an electric lamp, Q, so that the resistance R will divert a portion of the current into each division of the shunt-circuit.

12. In an electric lighting system, a lighting-circuit in which are combined a divided shunt-circuit around the lamp, a by-circuit including the lamp, and a lighting-switch, substantially as described.

13. In an electric lighting system, a lighting-circuit in which are combined a divided shunt-circuit, an electric lamp, and a safety-switch, substantially as described.

WM. E. SAWYER.
ALBON MAN.

Witnesses:
AMOS BROADNAX.
WM. H. BROADNAX.

2782

CONSOLIDATED
vs.
MCKEESPORT.

COMPL'T'S EXHIBIT SAWYER MAN REGULATOR PATENT. W. T. F., S. E. March 28, 1889.

UNITED STATES PATENT OFFICE.

WILLIAM EDWARD SAWYER, of New York, and ALBON MAN, of Brooklyn, N. Y.

Improvement in Regulators for Electric Lights.

Specification forming part of Letters Patent No. 205,305, dated June 25, 1878; application filed May 25, 1878.

To all whom it may concern:

Be it known that we, William Edward Sawyer, of the city, county, and State of New York, and Albon Man, of the city of Brooklyn, county of Kings, and State of New York, have invented certain new and useful improvements in regulators for electric lights, of which the following is a full, clear, and exact description.

The objects of our invention are, first, to supply to an electrical circuit or circuits containing electric lamps an absolutely uniform volume of current, in order to obviate the unsteadiness which has characterized most attempts at distribution; second, to supply, automatically, only so much current as may be necessary to meet the demand, thereby insuring the economical and satisfactory operation of a distributing system; and, third, when the demand for the current is lessened or increased by the removal of lamps from or their introduction into the circuit or circuits supplied by the generator, to cut off steam from, or add steam to, the engine driving the generator, in order that there may be no waste of power when the demand for the current calls for a limited application of it merely.

(Here follows diagram marked p. 2781.)

Referring to the drawings accompanying and forming a part of this specification, figures 1 and 3 are views of our electrical regulator and circuits connected therewith, and Figs. 2 and 4 are separate views of parts thereof.

The regulator of our invention so controls the steam or other power actuating the generator of electricity that this power is increased or diminished as the demand for the current is increased or diminished; and, while we have shown the result as accomplished in one way, we do not confine ourselves to the precise apparatus and the manner of its operation shown and described.

We prefer to place a sensitive magnetic apparatus in the circuit of the generator, which, when a lamp is lighted, so to speak, au-

No. 286.
C. E. Light Co.
v.
McK. Light Co. } p. 2781.

W. E. SAWYER & A. MAN.
Regulator for Electric-Lights.

No. 205,305. Patented June 25, 1878.

Fig. 1.

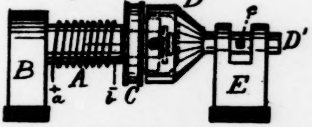

Fig. 2.

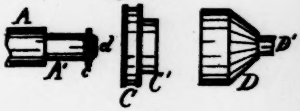

Fig. 3.

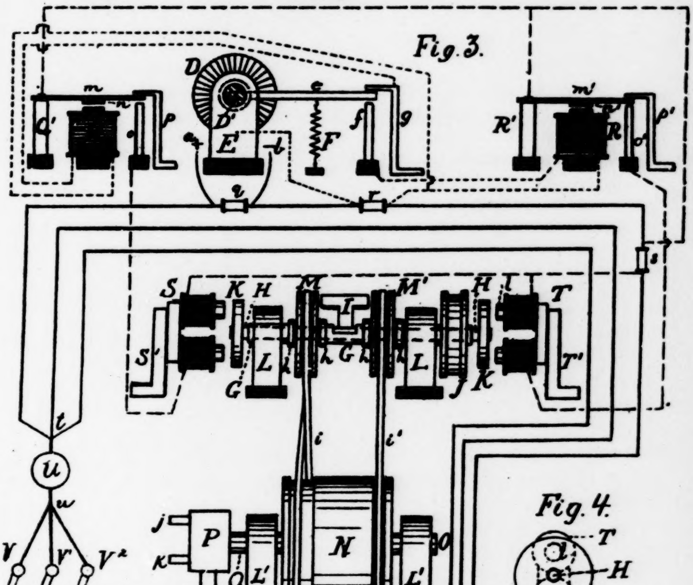
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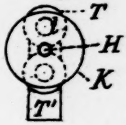
Fig. 4.



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G. M. Stratton
Wm. H. Church,

Inventors:
W. E. Sawyer
Albon Man

tomatically takes cognizance thereof, and supplies that quantity of steam to the engine which is necessary to drive the generator at that speed which will give the exact required volume of electricity. We may so arrange our apparatus, however, that the regulator shall start different generators or couple different parts of a single generator in circuit, as may be required to supply the current; or we may arrange the regulator to control the current by the automatic changing of resistances. We may, in fact, in many ways, naturally suggestive, vary the application of our invention; and hence we do not limit ourselves to the employment of any special form of apparatus.

Referring to the drawings, figure 1 is a side view of the primary features of the regulator.

A is a single round iron bar, held in standard B, and provided with a journal, A′, also of iron, upon which journal, driven by any power having uniformity of motion, is a pulley, C, also of iron, provided with a flange or hub, C′. The motive-power driving pulley C we have not deemed it necessary to illustrate, inasmuch as it may be in the form of a clock-work or any power whatever derived from any source whatever, the only requisite being uniformity of motion.

The pulley C is held in place by washer *c*, secured by screw *d* entering the end of journal A′. If desired, the journal A′ may be provided with a thin bushing of Babbitt or other anti-friction metal; but, as such a bushing is not essential to the practical operation of our invention, we have not shown it in the drawings.

Closing over the flange C′, but not touching it, is an iron cap, D, hollowed out, as indicated by the dotted lines, whose shaft D′ has its bearings in standard E, in which it is free to turn. In Fig. 2 these several parts are shown disconnected.

The bar A is wound with conducting-wire *a b*, in the ordinary manner, so as to render the bar an electro-magnet.

Referring to Fig. 3, in which is given a partial end view of the before-described apparatus, *e* is a metal lever let into shaft D′, the extremity of which plays between the two contacts *f* and *g*. F is a retractile spring, (or it may be a weight,) capable of any adjustment,
by means of which the lever *e*, when no counter force is ex-
2783 erted, is held in contact with standard *f*. The pulley C is re-
volved in the direction opposite to that of the retraction of spring F. The speed of its rotation may be anywhere between one hundred and two thousand five hundred revolutions per minute.

The bar A becoming a magnet by reason of the current circulating in the coils *a b* the journal A′, pulley C, and hub C′ also becomes magnetic, and the tendency of the hub C′ is to attract the cap D in the direction of rotation of the pulley C, and thus to overcome the retractile force of spring F. The spring F is so adjusted that when the required strength of current is supplied by the generator, its retracting effect is exactly balanced by the counter attraction of the revolving magnetic hub C′, and the lever *e* remains counterpoised between the two contacts *f g*, touching neither of them, which is the normal position of the lever.

Referring now to Figs. 3 and 4, G is a hollow shaft, constantly revolving in standards L L, the motive power, of any kind whatever, being applied through the pulley J. Upon the shaft G, held in position by ferrules *h h h h*, are two loose pulleys, M M′, over which pass the belts *i i′* to drum N, provided with grooves N′ N′. Belt *i* is crossed, and belt *i* is run in the ordinary manner. Thus the drum N on shaft O, whose bearings are in standards L′ L′, revolves in one direction or the other, accordingly as pulley M or pulley M′ is actuated by shaft G.

Passing loosely entirely through hollow shaft G is a second shaft, H, upon each end of which is an iron disk, K. The shaft G is slotted near the middle, and through the slot the T-shaped piece I is fixed to the inner shaft H, whereby the inner shaft is caused to rotate with shaft G. The T-shaped piece I serves to impart motion to the loose pulleys M and M′, accordingly as it is drawn to the right or to the left, by the right or left movement of the inner shaft H, and thus caused to impinge upon one pulley or the other. The iron disks K, constantly revolving, constitute the armatures of electro-magnets S and T, fixed to standards S′ and T′. They rotate before the pole ends *l* of the magnets, and are attracted to the left or to the right, accordingly as magnet S or magnet T is actuated. If to the left, the T-shaped piece I is caused to impinge upon pulley M, and the drum N revolves in one direction. If to the right, the pulley M′ is actuated, and the drum N revolves in the opposite direction.

The shaft O of drum N enters the steam-chest P on standard P′, *j* and *k* representing the pipes leading thereinto and therefrom. By the rotation of this shaft steam is let into or cut off from the engine (not shown) which drives the generator U. The valve arrangements for the letting in or cutting off of steam we have not designed to show, the same constituting no part of our invention, and steam-cut-off valves being well-known mechanical devices. We remark, however, that the shaft O may operate upon the valve or valves by means of a screw or lever movement, or rotating or sliding ports.

The apparatus, Fig. 1, being preferably delicate, and the contacts between the lever *e* and standards *f* and *g* correspondingly light, we have thought it best to resort to relay-magnets Q and R to establish the circuits of magnets S and T. The armatures *n* and *n′* are fixed to spring-levers *m* and *m′*, attached to standards Q′ and R′. When no current is circulating in the coils of the magnets Q and R, the levers *m m′* bear against the stop-standards *p p′*; but when these magnets are actuated their levers are brought into contact with standards *o o′*. The three resistances *q r s* serve to divert the required portions of the current from generator U into the several local circuits.

V, V^1, and V^2 are three switches, whose studs W, W^1, and W^2 are connected, respectively, with the electric lamps or other apparatus, X, X^1, and X^2.

The operation of our invention is as follows: The lamp X is put in circuit by switch V, (which, we remark, is not essential, as it and the lamp may both be omitted from this branch,) and the engine (not shown) which drives the generator U being set in motion, a current of electricity is generated in the circuit of the lamp X, indicated by the unbroken line, branching from the generator at the points *t u*. In this branch are the three resistances *q r s*. By means of the resistance *q* a portion of the current is diverted into the coils *a b* of magnet A, and the speed of rotation of the pulley C being independent of the speed of the engine, and a uniform motion in itself, it follows that if the retractile force of the spring F is adjusted so as to be exactly counterbalanced by the magnetic force of the hub C′ acting upon the paramagnetic cap D, the lever *e* will remain in a counterpoised position between the two contacts *f g*, touching neither of them.

Let it now be assumed that the engine increases its speed, or that from any other cause too much electricity is supplied to the circuit, the magnetic attraction of hub C′ for the cap D overbalances the retractile force of spring F, and the lever *e*, rising, makes connection with contact *g*. The current used through this connection is diverted by resistance *r*, as shown by the dotted lines, the connection of the lever *e* with contact *g* causing it to flow from one side of the resistance through the standard E, shaft D′, lever *e*, contact *g*, magnet Q, and thence to the other side of the resistance. The result is that armature-lever *m* is attracted, contact is made with standard *o*, and the current used through this connection is diverted by resistance *s*, as shown by the broken or dash lines, into magnet S. The disk-armature K of that side is attracted, and, T-piece I impinging upon pulley M, drum N is rotated in one direction, and less steam is supplied to the engine, the effect of which is to drive the generator at a reduced speed, and consequently to supply less current to the circuit.

2784 Assuming, on the other hand, that the engine decreases its speed, or that from any other cause an insufficient volume of electricity is supplied to the circuit of lamp X, the magnetic attraction of hub C′ for the cap D is overbalanced by the retractile force of spring F, and lever *e*, falling, establishes connection with contact *f*. The result is that magnet R is actuated, lever *m*′ makes contact with standard *o*′, magnet T is actuated, and, T-piece I impinging upon pulley M′, that pulley is caused to rotate with shafts G and H; and drum N turning in the direction opposite to that in the first instance, more steam is supplied to the engine, the speed of the generator U is increased, and a greater volume of electricity is supplied to the circuit.

Now let switch V^1 be moved upon its stud W^1, lamp X^1 is put in circuit. The two circuits of lamps X and X^1 being of equal resistance, but one-half as much current is now supplied to the coil *a b* as in the first instance; and hence lever *e* makes connection with contact *f*, and, through the actions before noted, more steam is supplied to the engine; and the generator U being driven at greater speed, the equipoise between the attraction of magnet A and the retraction of spring F is quickly established. The same may be said of the placing of the lamp X^2 in circuit, the division of the current lessening its force in the circuit of lamp X, and augmentation immediately following.

When the circuits are parallel circuits, as shown, and the current is divided among them, it may be preferable to arrange the drum N so as to increase the quantity of current supplied, by coupling together several generators or parts of a single generator, rather than to increase the speed of the engine.

When the lamps are arranged in series, so that the current passing into and out of one lamp enters another, and so on, the introduction of a lamp, inasmuch as it increases the resistance of the circuit, and thus renders an increase in the tension of the current necessary, should preferably have the effect of increasing the speed of the generator.

Having thus fully described our invention, what we claim as such, and desire to secure by letters patent, is—

1. In an electrical regulator, the combination of two paramagnetic parts, C′ and D, operating substantially as set forth.

2. In an electric lighting system, a generator of electricity, two or more electric lamps supplied thereby, and an independent electromagnetic switch or regulator, energized by the current from the generator, and acting automatically upon the occurrence of any change of electrical condition in the circuit or circuits supplied, to allow of a corresponding change in the quantity or intensity of the current generated.

WILLIAM EDWARD SAWYER.
ALBON MAN.

Witnesses:
P. M. STRATTON.
WM. H. CHURCH.

2786

Consolidated
vs.
McKeesport.

Compl't's Exhibit Sawyer-Man Electric Meter Patent.
W. T. F., S. E. March 28, 1889.

United States Patent Office.

William E. Sawyer, of New York, N. Y.

Improvement in Electric Meters.

Specification forming part of Letters Patent No. 210,151, dated November 19, 1878; application filed October 17, 1878.

To all whom it may concern:

Be it known that I, William Edward Sawyer, of the city, county, and State of New York, have invented a new and useful electric meter; and I do hereby declare the following to be such a description of the same, reference being had to the accompanying drawing, making part of this specification, as will enable any one skilled in the art or science to which it appertains, or with which it is most nearly connected, to make, construct, and use the invention.

In letters patent of the United States No. 191,111, heretofore granted to me as sole inventor, and in other letters patent No. 205,303, granted to me and to Albon Man, of Brooklyn, and State aforesaid, as joint inventors, certain methods of dividing the current from a single generator among two or more electric lamps, or other electrical apparatus, are fully shown and described.

The object of my present invention is to provide a meter or register of the current expended in the production of electric light as applied to an electric lamp or group of lamps, and such a device being entirely new in the arts I intend to claim it broadly, not only as a meter or register, but in its combination with an electric light; and I do not confine myself to any particular device or arrangement of parts.

The meter I prefer is one which indicates with dial-hands the current expended, in which respect the apparatus of my invention does not differ from an ordinary gas-meter; and I prefer to actuate it by electro-magnetism, although I have very fully considered apparatus for registering by marks or indentations made upon a roll of paper, and mechanism energized by the expansion of metallic conductors from electrical heading.

The best form of electric-light meter I have found to be that of a time-meter—that is to say, I prefer as a meter one which operates to record the time during which a lamp is lighted rather than the quantity of current used, since the quantity of current being easily determined the element of time is the prime factor in ascertaining the amount of current consumed. Therefore I would place in a building supplied with electric lamps a meter which should indicate exactly how many hours in a given period these lamps may be lighted—viz., a meter which, if there are ten lamps in a building, and each of them is run for ten hours, would indicate a use of one hundred hours.

It is presumable that at least as often as once a month the record will be noted, and I prefer to actuate the mechanism by an ordinary clock-work, which shall be wound up once a month, although it is clear that I may employ a clock-work actuated by the electric current which operates the lamps, and which shall never require winding up.

For the sake of simplicity, I have shown in the drawing only the salient parts of my invention, omitting the clock-work as being a well-known apparatus, and also omitting—what will naturally suggest itself—a protecting-cover and lock, to render the apparatus accessible only to the proper parties.

(Here follows diagram marked p. 2785.)

Referring now to the drawing accompanying and forming a part of this specification, D is a metallic cylinder, fixed to shaft D′, which is provided with suitable bearings, (not shown,) and rotated by the clock-work, of which the reciprocating balance-wheel A, (or it may be a pendulum,) actuated in one direction by spring B, the nature of which is so clear as to render explanation unnecessary, constitutes the governor.

The cylinder D is provided with as many metallic contact-pins, E, set spirally, as there are lamps whose operation is to be registered; and these pins, as the cylinder is rotated in the direction of the arrow, make connection when the lamps are in operation with the spring armature-levers F of electro-magnets G.

When there is no current flowing in the coils of magnets G, the levers F are forced by springs I away from the magnets to contact with the stops H, so that the pins E may pass without making connection with the levers. All of the armature-levers F work freely upon shaft J, held in appropriate standards. (Not shown.)

Running along under the outer ends of the levers F is a metal strip, K, fixed to shaft L L, which, when the magnets G are not energized, is forced upward by spiral spring P, acting against arm L′ fixed to shaft L L. To this metal strip K is fixed an arm, M, carrying a light flat spring, N, to which is fixed a bent piece, O, the object of which will soon be made apparent.

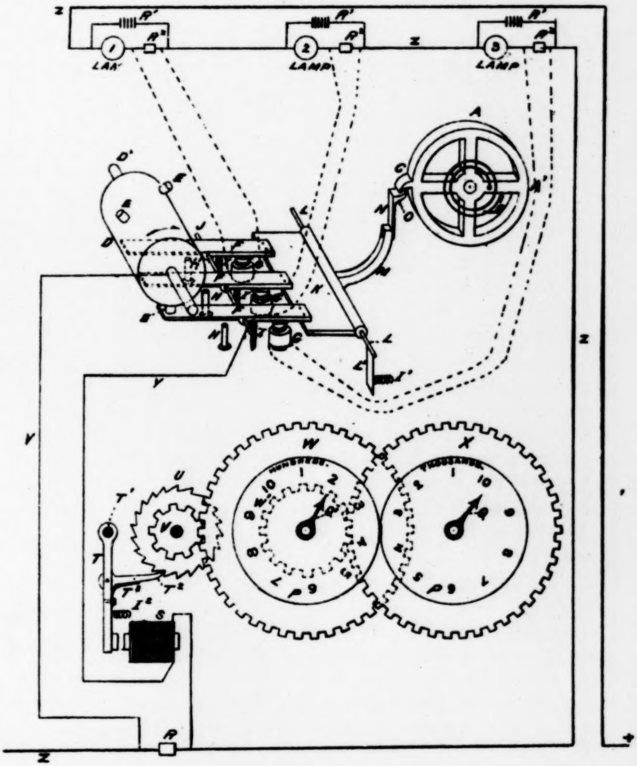
The current entering at the — point taverses a resistance, R, passes
through the several lighting apparatus of lamps 1, 2,
2787 & 2788 and 3, and thence outward at the + point. R^1 R^1 R^1
represent the lamp-lighting apparatus. (Shown in letters patent of the United States, number as aforesaid, heretofore granted to me as sole inventor, and to me and to Albon Man as joint inventors, number as aforesaid.)

The resistances R^2 R^2 R^2 serve when a lamp is lighted, to direct

No. 286.
C.E. Light Co. } p. 2785
2.
McK. Light Co.

W. E. SAWYER.
Electric-Meter.

No. 210,151. **Patented Nov. 19, 1878.**


Z
R¹
R²
LAMP
A
C
D¹
E
D
J
F
H
L
N
O
K
G
I¹
Y
W
X
HUNDREDS
THOUSANDS
U
V
T¹
T
T²
T³
I²
S
R
+

WITNESSES.

Thomas Smith
Amos Broadnax

INVENTOR.

W. E. Sawyer.

a portion of the current through the coils of the electro-magnets G G G, the currents being as shown by the broken lines.

To understand the operation of my invention, let it be assumed that the lamps are not actuated. The magnets G not being energized their armature-levers F are raised, and the strip K, also being raised, holds the bent piece O in the path of the bent piece C, fixed to the chronometer-balance A, and the motion of the clock-work, (not shown,) and consequently of cylinder D, is stayed. At this point a lamp is lighted; instantly one of the magnets G is energized, its armature-lever F is attracted, and, coming in contact with the strip K, the strip K is depressed, bent piece O thrown to the left, and an impetus imparted to the chronometer-balance by reason of the effort of bent piece O to disengage itself from bent piece C. The bent piece O no longer being in the path of C, the balance A begins and continues its reciprocating motion, passing from the position shown in the drawing to that in which the point C reaches the point A′, and thence back again, thus permitting the cylinder D to rotate in the direction of the arrow.

It makes no difference which of the armature-levers F is actuated; any one (or all of them together) serves to set the clock-work in motion. It will be clear that the clock-work may be kept continually in motion; but I have preferred that the clock-work shall run only so long as the lamps are run.

Let it be now assumed that the lamps are all extinguished. There being no magnet G energized, and no levers F depressing the strip K, the bent piece O drops into the path of C, which, as the balance A carries it to the left, rides over piece O by the yielding of spring N, and the motion of the clock-work is stopped.

The effect of the rotation of the cylinder D is as follows: By means of the resistance R, a portion of the current of the branch or main — +, when a pin, E, makes connection with a lever, F, as shown by the circuit of the light lines, is caused to energize an electro-magnet, S, the current passing from one side of R to the cylinder D, thence by way of a pin, E, to a lever, F, and thence by way of shaft J to the magnet S and armature to the other side of R. If but one lamp is lighted the magnet S will be energized but once in a revolution; if two are lighted it will be energized twice, and if three are lighted, three times, and so on. At each action of the magnet S its armature-lever T, pivoted at T^1, is attracted against spiral spring I^2, and by means of pawl T^2, held upward by spring T^3, causes the ratchet-wheel U to rotate one tooth. Thus if but one lamp is in operation the ratchet U will move but one tooth in one revolution of the cylinder D, and if all the lamps are in operation the ratchet will be constantly rotated by the constant vibration of armature-lever T.

The operation of the remainder of the apparatus is self-apparent, there being as many gears and pinions, hands, and dials as may be desired. The pinion V, fixed to ratchet U, actuates gear W; and pinion W′, fixed to gear W, actuates gear X. The hands Q and Q′ indicate upon the dials P P the current expended.

To properly estimate the "consumption" of current, so to speak, a lamp should be operated for a given number of hours, and the indication upon the dials noted. A single lamp operated for the same length of time will invariably present the same record, and two lamps will present a record of twice the value of one lamp, and so on, to any extent desired.

Having thus described my invention, I claim and desire to secure by letters patent—

1. In a system of two or more electric lamps or groups of lamps, an electric meter consisting of a registering apparatus and a rheotome or circuit-breaker driven by clock-work or other well known mechanical appliances, and operating to intermittently actuate the registering apparatus, when a lamp or lamps, or a group of lamps, is lighted.

2. In a system of two or more electric lamps or groups of lamps, an electric meter consisting of a registering apparatus and as many separate electric parts or apparatus connected to the lamps or groups of lamps as there are lamps or groups of lamps in circuit, each of said electrical parts or apparatus being separately connected with its respective lamp or group of lamps, and each separately actuating the register.

3. In an electric meter, the combination of two or more electromagnets, G G, and their armatures, the action of any one or more of which will start the register and denote the time any one or more lamps of a series is illuminated and the amount of current consumed in that time by each lamp.

4. In an electric meter, a separate electro-magnet, S, and its armature, by which the registering device is operated, in combination with one or more electro-magnets, G, by which the machinery of the meter is started, the two magnets to be connected, substantially as described, by which a series of electric impulses through G are successively concentrated upon S and made to register the current of each lamp in the series.

5. The combination, with two or more electric lamps or groups of lamps, of a single registering-meter, common to all of them, constructed to register for each and all of the lamps, substantially as shown and described.

WILLIAM EDWARD SAWYER.

Witnesses:
THOMAS SAULT.
AMOS BROADNAX.

2789 COMPLAINANT'S EXHIBIT SAWYER AND MAN BRITISH PATENT No. 4705 OF 1878.

A. D. 1878, 19th November. No. 4705.

Specification of Frederick John Cheesbrough.

Distributing, regulating, and applying electric currents for lighting, &c.

Printed by order of the commissioners of patents for inventions.
London: Published and sold at the commissioners of patents' sale department, 38 Cursitor street, Chancery lane, F. C. 1879. Price, 1s.

2790 A. D. 1878, 19th November. No. 4705.

Distributing, Regulating, and Applying Electric Currents for Lighting, &c.

Letters patent to Frederick John Cheesbrough, of the office for patents, 15 Water street, Liverpool, in the county of Lancaster, consulting engineer, for the invention of "An improved method or system of distributing, dividing, regulating, controlling, and measuring electric currents in the practical application of the same to electric lighting and other useful purposes." A communication from abroad by William Edward Sawyer, of New York city, county, and State, and Albon Man, of Brooklyn, county of Kings, State of New York, United States of America.

Sealed the 21st February, 1879, and dated the 19th November, 1878.

Provisional Specification Left by the said Frederick John Cheesbrough at the Office of the Commissioner of Patents on the 19th November, 1878.

Frederick John Cheesbrough, of the office for patents, 15 Water street, Liverpool, in the county of Lancaster, consulting engineer. "An improved method or system distributing, dividing, regulating, controlling, and measuring electric currents in the practical application of the same to electric lighting and other useful purposes." (A communication from abroad by William Edward Sawyer, of New York city, county, and State, and Albon Man, of Brooklyn, county of Kings, State of New York, United States of America.)

In order that this invention may be fully understood I have hereunto attached three sheets of drawings which illustrate the said invention, and in what manner the same is to be performed, reference being had to the drawings which are marked with letters and figures of reference corresponding with those in the following specification.

The object of this invention is to obtain a perfect distributing division, regulation, and mensuration of electric currents, as applied particularly to electric lighting, although the practical application of the invention is not limited to electric lighting apparatus, it being equally applicable to many other well-known electric apparatus.

The said invention consists of several parts to be hereinafter described, the several parts appertaining more or less to each other, and all contributing to the complete system, the several parts being novel, as well in themselves as in their combination into a system as a whole.

Part first of this invention consists—

Firstly. Of a novel method and apparatus by means of which electrical circuits containing electric lamps are supplied with electricity absolutely uniform in volume, and by means of which only so much current as is necessary to meet the demands is automatically supplied, and by means of which the motive power driving the generator is automatically increased or diminished in proportion as the number of lighted lamps is increased or diminished in the circuit of a system.

Secondly. Of a novel distributing system by means of which the current of a single electrical generator may be divided among an indefinite number of lamps.

Thirdly. Of an electric lamp lighting apparatus which not only turns the current on to and off from the lamp gradually, but admits of regulating the light proceeding from the lamp to any desired intensity, and at the same time avoids the danger of fracturing the carbon of the lamp, and of interrupting or changing the resistance of the circuit containing the lamp whenever it is lighted or extinguished.

Part second of this invention consists of an electric apparatus operating to measure the amount of current consumed in a given time by the lamp or other apparatus in circuit.

Part third of this invention consists of a novel method of practically distributing electric currents in towns or cities for the purpose of supplying the street lamps or buildings thereof with electricity in any quantity within the scope of the generator's power.

2791 The foregoing statement of the several parts of this invention, and the following is a detail description of them and of the manner of bringing them in their right relation to each other for operation as a whole, and of the manner of operating them.

(Here follow diagrams marked pp. 2801, 2802, & 2803.)

Part first, reference being had to the drawings:

Figure 1 illustrates an "electric lamp lighting switch," and figures 2, 3 and 4 are diagrams of distributing circuits in connection therewith. Figure 1 consists of a suitable metallic holder A fitted with a groove in its face to carry and hold in position a sliding piece B to which is fixed a flat spring *b*, to one end of which is secured a cross piece *b'*, which, as the slide is moved, makes contact successively with the sixteen pins E, E, and E', E', arranged eight on each side of the spring *b*.

A.D. 1878. Nov. 19. Nº 4705.
CHEESBROUGH'S PROVISIONAL SPECIFICATION.

(3 SHEETS)
SHEET 1

FIG. 1.

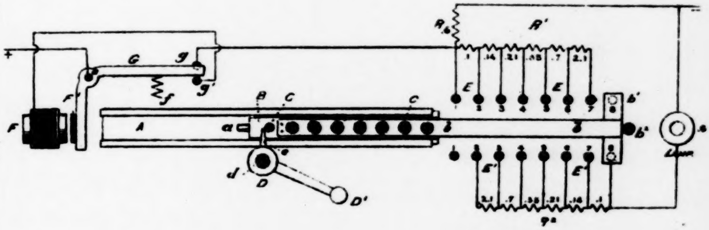

+
−
F
F'
G
g
g'
f
A
a
B
C
C
b
b
b'
b²
D
d
D'
e
R
R'
E
E
E'
E'
1
2
3
4
5
6
7
8
.1
.14
.21
.35
.7
2.1
Lamp

FIG. 2.

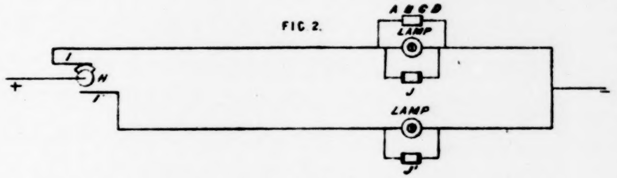

A B C D
LAMP
LAMP
I
I'
H
+
J
J'
−

FIG. 3.

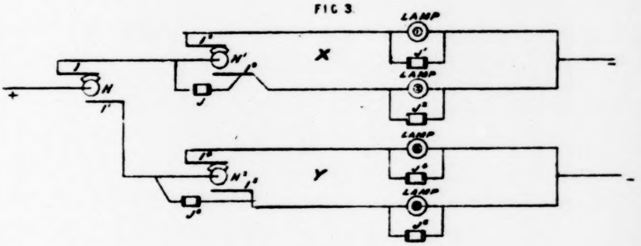
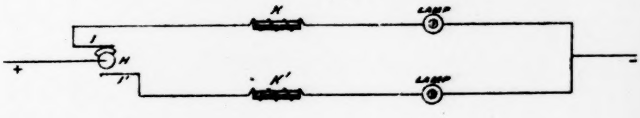

LAMP
LAMP
LAMP
LAMP
I
I'
H
+
I'
H'
J
X
Y
J'
J²
J³
J⁴
−
−

FIG. 4.


K
K'
LAMP
LAMP
I
I'
H
+
−

No. 286.
C. E. Light Co.
v.
McK. Light Co.
} p. 2801

Malby & Sons, Photo Litho.

London: Printed by George Edward Eyre and William Spottiswoode,
Printers to the Queen's most Excellent Majesty. 1879.

A.D. 1878. Nov. 19. № 4705.
CHEESBROUGH'S Provisional Specification.

(3 SHEETS)
SHEET 2.

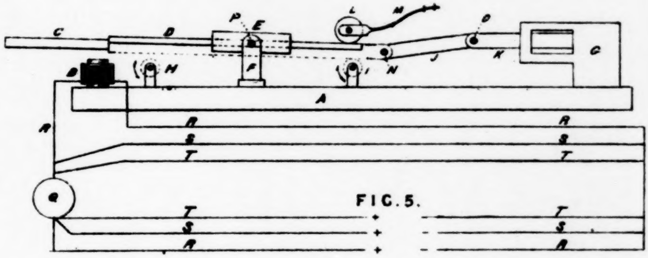

C
D
P
E
L
M
O
G
H
F
I
N
J
K
B
A
R
S
T
Q

FIG. 5.

FIG. 6.

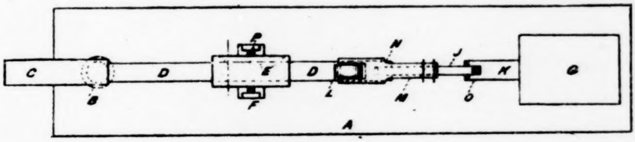
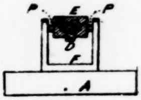

C
B
D
P
E
F
D
N
L
M
J
O
K
G
A

FIG. 7.



No. 286.
C.E. Light Co.
v.
McK. Light Co.
p. 2802

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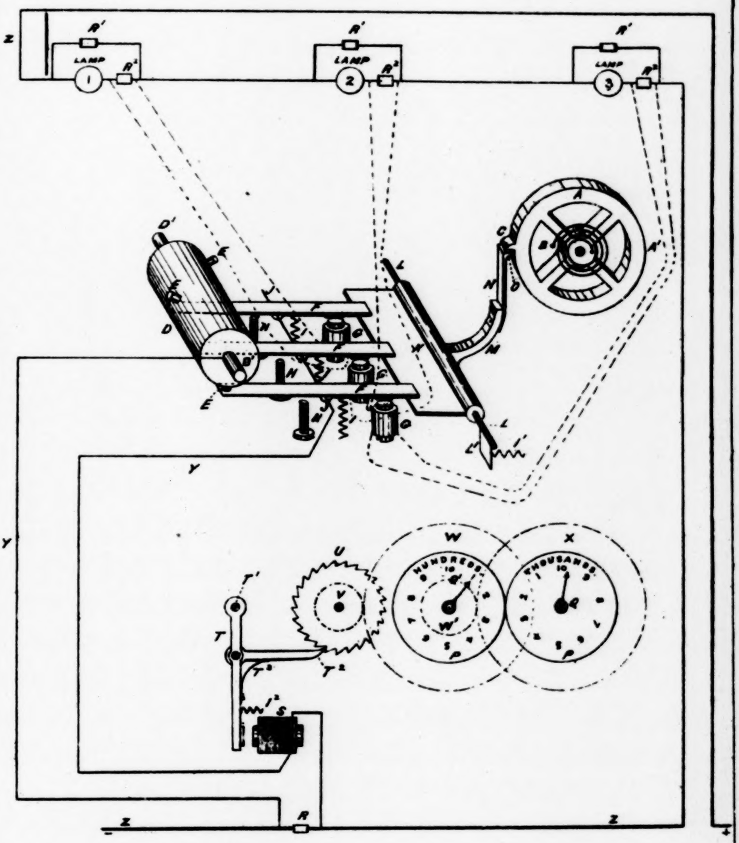
A.D. 1878. Nov. 19. Nº 4705.
CHEESBROUGH'S Provisional Specification

(3 SHEETS)
SHEET 3

FIG. 8.


Z
R'
LAMP
1
R²
R'
LAMP
2
R²
R'
LAMP
3
R²
D'
E
D
B
E
F
G
H
I
K
L
L'
I'
C
A
A'
B
N
O
Y
Y
U
V
T'
T
T²
T³
I²
S
W
HUNDREDS
W'
P
X
THOUSANDS
Q
P
Z
R
Z
-
+

No. 286
O.E. Light Co.
v
Wick Light Co

h 2803

Malby & Sons, Photo-Litho.

London. Printed by George Edward Eyre and William Spottiswoode,
Printers to the Queen's most Excellent Majesty. 1879.

The movement of the slide B backward and forward is accomplished by turning the crank D and D′ which rotates upon a suitable stud *d* set in the frame or bed plate of the switch. At each revolution of the crank the pin *c* fixed in the hub of the crank engages with a tooth C and moves the slide forward one tooth until it has acted upon the last in the slides, when farther motion in that direction is prevented by contact of the cross piece *b*′ with the stop-pin B^2.

Turning the crank in the opposite direction in like manner moves the slide backward until its motion is arrested by contact of the pin *a* with the armature lever G. In lighting an electric lamp it is important to turn on the current gradually, otherwise fractures of carbon burners may ensue. It is possible also that at times when the current is fully turned on to the lamp there may occur an interruption in the supply, extinguishment of the light then follows, and the carbon grows cool. Suppose now that the circuit of the lamp not having been destroyed, but being set for the full force of the current, the supply is suddenly renewed, instantly the illuminating carbon is heated from a low to an exceedingly high temperature, and its fracture may be expected. The electro-magnet F attached to the switch effectually guards against this danger.

Unless the current is circulating in its coils the lamp cannot be lighted, and if there be an interruption in the supply the current cannot circulate in its coils, although the supply may be renewed until the lamp shall first have been taken out of the circuit.

The armature F′ is fixed to the bent lever G (pivoted at *e*), one extremity of which plays between the studs *g* and *g*′, according as the magnet is or is not actuated by the current. The spring *f* acts to force the armature away from the magnet, and establish a connection between the lever G and the stud *g*.

The current from the + side of the generator enters the lever G, and when the circuit is in its normal condition passes by way of the stud *g*′ through the coils of the magnet F to the slide holder A; then by way of the slide B, spring *b*, cross piece *b*′ and the eight pins E′ to the lamp, and outward at the — point. Now a sudden interruption occurs instantly the armature is forced away from the magnet by the spring *f*, and contact of the lever G, with the stud *g* is established. The lamp is now entirely out of the circuit and the current flows solely from the lever through the stud *g* and resistance R outward at the — point.

It is in this position the switch is shown, and the lamp can never be relighted unless the slide B be moved back until the cross piece *b*′ makes contact with pin 1 E when the pin *a* strikes the lever G and forces the armature within the grasp of the magnet, and at the same time establishes a connection between G and *g*′; then if there be a supply of the current the lamp may be lighted by moving the slide B forward, but if there be no supply moving the slide forward will simply release the armature and the lever G will again move to the stud *g*.

It is found that the internal resistance of a properly devised and constructed electric lamp lighted by incandescence is about a sixteenth of an ohm, and it is clearly important to the end that the conditions surrounding other lamps in circuit may not be affected that the 1 resistance of the circuit from the + to — points shall be constant whether the lamp be in or out of the circuit, or whether it be lighted feebly or at its full head. Therefore when the lamp is out of the circuit, i. e., when the cross piece *b′* rests upon the pins 1, 1, the current flows by way of the pin 1 E through the sixteenth of an ohm, resistance R, and outward at the — points. Thus when the lamp is entirely cut out the resistance of the circuit is precisely the same as when the lamp is fully lighted. The pins 1 E′ and 8 E serve no useful purpose other than to keep the cross piece *b′* in position.

Assuming now that it is desired to light the lamp, the current is let on by sevenths, but any other small fraction pursued regularly or varied may be substituted, a single turn of the crank advances the cross piece *b′* upon the two pins 2, 2, and the current divides, six-sevenths of it passing through resistance R′ of one-tenth of an ohm, and resistance R of six-tenths of an ohm outward at — point. The resistance of the first circuit, which we will call the shunt, is therefore .7 ohm, and that of the lamp, 4, .2 ohms, making the resistance from the + point to the — point .6 ohm.

2792 At the next turn of the crank the cross piece b′ bears upon pins 3, 3, and the resistance is as follows:—In the shunt circuit ·84 ohm; in the lamp circuit 2·1 = ·6 ohm. Upon pins 4, 4, the resistance is in the shunt circuit 1·05, in the lamp circuit 1·4, = ·6 ohm. Upon pins 5, 5, the resistance is, in the shunt circuit 1·4, in the lamp circuit 1·05, = ·6 ohm. Upon pins 6, 6, the resistance is, in the shunt circuit 2.1, in the lamp circuit ·84, = ·6 ohm. Upon pins 7, 7, the resistance is, in the shunt circuit 4·2, in the lamp circuit ·7 = ·6 ohm. Upon pins 8, 8, the current no longer flows through the shunt circuit, but solely through the lamp, the resistance of which is ·6 ohm.

To distribute the current from a single generator to two or more electric lamps, engines, or other apparatus we also have recourse to a commu-ator in connection with the generator, which, when there are two circuits from the generator, transmits the electric impulse alternately into each other, and when there are more than two circuits transmits these impulses seriatim into the several circuits.

The method of distribution will be readily understood upon reference to figure 2 of the drawing, in which H is a rotating circuit breaker which alternately establishes and disrupts the circuit from the + side of the generator through the two springs I and I′. Let A, B, C, D, of figure 2, represent the lighting apparatus of figure 1. Now when the spring I is in connection with the rotating commutator disk H the current entering the lamp 1, passes out by way of the point —. The rotation of the eccentric disc now disrupts the current, and by its contact with the spring I′ the current also passing out from the lamp by way of the point —. Were this the whole of the operation the current in each lamp would obviously be intermittent and the light emitted correspondingly so, but by the use of the electric condensers J and J′ the current in the lamp 1 and 2 is rendered continuous, the condensers being so arranged that their discharge through the lamp fills up the gap (so to speak) between the impulses from the generator.

Figure 3 of the drawing indicates many an extension of the plan or method. The impulses from the first commutator H, I, I', are resolved into a continuous current by means of the condensers J and J^3 being directed by means of commutators H', I^2, I^3, and H^2, I^4, I^5, between subcurrents X, Y, and the lamps 1, 2, 3, and 4 provided with condensers J', J^2, J^4, and J^5. It is obvious that this system of subdivision may be continued indefinitely, using one or more condensers, as circumstances may require, for any number of lamps. In figure 4 of the drawings there is substituted for a condenser in a shunt circuit electro magnets or inducing coils K and K' in the direct circuit, the impulses from the commutator, while actuating the lamps, charge the coil. Upon cessation of the impulses the coil discharges a current of the same direction as that which actuated it. The current in each of the circuits is thus rendered continuous.

By figures 5, 6, and 7 of the drawing is shown an adjunct of the distributing apparatus by means of which and its connections with the motive power actuating the electric generator, the supply of current is increased or decreased according to the wants of the lamps or other apparatus in operation. Figure 5 is a side elevation of this apparatus; figure 6, a top view; and figure 7 a cross-section. A is any suitable base piece; B, an electro magnet; C an elongated armature upon the end of a T-shaped cog bar D arranged to slide in gro-ves cut in piece ,E, which piece is pivoted at P in standard F; H and I are pinion wheels meshing in the cogs D, according as that bar is tipped one way or the other. These pinion wheels are in constant motion (motive power not shown) rotating in opposite directions as indicated by the arrows. When the magnet B is not of sufficient power, the spring M, by means of roller L which it carries, depresses the rod D so as to cause its cogs to mesh with pinion I. When the magnet B is strong enough to overcome the spring M the cogs of rod B are thrown out of gear with pinion I and into gear with pinion H; G is a steam chest containing valves operated by a rod K jointed at O with rod J, and rod J is jointed at M with the cog bar D. The rod K moves to the right or left and opens or closes the steam valve according as the spring M or magnet B preponderates in power; Q is the generator of electricity; the points + and — represent the working parts of the circuits of the conductors R, S. T. The magnet B is constantly in the circuit of the conductor. When the supply of current is about right the cog bar D will be in a state of vibration over the pinions I and H. When the circuit of conductor S is made, but half the current originally flowing in R passes through R and the effect upon magnet B is lessened; the armature C then rises and rod D meshes into pinion I, whereby the valve is moved and more steam let into the engine and the generator correspondingly actuated. When the circuit T is established the flow through R is again diminished and a similar operation of the parts results.

It will be seen that the generator so controls the steam or other power actuating the generator of electricity, that the power is increased or diminished as the demand for the current is increased or diminished, and while I have shown the result as accomplished in one way, I do not intend to limit the invention to the precise 2793 apparatus and the manner of its operation shown and described. It is preferred, as shown and described, to place a sensitive magnet apparatus in the circuit of the generator, which, when a lamp is lighted, so to speak, automatically takes cognizance thereof and supplies that quantity of steam to the engine which is necessary to drive the generator at that speed which will give the exact required volume of electricity. The apparatus is so construed, however, that the regulator may be made to start different generators or couple different parts of a single generator in circuit, as may be required to supply the current, or the regulator may be arranged to control the current by the automatic changing of resistances. There are, in fact, many ways naturally suggestive to vary the application of the invention, and hence the invention is not limited to the em*y*loyment of any special form of apparatus, but includes also the substance of the form.

Here ends a detailed description of part first of this invention, which, it will be seen, embraces and includes a novel arrangement, combination and application of electric circuits and lamps in relation to each other, and also a novel distributing division, gradual and safe application of the electric currents to and through the same.

Part second of the invention consists, as before stated, of an "electric measuring apparatus," a detailed description of which is as follows, reference being had to figure 8 of the drawings:

The object of this part of this invention is to provide a meter or register of the current expended in the production of electric light, and such a device being entirely new in the arts, it is intended to claim it broadly as an electric meter, as well as a part of the system comprising this invention as a whole, and it is not intended to confine this invention to the particular form thereof as it appears by the drawings, but it is intended to embrace all forms of meter that include the substance of the form here shown and described.

The meter illustrated and particularly described is one which indicates with dial hands the current expended, in which respect the apparatus does not differ materially from an ordinary gas meter, and it is preferred to actuate it by electro-magnetism, although the apparatus has been very carefully considered for registering by marks or indentations made upon a roll of paper, and mechanism energized by the expansion of metallic conductors from electric heating. The quantity of current being easily determined, the element of time is the prime factor in ascertaining the amount of current consumed. There is therefore placed in a building supplied with electric lamps a meter which indicates exactly how many hours in a given period these lamps may be lighted, viz., a meter which, if there are ten lamps in a building, and each of them be run for ten hours, will indicate a use of one hundred hours.

It is presumable that at least as often as once a month the index will be noted, and it is preferred to actuate the mechanism by ordinary clockwork, to be wound up once a month, though it is obvious that clockwork may be employed to be actuated by the electric current which will not require to be wound up.

For the sake of simplicity, only the salient parts of the meter are shown by the drawing, omitting the clockwork and the case or cover, and such other parts as are well known to those familiar with mechanism of the kind.

Referring to the drawing, D is a metallic cylinder fixed to shaft D′, which is provided with suitable bearings (not shown), and rotated by the clockwork, of which the reciprocating balance-wheel A, actuated in one direction by an ordinary coiled spring, B, constitutes a governor. The cylinder D is provided with as many metallic "contact" pins, E, set spirally, as there are lamps whose operation is to be indicated, and these pins, as the cylinder is rotated in the direction of the arrow, make connection, when the lamps are in operation, with the spring armature levers F, of electro magnets G. When there is no current flowing in the coils of magnet G, the levers F are forced by spring I away from the magnets to contact with the stops H, so that the pins E may pass without making connections with the levers.

All the armature levers F work freely upon shaft J, held in suitable standards, not shown by the drawing. Running along under the outer ends of the levers F is a metal strip, K, fixed to shaft L, L, which when the magnets G are energized, is forced upward by spiral springs I′, acting against arm L′ fixed to the shaft L, L.

To the metal strip K is fixed an arm M, carrying a light flat spring N to which is fixed a bent piece O, the object of which will soon be apparent.

The electric current entering at the + point, traverses a resistance R, passes through the several lighting apparatus of the lamps 1, 2, and 3, and thence outward at the point. R′, R′, R′ are intended to indicate the place of the lamp-lighting apparatus, and the resistance R^2, R^2, R^2, serve, when a lamp is lighted, to direct a portion of the current through the coils of electro-magnets G, the current being as shown by the broken lines.

To understand the operation of this part of the invention, let it be assumed that the lamps are not actuated. The magnets G not being energized, their armature levers F, are raised, and the strip K
also being raised hold the bent piece O in the path of the bent
2794 piece C, fixed to the chronometer-balance A, and the motion
of the clock-work, and consequently of cylinder D, is stayed.
At this point a lamp is lighted; instantly one of the magnets G is energized, its armature lever F is attracted, and coming in contact with the strip K depresses it, by which the bent piece O is thrown to the left and an impetus imparted to the chronometer-balance by reason of the effect of the bent piece O to disengage itself from the bent piece C. The bent piece O being no longer in the path of C, the balance A begins and continues its reciprocating motion, passing from the position shown in the drawing to that in which C

reaches the point A' and thence back again, thus permitting the cylinder D to rotate in the direction of the arrow.

It makes no difference which of the armature levers F is actuated, any one (or all of them together) serve to set the clock-work in motion. It is apparent that the clock-work may be kept continually in motion, but it is preferred that it shall run only so long as the lamps are in operation.

Let it be assumed that the lamps are all extinguished, there being no magnet G energized and no lever F depressing the strip K, the bent piece O drops into the path of C, which as the balance A carries it to the left, rides over piece O by the yielding of spring N, and the motion of the clock-work is stopped. The effect of the rotation of cylinder D is as follows: By means of the resistance R, a portion of the current of the branch or main when a pin E makes connection with a lever F, as shown by the circuit of the light lines, is caused to energize an electro magnet S, the current passing from one side of R to the cylinder D, thence by way of a pin E to a lever F, and thence by way of shaft J to the magnet S, an armature to the other side of R.

If but one lamp is lighted the magnet S will be energized but once in a revolution; if two are lighted it will be energized twice, and if three are lighted, three times, and so on. At each action of the magnet S its armature lever T, pivoted at T', is attracted against spiral spring 1^2, and by means of pawl T^2 held upward by spring T^3, causes the ratchet wheel U to rotate one tooth. Thus, if but one lamp be in operation, the ratchet wheel U will move but one tooth in one revolution of the cylinder D, and if all the lamps are in operation the ratchet will be constantly rotated by the constant vibration of the armature lever T.

The operation of the remainder of the apparatus is apparent, there being as many gears and pinions, hands and dials as may be desired.

The pinion V fixed to ratchet wheel U actuates gear W, and pinion W' fixed to gear W actuates gear *x*. The hands Q, Q', indicate upon disc P P, the current expended.

To properly estimate the consumption of current, so to speak, a lamp should be operated for a given number of hours and the indicators upon the dials noted.

A single lamp operated for the same length of time will invariably present the same record, and two lamps will present a record of twice the value of one lamp, and so on to any extent desired.

Part third of the invention consists as above stated of a novel method of practically distributing electric circuits and currents through the blocks of cities, towns, and villages. The number of blocks may be more or less, as may seem desirable, and the sup-lying station may be located wherever may seem most desirable. There may be any number of generators and conductors employed, and they may be located in the most convenient or desirable places to supply the lamps and the buildings of streets and blocks.

In concluding the description of this invention, it must be repeated that it consists not only of the method or system as a whole, but also of the several parts and subdivisions in whole and in detail, the following points or parts being embraced and included in it, viz:

First. In a single conductor supplied with electricity, two or more lamps in the circuit of the said conductor, and a shunt around each lamp containing a switch.

Second. In a single conductor supplied with electricity, two or more lamps in the circuit of said conductor, and a shunt around each lamp containing a resistance.

Third. In a single conductor supplied with electricity, two or more lamps in the circuit of said conductor, and a shunt around each lamp containing an adjustable resistance.

Fourth. In an electric lighting system in which two or more electric lamps are supplied with electricity from a generator common to both or all of them, the combination with an electric lamp of a secondary circuit, the switch for which destroys the continuity of the secondary circuit at the instant that it directs the flow of current through the lamp, and destroys the continuity of circuit through the lamp at the instant that it completes the secondary circuit with or without a resistance, plain or adjustable around such lamp, substantially as shown and described.

Fifth. In an electric lighting system in which two or more electric lamps are supplied with electricity from a generator common to both or all of them, the combination with two main conductors,
leading one from each pole of the generator in a course per-
2795 fectly parallel of branches connecting the two main con-
ductors at the requisite intervals, in which branches are
placed electric lamps provided with circuit-continuity-preserving apparatus, so that the flow through any branch may never be broken, whether the lamp in that branch is or is not in operation.

Sixth. In an electrical regulator, the combination of two paramagnetic parts C and B, operating substantially as set forth.

Seventh. In an electric lighting system, a generator of electricity, two or more electric lamps supplied thereby, and an independent electro magnet, switch or regulator energized by the current from the generator and acting automatically upon the occurrence of any change of electrical condition in the circuit or circuits supplied to allow of a corresponding change in the quantity or intensity of the current generated.

Eighth. The combination with an electric lamp of a switch, which in lighting the lamp gradually removes a resistance from the circuit thereof.

Ninth. The combination with an electric lamp of a switch, which while preserving the continuity of the circuit gradually removes a resistance from the circuit of the lamp.

Tenth. The combination with an electric lamp of a resistance in the circuit thereof, which is lessened as the resistance of the lamp is increased.

Eleventh. The hereinbefore described method of lighting an electric lamp, consisting in causing the flow of current in such lamp to increase in strength slowly.

Twelfth. The combination with an electric lamp and a lamp lighting switch of two electrical circuits connected therewith, the switch operating to reduce the resistance of one circuit and increase the resistance of the other, in such manner that at each reduction in the resistance of one circuit there will be an increase in the resistance of the other.

Thirteenth. The combination of an electric lamp and a lamp lighting switch of electrical circuits, so arranged that as the resistance in the circuit of the lamp is lessened, and consequently more current caused to flow through the lamp, the resistance of an extraneous channel or channels is increased, each reduction in the resistance of the lamp circuit being accomplished by such increase in the resistance of the extraneous channel or channels that the resistance of the main or branch circuit, which contains the circuit of the lamp and the extraneous channel or channels is maintained at a constant quantity or nearly so.

Fourteenth. The combination with an electric lamp and a shunt or derived circuit around the lamp, of a switch which operates to light the lamp by increasing the resistance of the shunt or derived circuit.

Fifteenth. The combination with an electric lamp of a switching apparatus, which after an interruption of the flow of the current operates to cut the lamp out of the circuit of such switching apparatus before it can be relighted.

Sixteenth. The combination with an electric lamp lighting switch of an apparatus, which operates to prevent the completion of the lamp circuit, when there is no current to energize the lamp.

Seventeenth. The combination of an electric lamp lighting switch with an apparatus energized by the current which actuates the lamp, and that operates to prevent the opening of the lamp circuit to the flow of the current when there is no supply.

Eighteenth. The combination with an electric lamp lighting switch of an apparatus energized by the current which actuates the lamp, and that operates when there is an interruption in the flow of the current to close the circuit of the lamp against a sudden recurrence of such flow.

Nineteenth. The combination with an electric lamp of a switching apparatus, which after an interruption of the flow of the current operates to introduce a resistance into the circuit of the switching apparatus and the lamp before the lamp can be lighted.

Twentieth. In an electric lighting system an electrical apparatus energized by the current flowing in such system, which when there is an abnormal flow of current in a part or parts of such system, automatically operates to disrupt, disconnect or change the current of such part or parts.

Twenty-first. In an electric lighting system two or more conductors supplied with electricity by the generator of electricity, which is the common source of supply for such system, and in each of these conductors or in circuits derived therefrom two or more electric lamps, the same being so arranged for the purpose of insuring the necessary distribution and subdivision of the current, without artificial lengthening of the circuits by the introduction of resistances which would only waste the current, as set forth.

Twenty-second. An electric distributing system in which the current from a single generator transmitted intermittently through two or more circuits, is rendered continuous in such circuits by induction apparatus energized by such intermittently transmitted current.

Twenty-third. The combination with one or more electric lamps of a meter or register, showing the consumption or expenditure of current in operating the same.

Twenty-fourth. The combination with one or more electric lamps of a meter or register, showing the time during which the said lamp or lamps are operated.

2796 Twenty-fifth. A meter or register of the consumption or expenditure of current in the operation of one or more electric lamps, consisting of a dial or dials actuated by the current.

Twenty-sixth. In a meter or a register of the consumption or expenditure of current in the operation of one or more electric lamp apparatus, actuated by the current to indicate the time during which the operation of the same continues.

Twenty-seventh. In a meter or register of the consumption or expenditure of current in the operation of one or more electric lamp mechanism, set in motion by the current upon the lighting of a lamp, and stopped upon the extinguishment of the same or all the lamps.

Twenty-eighth. In a meter or register of the consumption or expenditure of current in the operation of one or more electric lamps, the combination with primary apparatus for setting a clockwork in motion of secondary apparatus, actuated by any one or more lamps to actuate the primary apparatus.

Twenty-ninth. In a meter or register of the consumption or expenditure of current in the operation of one or more electric lamps, the combination with such lamp or lamps of apparatus energized by the current operating such lamp or lamps.

Thirtieth. In an electric light meter, the cylinder D presenting spirally arranged points of contact.

Thirty-first. In an electric light meter, the combination of the cylinder D and levers F.

Thirty-second. In an electric light meter, the combination of the cylinder D, and electro magnet G.

Thirty-third. In an electric light meter, the combination of the lever and magnet G.

Thirty-fourth. In an electric light meter, the combination of the lever F and strip K.

Thirty-fifth. In an electric light meter, the combination of the detent piece O and spring N.

Specification in pursuance of the conditions of the letters patent filed by the said Frederick John Cheesbrough in the Great Seal Patent Office on the 17th May, 1879.

Frederick John Cheesbrough, of the office for patents, 15 Water street, Liverpool, in the county of Lancaster, consulting engineer. "An improved method or system of distributing, dividing, regulating, controlling, and measuring electric currents in the practical application of the same to electric lighting and other useful purposes." A communication from abroad by William Edward Sawyer, of New York city, county, and State, and Albon Man, of Brooklyn, county of Kings, State of New York, United States of America.

In order that this invention may be fully understood, I have hereunto attached a sheet of drawings, which illustrates the said invention and in what manner the same is to be performed, reference being had to the drawings, which are marked with letters and figures of reference corresponding with those in the following specification.

The object of this invention is to obtain a perfect distributing division, regulation, and mensuration of electric currents as applied particularly to electric lighting, although the practical application of the invention is not limited to electric lighting apparatus, it being equally applicable to many other well known electric apparatus.

The said invention consists of several parts to be hereinafter described, the several parts appertaining more or less to each other, and all contributing to the complete system, the several parts being novel as well in themselves as in their combination into a system as a whole.

Part first of this invention consists :—

Firstly. Of a novel method and apparatus, by means of which electrical circuits containing electric lamps are supplied with electricity absolutely uniform in volume, and by means of which only so much current as is necessary to meet the demand is automatically supplied, and by means of which the motive power driving the generator is automatically increased or diminished in proportion as the number of lighted lamps is increased or diminished in the circuit of a system.

Secondly. Of a novel distributing system, by means of which the current of a single electrical generator may be divided among an indefinite number of lamps.

Thirdly. Of an electric lamp lighting apparatus, which not only turns the current on to and off from the lamp gradually, but admits of regulating the light proceeding from the lamp to any desired intensity, and at the same time avoids the danger of fracturing the carbon of the lamp, and of interrupting or changing the resistance of the circuit containing the lamp, whenever it is lighted or extinguished.

2797 Part second of this invention consists of an electric apparatus operating to measure the amount of current consumed in a given time by the lamp or other apparatus in the circuit.

Part third of this invention consists of a novel method of practically distributing electric currents in towns or cities, for the purpose of supplying the street lamps or buildings thereof with electricity in any quantity within the scope of the generator's power.

The foregoing is a general statement of the several parts of the invention, and the following is a detail description of them, and of the manner of bringing them in their right relation to each other for operation as a whole, and of the manner of operating them.

Part first, reference being had to the drawings:

Figure 1 illustrates an "electric lamp lighting switch," and figures 2, 3 and 4, are diagrams of distributing circuits in connection therewith. Figure 1 consists of a suitable metallic holder A, fitted with a groove in its face to carry and hold in position a sliding piece B, to which is fixed a flat spring *b*, to one end of which is secured a cross piece *b'*, which as the slide is moved makes contact successively with the sixteen pins E, E, and E', E', arranged eight on each side of the spring *b*.

The movement of the slide B backward and forward is accomplished by turning the crank D and D', which rotates upon a suitable stud *d* set in the frame or bed plate of the switch. At each revolution of the crank, the pin C fixed in the hub of the crank engages with a tooth *c* and moves the slide forward one tooth until it has acted upon the last in the slide, when further motion in that direction is prevented by contact of the cross piece *b'* with the stop pin *b* 2.

Turning the crank in the opposite direction in like manner moves the slide backward until its motion is arrested by contact of the pin *a*, with the armature lever G. In lighting an electric lamp it is important to turn on the current gradually, otherwise fractures of the carbon burners may ensue. It is possible also that at times, when the current is fully turned on to the lamp, there may occur an interruption in the supply, extinguishment of the light then follows, and the carbon grows cool. Suppose now that the circuit of the lamp not having been destroyed but being set for the full force of the current, the supply is suddenly renewed, instantly the illuminating carbon is heated from a low to an exceedingly high temperature, and its fracture may be expected. The electro-magnet F attached to the switch effectually guards against this danger.

Unless the current is circulating in its coils the lamp cannot be lighted, and if there be an interruption in the supply the current cannot circulate in its coils, although the supply may be renewed until the lamp shall first have been taken out of the circuit.

The armature F' is fixed to the bent lever G (pivoted at E), one extremity of which plays between the studs *g* and *g'*, according as the magnet is or is not actuated by the current. The spring *f* acts to force the armature away from the magnet and establish a connection between the lever G and the stud *g*.

The current from the + side of the generator enters the lever G, and when the circuit is in its normal condition passes by way of the stud *g'* through the coils of the magnet F to the slide holder A. then by way of the slide B, spring *b*, cross piece *b'*, and the eight pins E' to the lamp and outward at the — point. Now a sudden interruption occurs instantly the armature is forced away from the magnet by the spring *f*, and contact of the lever G with the stud *g* is established. The lamp is not entirely out of the circuit, and the current flows solely from the lever through the stud *g* and resistance R outward at the — point.

It is in this position the switch is shown, and the lamp can never be relighted unless the slide B be moved back until the cross piece *b'* makes contact with pin 1 E, when the pin *a* strikes the lever G and forces the armature within the grasp of the magnet, and at the same time establishes a connection between G and *g'*; then, if there be a supply of the current the lamp may be lighted by moving the slide B forward, but if there be no supply, moving the slide forward will simply release the armature, and the lever G will again move the stud *g*.

It is found that the internal resistance of a properly devised and constructed electric lamp lighted by incandescence is about a sixteenth of an ohm, and it is clearly important to the end that the conditions surrounding other lamps in circuit may not be affected, that the 1 resistance of the circuit from the + to — points shall be constant, whether the lamp be in or out of the circuit, or whether it be lighted feebly or at its full head. Therefore when the lamp is out of the circuit, *i. e.*, when the cross piece *b'* rests upon the pins 1, 1, the current flows by way of the points. Thus, where the lamp is entirely cut out the resistance of the circuit is precisely the same as when the lamp is fully lighted. The pins 1 E' and 8 E serve no useful purpose other than to keep the cross piece *b'* in position.

Assuming now that it is desired to light the lamp the current is led on by sevenths, but any other small fraction pursued regularly or varied may be substituted; a single turn of the crank advances the cross piece *b'* upon the two pins 2, 2, and the current divides, six-sevenths of it passing through resistance R' of one-tenth
2798 of an ohm, and resistance R of six-tenths of an ohm outward at the — points. The resistance of the first circuit, which we will call the shunt is, therefore, .7 ohm, and that of the lamp 4.2 ohms, making the resistance from the + point to the — point .6 ohm.

At the next turn of the crank the cross piece *b'* bears upon pins 3, 3, and the resistance is as follows: In the shunt circuit .84 ohm, in the lamp circuit 2.1=.6 ohm. Upon pins 4, 4, the resistance is in the shunt circuit 1.05, in the lamp circuit 1.4=.6 ohm. Upon pins 5, 5, the resistance is in the shunt circuit 1.4, in the lamp circuit 1.05=.6 ohm. Upon pins 6, 6, the resistance is in the shunt circuit 2.1, in the lamp circuit .84=.6 ohm. Upon pins 7, 7, the resistance is in the shunt circuit 4.2, in the lamp circuit .7=.6 ohm. Upon pins 8, 8, the current no longer flows through the shunt circuit, but solely through the lamp, the resistance of which is .6 ohm.

To distribute the current from a single generator to two or more electric lamps, engines, or other apparatus, we also have recourse to a commutator in connection with the generator, which when there are two circuits from the generator transmits the electric impulse alternately into each, and when there are more than two circuits transmits these impulses seriatim into the several circuits.

The method of distribution will be readily understood upon reference to figure 2 of the drawing, in which H is a rotating circuit breaker which alternately establishes and disrupts the circuits from the + side of the generator through the two springs I and I'. Let A, B, C, D, of figure 2, represent the lighting apparatus of figure 1, now when the spring I is in connection with the rotating commutator disk H, the current entering the lamp 1 passes out by way of the point —. The rotation of the eccentric disk now disrupts the current, and by its contact with the spring I', the current also passing out from the lamp by way of the point —. Were this the whole of the operation the current in each lamp would obviously be intermittent and the light emitted correspondingly so, but by the use of electric conductors J and J', the current in the lamp 1 and 2 is rendered continuous, the condensers being so arranged that their discharge through the lamp fills up the gap (so to speak) between the impulses from the generator.

Figure 3 of the drawing indicates merely an extension of the plan or method. The impulses from the first commutator H, I, I', are resolved into a continuous current by means of the condensers J and J^3 being directed by means of commutators H', I^2, I^3, between subcurrents X, Y, and lamps 1, 2, 3, and 4, provided with condensers J', J^2, J^4 and J^5. It is obvious that this system of subdivision may be continued indefinitely, using one or more condensers as circumstances may require for any number of lamps. In figure 4 of the drawing there is substituted for a condenser in a shunt circuit electro-magnets or inducing coils K and K'; in the direct circuit the impulses from the commutator while actuating the lamps charge the coil. Upon cessation of the impulses the coil discharges a current of the same direction as that which actuated it. The current in each of the circuits is thus rendered continuous.

By figures 5, 6 and 7, of the drawings is shown an adjunct of the distributing apparatus by means of which and its connections with the motive power actuating the electric generator the supply of current is increased or decreased according to the wants of the lamps or other apparatus in operation. Figure 5 is a side elevation of this apparatus; figure 6 is a top view; and figure 7, a cross section. A is any suitable base piece; B, an electro magnet; C, an elongated armature upon the end of a T-shaped cog bar D arranged to slide in grooves cut in piece E, which piece is pivoted at P in standard F; H and I are pinion wheels meshing in the cogs of D according as that bar is tipped one way or the other. These pinion wheels are in constant motion (motive power not shown) rotating in opposite directions, as indicated by the arrows. When the magnet B is not of sufficient power the spring M by means of roller L, which it carries, depresses the rod D so as to cause its cogs to mesh with pinion I. When the magnet B is strong enough to overcome the spring M the cogs of rod D are thrown out of gear with pinion I and into gear with pinion H; G is a steam chest containing valves operated by a rod K jointed at O with rod J, and rod J is jointed at N with the cog bar D. The rod K moves to the right or left and opens or closes the steam valve according as the spring M or magnet B preponderates in power; Q is the generator of electricity; the points + and — represent the working parts of the circuit of the conductors R S T. The magnet B is constantly in the circuit of the conductor. When the supply of current is about right the cog rod D will be in a state of vibration over the pinions I and II. When the circuit of conductor S is made, but half the current originally flowing in R passes through R, and the effect upon magnet B is lessened; the armature C then rises and rod D meshes into pinion I, whereby the valve is moved and more steam let into the engine and the generator correspondingly actuated. When the circuit T is established the flow through R is again diminished and a similar operation of the parts results.

2799 It will be seen the generator so controls the steam or other power actuating the generator of electricity that the power is increased or diminished as the demand for the current is increased or diminished, and while I have shown the result as accomplished in one way I do not intend to limit the invention to the precise apparatus and the manner of its operation shown and described. It is preferred, as shown and described, to place a sensitive magnetic apparatus in the circuit of the generator which, when a lamp is lighted, so to speak, automatically takes cognizance thereof and supplies that quantity of steam to the engine which i*f* necessary to drive the generator at that speed which will give the exact required volume of electricity. The apparatus is so constructed, however, that the regulator may be made to start different generators or couple different parts of a single generator in circuit as may be required to supply the current, or the regulator may be arranged to control the current, by the automatic changing of resistances. There are in fact many ways naturally suggestive to vary the application of the invention, and hence the invention is not limited to the employment of any special form of apparatus, but includes also the substance of the form.

Here ends a detail description of part first of the invention, which will be seen embraces and includes a novel arrangement, combination, and application of electric circuits and lamps in relation to each other and also a novel distributing division, gradual and safe application of the electric currents to and through the same.

Part second of the invention consists as before stated of an "electric measuring apparatus" a detail description of which is as follows, reference being had to figure 8 of the drawings:

The object of this part of this invention is to provide a meter or register of the current expended in the production of electric light, and such a device being entirely new in the arts, it is intended to claim it broadly as an electric meter as well as a part of the system comprising this invention as a whole, and it is not intended to confine this invention to the particular form thereof, as it appears by the drawings, but it is intended to embrace all forms of meter that include the substance of the form here shown and described.

The meter illustrated and particularly described is one which indicates with dial hands the current expended in which respect the apparatus does not differ materially from an ordinary gas meter, and it is preferred to actuate it by electro-magnetism although the apparatus has been very carefully considered for registering by marks or indentations made upon a roll of paper, and mechanism energized by the expansion of metallic conductors from electric heating. The quantity by current being easily determined, the element of time is the prime factor in ascertaining the amount of current consumed. There is therefore placed in a building supplied with electric lamps a meter, which indicates exactly how many hours in a given period these lamps may be lighted, viz., a meter which if there are ten lamps in a building, and each of them be run for ten hours will indicate a use of one hundred hours.

It is presumable that at least as often as once a month the index will be noted, and it is preferred to actuate the mechanism by ordinary clock-work to be wound up once a month though it is obvious that clock-work may be employed to be actuated by the electric current, which will not be required to be wound up.

For the sake of simplicity only the salient parts of the meter is shown by the drawing, omitting the clock-work and case or cover, and such other parts as are well known to those familiar with mechanism of this kind.

Referring to the drawing, D is a metallic cylinder fixed to shaft D', which is provided with suitable bearings (not shown) and rotated by the clock-work, of which the reciprocating balance wheel A actuated in one direction by an ordinary coil spring B constitutes the governor. The cylinder D is provided with as many metallic "contact" pins E, set spirally as there are lamps whose operation is to be indicated; and these pins as the cylinder is rotated in the direction of the arrow make connection when the lamps are in operation with the spring armature levers F of electro-magnets G. When there is no current flowing in the coils of magnets G, the levers F are forced by spring I away from the magnets to contact with the stops H, so that the pins E may pass without making connection with the levers.

All the armature levers F work freely upon shaft J held in suitable standards, not shown by the drawing. Running along under the outer ends of the levers F is a metal strip K fixed to shaft L L, which when the magnets G are energized is forced upward by spiral springs I' acting against arm L' fixed to the shaft L L.

To the metal strip K is fixed an arm M carrying a light flat spring N to which is fixed a bent piece O, the object of which will soon be apparent.

The electric current entering at the — point traverses a resistance R, passes through the several lighting apparatus, and the resistances R^2, R^2, R^2, serve when a lamp is lighted to direct a portion of the current through the coils of the electro magnets G, the current being as shown by the broken lines.

To understand the operation of this part of the invention,
2800 let it be assumed that the lamps are not actuated. The
magnets G not being energized, their armature levers F are

raised and the strip K also being raised, holds the bent piece O in the path of the bent piece C fixed to the chronometer balance A and the motion of the clock-work, and consequently of cylinder D is stayed. At this point a lamp is lighted, instantly one of the magnets G is energized its armature lever F is attracted, and coming in contact with the strip K depresses it, by which the bent piece O is thrown to the left, and an impetus imparted to the chronometer balance, by reason of the effort of the bent piece O to disengage itself from bent piece C. The bent piece O being no longer in the path of C, the balance A begins and continues its reciprocating motion, passing from the position shown in the drawing to that in which C reaches the point A', and thence back again. Thus permitting the cylinder D to rotate in the direction of the arrow.

It makes no difference which of the armature levers F is actuated; any one (or all of them together) serve — set the clock-work in motion. It is apparent that the clock-work may be kept continually in motion, but it is preferred that it shall run only so long as the lamps are in operation.

Let it be assumed that the lamps are all extinguished. There being no magnet G energized and no lever F depressing the strip K, the bent piece O drops into the path of *c*, which as the balance A carries it to the left, rides over piece O by the yielding of spring N, and the motion of the clock-work is stopped. The effect of the rotation of cylinder D is as follows: By means of the resistance R a portion of the current of the branch or main, when a pin E makes connection with a lever F as shown by the circuit of the light lines, is caused to energize an electro magnet S, the current passing from one side of R to the cylinder D, thence by way of a pin E to a lever F, and thence by way of shaft J to the magnet S and armature to the other side of R.

If but one lamp is lighted it will be energized but once in a revolution, if two are lighted it will be energized twice, and if three are lighted three times, and so on. At each action of the magnet S its armature lever T pivoted at T' is attracted against spiral spring I^2, and by means of pawl T^2 held upward by spring T^3 causes the ratchet wheel U to rotate one tooth. Thus if but one lamp be in operation the ratchel wheel U will move but one tooth in one revolution of the cylinder D, and if all the lamps are in operation the ratchet will be constantly rotated by the constant vibration of the armature lever T.

The operation of the remainder of the apparatus is apparent, there being as many gears and pinions, hands and dials, as may be desired.

The pinion V, fixed to ratchet wheel U, actuates gear W, and pinion W' fixed to gear W, actuates gear X. The hands Q and Q' indicate upon disc P, P, the current expended.

To properly estimate the consumption of current, so to speak, a lamp should be operated for a given number of hours, and the indications upon the dials noted.

A single lamp operated for the same length of time will invariably present the same record, and two lamps will present a record of twice the value of one lamp, and so on to any extent desired.

Part third of the invention consists, as above stated, of a novel method of practically distributing electric circuits and currents through the blocks and streets of cities, towns, and villages. The number of blocks may be more or less as may seem desirable. There may be any number of generators and conductors employed, and they may be located in the most convenient or desirable places to supply the lamps and buildings of the streets and blocks.

In concluding the description of this invention, it must be repeated that it consists not only of the method or system as a whole, but also of the several parts and subdivisions in whole and in detail, the following points or parts being embraced and included in it, viz:

(Here follow claims thirty-five in number, which are identical with those of the provisional specification.)

In witness whereof, I, the said Frederick John Cheesbrough, have hereunto set my hand and seal, this fifteenth day of May, in the year of our Lord, one thousand eight hundred and seventy-nine.

FREDERICK JOHN CHEESBROUGH. [L. S.]

London: Printed by George Edward Eyre and William Spottiswoode, printers to the Queen's most excellent majesty, for her majesty's stationery office. 1879.

2804 U. S. Circuit Court, Southern District of New York.

CONSOLIDATED ELECTRIC LIGHT COMPANY
vs.
EDISON ELECTRIC LIGHT COMPANY and T. A. EDISON. } Dock. H., 3553.

COMPLAINANT'S EXHIBIT NO. 1, PATENT IN SUIT. May 11, 1886.
T. G., Ex'r.

THE UNITED STATES OF AMERICA.

(Engraving.)

No. 317,676.

To all to whom these presents shall come:

Whereas, William Edward Sawyer of New York, and Albon Man of Brooklyn, New York, have presented to the Commis-

2805 sioner of Patents a petition praying for the grant of letters patent for an alleged new and useful improvement in electric lights, they having assigned their right, title and interest in said improvement to the Electro Dynamic Light Company, of New York, a description of which invention is contained in the specification of which a copy is hereunto annexed and made a part hereof, and have complied with the various requirements of law in such cases made and provided; and

Whereas, upon due examination made, the said claimants are adjudged to be justly entitled to a patent under the law.

Now therefore, these letters patent are to grant unto the said Electro Dynamic Light Company, its successors or assigns for the term of seventeen years from the twelfth day of May, one thousand eight hundred and eighty-five, the exclusive right to make, use and vend the said invention throughout the United States and the territories thereof.

In testimony whereof I have hereunto set my hand and caused the seal of the Patent Office to be affixed, at the city of Washington, this twelfth day of May, in the year of our Lord one thousand eight hundred and eighty-five, and of the Independence of the United States of America the one hundred and ninth.

H. L. MULDROW,
Acting Secretary of the Interior.

Countersigned.
M. V. MONTGOMERY,
Commissioner of Patents.

2806 UNITED STATES PATENT OFFICE.

WILLIAM EDWARD SAWYER, of New York, and ALBON MAN, of Brooklyn, N. Y., assignors to Electro Dynamic Light Company of New York.

Electric Light.

Specification forming part of Letters Patent No. 317,076, dated May 12, 1885. Application filed January 9, 1880.

To all whom it may concern:

Be it known that we, William E. Sawyer, a resident of the city, county, and State of New York, and Albon Man, a resident of Brooklyn, in the county of Kings and State aforesaid, both citizens of the United States, *improvements in electric lamps, of which jointly have invented certain new and useful improvements the following is a specification:*

Our invention, speaking generally, relates to that class of electric lamps employing an incandescent conductor inclosed in a transparent hermetically sealed vessel or chamber, from which oxygen is excluded, and constitutes an improvement upon the apparatus shown in letters patent No. 205,144, granted to us June 18, 1878.

Our invention relates more especially to the incandescing conductor, its substance, its form, and its combination with the other elements composing the lamp. Its object is to secure a cheap and effective apparatus; and our improvement consists, first, of the combination, in a lamp chamber composed wholly of glass, as described in patent No. 205,144, of an incandescing conductor of carbon made from a vegetable fibrous material, in contradistiction to a similar conductor made from mineral or gas corbon, and also in the form of such conductor so made from such vegetable carbon, and combined in the lighting circuit within the exhausted chamber of the lamp.

The accompanying drawings show all our improvements
2807 embodied in an apparatus or lamp substantially like that
represented in the patent above referred to, being the form in which we have practically used it; but some of our improvements may be used in connection with other forms of lamps with equally good effect.

Reference being had to said drawings, figure 1 is a top view of the lamp; Fig. 2, a side elevation thereof; Fig. 3, a side view in elevation of the burner on an enlarged scale to show its details more clearly, and Fig. 4 is a similar edge view.

Fig. 5 of the drawings shows a vertical section through the bottom of the lamp. In this figure *x* is a glass flange on the bottom of the lamp chamber. *y* is a glass disk corresponding in size to the flange, and is ground to the bottom thereof to form an air-tight joint so that the entire wall of the chamber is formed of glass, the electrodes passing through the glass disk in the manner shown to form the lighting circuit in the chamber, substantially as in said patent No. 205,144. The sealing of the electrodes, where they pass through the glass wall, is done with any suitable cement, or in any of the well-known methods of sealing glass upon metal electrodes previous to the filing of this application.

The electric connections of this lamp are made in the base thereof, substantially the same as in our patent No. 210,809, dated December 10, 1878, and the whole bottom is inclosed in a cup filled with wax or other suitable cement, the same as in that patent, the cement sealing in this lamp being also applied in substantially the same way as in the patent last above mentioned, the invention making the subject-matter of this application being improvements upon the lamps described in the patents above referred to, to the extent of the claims making part hereof.

In the practice of our invention we have made use of carbonized
paper, and also wood carbon. We have also used such con-
2808 ductors or burners of various shapes such as pieces with their
lower ends secured to their respective supports and having their upper ends united so as to form an inverted-V-shaped burner. We have also used conductors of varying contours—that is, with rectangular bends instead of curvilinear ones; but we prefer the arch shape.

No especial description of making the illuminating carbon conductors, described in this specification and making the subject-matter of this improvement, is thought necessary, as any of the ordinary methods of forming the material to be carbonized to the desired shape and size, and carbonizing it while confined in retorts in powdered carbon, substantially according to the methods in practice before the date of this improvement, may be adopted in the practice thereof by any one skilled in the arts appertaining to the making of carbons for electric lighting or for other use in the arts.

An important practical advantage which is secured by the arch form of incandescing carbon is that it permits the carbon to expand and contract under the varying temperatures to which it is subjected when the electric current is turned on or off without altering the position of its fixed terminals. Thus the necessity for a special mechanical device to compensate for the expansion and contraction which has heretofore been necessary is entirely dispensed with, and thus the lamp is materially simplified in its construction. Another advantage of the arch form is that the shadow cast by such burners is less than that produced by others of burners when fitted with the necessary devices to support them.

Another important advantage resulting from our construction of the lamp results from the fact that the wall forming the chamber of the lamp through which the electrodes pass to the interior of the lamp is made wholly of glass, by which all danger of oxidation, leakage, or short-circuiting is avoided.

2809 The advantages resulting from the manufacture of the carbon from vegetable fibrous or textile material instead of mineral or gas carbon are many. Among them may be mentioned the convenience afforded for cutting and making the conductor in the desired form and size, the purity and equality of the carbon obtained, its susceptibility to tempering, both as to hardness and resistance, and its toughness and durability. We have used such burners in closed or hermetically sealed transparent chambers, in a vacuum, in nitrogen gas, and in hydrogen gas; but we have obtained the best results in a vacuum, or an attenuated atmosphere of nitrogen gas, the great desideratum being to exclude oxygen or other gases capable of combining with carbon at high temperatures from the incandescing chamber, as is well understood.

The nature of our inventions and the operation of our improved lamp will be readily understood from the foregoing description and the following claims.

We claim as our joint invention—

1. An incandescing conductor for an electric lamp, of carbonized fibrous or textile material and of an arch or horseshoe shape, substantially as hereinbefore set forth.

2. The combination, substantially as hereinbefore set forth, of an electric circuit and an incandescing conductor of carbonized fibrous material, included in and forming part of said circuit, and a transparent hermetically sealed chamber in which the conductor is inclosed.

3. The incandescing conductor for an electric lamp, formed of carbonized paper, substantially as described.

4. An incandescing electric lamp consisting of the following elements in combination: first, an illuminating chamber made wholly of glass hermetically sealed, and out of which all carbon-consuming gas has been exhausted or driven; second, an electric 2810 circuit conductor passing through the glass wall of said chamber and hermetically sealed therein, as described; third, an illuminating conductor in said circuit, and forming part thereof within said chamber, consisting of carbon made from a fibrous or

textile material, having the form of an arch or loop, substantially as described, for the purpose specified.

In testimony whereof we have hereunto subscribed our names this 8th day of January, 1880.

WILLIAM EDWARD SAWYER.
ALBON MAN.

Witnesses:
WM. H. CHURCH.
WM. D. BALDWIN

2811 Complainant's Exhibit Patent Office Proceedings No. 1.

File-wrapper and Contents. Application for Patent in Suit. May 11, 1886. T. G., Ex'r.

Consolidated Electric Light Co.
vs. } G, 3553.
Edison Electric Light Co. *et al.*

Department of the Interior,
United States Patent Office.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the files of this office of the file-wrapper and contents in the matter of the letters patent granted William Edward Sawyer and Albon Man, assignors to Electro-Dynamic Light Company, May 12, 1885, number 317,676, for improvement in electric light.

In testimony whereof I, M. V. Montgomery, Commissioner of Patents, have caused the seal of the Patent Office to be affixed [L. S.] this 16th day of June, in the year of our Lord one thouthousand eight hundred and eighty-five, and of the Independence of the United States the one hundred and ninth.

M. V. MONTGOMERY,
Commissioner.

2812 To the Commissioner of Patents:

Your petitioners, William E. Sawyer, a resident of the city, county and State of New York, and Albon Man, a resident of the city of Brooklyn, in the county of Kings, in the State aforesaid, both citizens of the United States, pray that letters patent of the United States may be granted to the Electro-Dynamic Light Company of New York as their assignees for the improvements in electric lamps or lights set forth in the annexed specification.

Also, that you will recognize William D. Baldwin, of Washington, D. C., as their duly authorized attorney in the premises, with full power of substitution and revocation to prosecute this application, to make alteration and amendments therein, to receive the patent and to transact all business in the Patent Office connected therewith.

And they hereby request that the patent may be issued to the Electro-Dynamic Light Company of New York as their assignee.

WILLIAM EDWARD SAWYER.
ALBON MAN.

The Electro-Dynamic Light Company hereby concurs in the above petition and power of attorney.

2813 To all whom it may concern:

Be it known that we, William E. Sawyer, a resident of the city, county and State of New York, and Albon Man, a resident of Brooklyn, in the county of Kings and State aforesaid, both cit*cit*izens of the United States, jointly have invented certain new and useful improvements in electric lights or lamps, of which improvements the following is a specification:

Erase per sub., May 17, '88.

Our invention, speaking generally, relates to that class of electric light employing an incandescent conductor enclosed in a vessel or chamber from which oxygen is excluded, and constitutes an improvement upon the apparatus shown in letters patent No. 206,144, granted to us June 18, 1878.

Our present invention especially relates to the incandescent conductor; its object is to secure a cheap and effective apparatus, and our improvement consists in the employment of an incandescent arc of carbon in the circuit as the light-giving medium. The subject-matter claimed is hereinafter specifically designated..

The accompan-ing drawings show our improvement as embodied in an apparatus substantially like that represented in the patent above mentioned, being the form in which we have practically used it, but it may be used in connection with other forms of apparatus with good effect.

Fig. 1 represents a plan or top view of the apparatus.

Fig. 2, a side elevation thereof. The apparatus being old and well known except as hereinafter stated and constituting no part of the subject-matter herein claimed, needs no particular description.

Fig. 3, a side view or elevation of the burner on an enlarged scale to show its details more clearly, and

2814 Fig. 4, a similar edge view.

Our improved burner or incandescent arc consists of an arc-shaped or semi-cylindrical piece of carbon, A, mounted in its clamps or supports in usual well-known ways.

We have tried c*rr*bonized paper, covered with powdered plumbago, wood carbon or charcoal, and ordinary gas carbon.

We have also used such arcs or burners of various shapes such as pieces with their lower ends secured to their respective sup-

[Matter enclosed between rules erased in copy.]

ports, and with their upper ends united so as to form an inverted-V-shaped burner.

We have also used arcs of varying contours, that is, with rectangular bends instead of curvilinear ones; but prefer the arch shape as the shadow cast by such a burner is less than that produced by other forms of burners.

We have used such burners in close transparent chambers in a vacuum, in nitrogen gas and in hydrogen gas, but have attained the best results in a vacuum or attenuated atmosphere of nitrogen, the great desideratum being to exclude oxygen from the combustion chamber as is well understood.

The operation of our improved apparatus will readily be understood from the foregoing description.

We claim as of our own joint invention:

First. Incandescing arcs for electric lights made of carbon, substantially as hereinbefore set forth.

Second. Incandescing arcs of carbon in combination with the circuit of an electric light.

Third. The combination substantially as hereinbefore set forth, of the circuit of an electric light, an incandescing arc of carbonized paper included in the circuit and a close transparent chamber in which the arc is inclosed.

2815 Fourth. An incandescing arc made of carbonized fibrous or textile material.

In testimony whereof, we have hereunto subscribed our names this eighth day of January, 1880.

WILLIAM EDWARD SAWYER.
ALBON MAN.

Witnesses:
WM. H. CHURCH.
W. D. BALDWIN.

2816 CITY, COUNTY, AND STATE OF NEW YORK, *ss:*

Wm. E. Sawyer, one of the above-named petitioners, being duly sworn, doth depose and say: That he verily believes the above-named Albon Man, and himself jointly, to be the original and first inventors of the improvements in electric lamps or lights set forth in the annexed specification; that he does not know and does not believe that the same were ever before known or used; and that they have not been patented to him or them with his knowledge or consent in any foreign country, and that he is a citizen of the United States and a resident of the city, county and State of New York.

WILLIAM EDWARD SAWYER.

[Matter enclosed between rules erased in copy.]

Sworn to and subscribed before me, this eighth day of January, 1880.

JAS. G. COOPER,
[L. S.] *Notary Public, Kings Co., N. Y., and N. Y. Co.*

2817 City, County, and State of New York, *ss:*

Albon Man, one of the above-named petitioners, being duly sworn, doth depose and say: That he verily believes the above-named Wm. E. Sawyer, and himself jointly, to be the original and first inventors of the improvements in electric lamps or lights, set forth in the annexed specification; that he does not know and does not believe that the same were ever before known or used; and that they have not been patented to him or them with his knowledge or consent in any foreign country, and that he is a citizen of the United States and a resident of the city of Brooklyn, in the county of Kings and State of New York.

ALBON MAN.

Sworn to and subscribed before me, this eighth day of January, 1880.

JAS. G. COOPER,
[L. S.] *Notary Public, Kings Co., N. Y., and N. Y. Co.*

(Endorsement: Application Sawyer and Man electric light. Cancelled per sub. spec., May 17, '80. Patent Office, Jan. 9, 1880, U. S. A. Wm. D. Baldwin, att'y.)

2818 New York, *January 9th*, 1880.

To the Commissioner of Patents.

Sir: Messrs. Sawyer and Man having this day made an application for patent for electric lamp, and assigned the same to the Electro-Dynamic Light Company of New York, and in said application Mr. Wm. D. Baldwin was appointed attorney for the inventors. Now the said company hereby assents to and concurs in said appointment.

THOMAS WALLACE,
Pres't Electro-Dynamic Light Co.

Witness-:
ALBON MAN.
W. K. APPLEBAUGH, *New York.*

(Endorsement: Sawyer and Man, electric light. Filed January 9, 1880. Concurrence of assignees. U. S. Patent Office, Jan. 10, 1880.)

Washington, D. C., *Jan. 14th*, 1880.

To the Commissioner of Patents.

Sir: I hereby appoint Baldwin, Hopkins & Peyton, of Washington, D. C., (a firm composed of Wm. D. Baldwin, Marcus S. Hopkins, and Jos. I. Peyton) my associate attorneys in the matter of the application of Sawyer & Man for patent for electric light, filed

January 9, 1880, with full power to transact all business in connection therewith.

Respectfully, WM. D. BALDWIN.

(Endorsement: Asso. power of att'y, Jan. 14, '80. U. S. Patent Office, Jan. 14, 1880.)

2819 Copied.

Room No. 118.

Department of the Interior,
United States Patent Office,
Washington, D. C., *Feb.* 28, 1890.

Electric lamps. Jan. 9, 1880. No. 547.

W. E. Sawyer and A. Man, care Wm. D. Baldwin:

Claims one and two, in view of well-known use of incandescent carbon, are fully met by patent of Gardiner, Jr., and Blossom, 20706, June 29, 1858, (elec. lights).

Claim 4, as drawn, is not considered patentable in view of the well-known use of wood charcoal for lighting purposes. See Prescott on "Speaking Telephone Electric Light," etc., New York, 1879, pages 438 and 439.

Claims 1, 2 and 4 are rejected.

H. C. TOWNSEND, *Ex'r.*

P. W. PAGE, *Ass't Ex.*

(Endorsement: $\frac{155}{37}$. 1. Rej. Feb. 28, '80.)

2820 Copied.

Room No. 118.

Department of the Interior,
United States Patent Office,
Washington, D. C., *Apr. 26th,* 1880.

Electric lamps or lights. Filed Jan. 9th, 1880. No. 549.

Sawyer and Man, care Wm. D. Baldwin, present:

Applicant is requested to amend his case in accordance with official letter of Feb. 28th, on or before the [17th of May, in order that an interference may be]* declared between this and another pending application.

H. C. TOWNSEND, *Ex'r.*

SEELY.

(Endorsement: $\frac{155}{73}$. 2. Letter Apr. 26, '80.)

[*Words and figures enclosed in brackets erased in copy.]

2821 In the United States Patent Office.

In the Matter of the Application of SAWYER AND MAN for Electric Lamps. Filed Jan. 9, 1880. } No. 547.

To the Commissioner of Patents:

Substitute the following for the specification originally filed:

"To all whom it may concern:

Sub. spec., May 17, '80.

Be it known, that we, William E. Sawyer, a resident of the city, county and State of New York, and Albon Man, a resident of Brooklyn, in the county of Kings and State aforesaid, both citizens of the United States, jointly have invented certain new and useful improvements in electric lamps; of which improvements the following is a specification:

Feb. 19, '85.

Our invention, speaking generally, relates to that class of electric lamps employing an incandescent conductor enclosed in a transparent hermetically sealed vessel or chamber from which oxygen is excluded, and constitutes an improvement upon the apparatus shown in letters patent No. 205,144 [206,144,]* granted to us June 18, 1878.

Substitute B, Feb. 28, '83.

Feb. 19, '85.

Our invention more especially relates to the incandescent conductor. Its object is to secure a cheap and effective apparatus, and our improvement consists in the employment of an incandescing arch [arc]* of carbon in the circuit as the light-giving medium. The subject-matter claimed is hereinafter specifically designated.

2822 The accompanying drawings show all our improvements as embodied in an apparatus substantially like that represented in the patent above mentioned, being the form in which we have practically used it, but some of our improvements may be used in connection with other forms of apparatus with good effect.

Figure 1, represents a plan or top view of the apparatus.

Figure 2, a side elevation thereof.

Figure 3, a side view in elevation of the burner on an enlarged scale to show its details more clearly; and

Figure 4, a similar edge view.

The apparatus being old and well known, except as hereinafter stated, and constituting no part of the subject-matter herein claimed, needs no particular description.

Feb. 19, '85.

Our improved burner or incandescing conductor [arc]*

[* Words and figures enclosed in brackets erased in copy.]
[Matter enclosed between rules erased in copy.]

circular
" " " consists of a horseshoe-shaped or semi-[cylin-
made
drical]* arch of carbon, [preferably]* of carbonized, fibrous or textile material, A, mounted in suitable stationary clamps or supports, and included in an electric circuit. We have made
Feb. 20, '85. use of carbonized paper, [covered with powdered plumbago;]* also wood carbon, charcoal,
the like.
and [ordinary gas carbon.]* We have also
incandescing conductors
used such [arcs]* or burners of various shapes, such as pieces with their lower ends secured to their respective supports, and with their upper ends united so as to form an inverted-V-shaped
incandescing conductors
" " " burner. We have also used [arcs]* of varying contours, that is, with rectangular bends instead of curvilinear ones, but prefer the arch shape. An important practical advantage, which is secured by the arched form of the incandescing carbon, is that it permits the carbon to
2823 expand and contract longitudinally, under the varying temperatures to which it is subjected, when the electric current is turned on or of-, without altering the position of its fixed terminals. Thus the necessity of a special mechanical device to compensate for the expansion and contraction which has heretofore been necessary, is entirely dispensed with, and thus the lamp is materially simplified in its construction. Another advantage of the arched form is that the shadows cast by such a burner is less than that produced by other forms of burners.

We have used such burners in close or hermetically sealed transparent chambers in a vacuum, in nitrogen gas, and in hydrogen gas; but have attained the best results in a vacuum or attenuated atmosphere of nitrogen gas, the great desideratum being to exclude oxygen or other gases which are capable of combining with carbon at high temperatures from the incandescing chamber, as is well understood.

The operation of our improved apparatus will readily be understood from the foregoing description.

We claim as our joint invention:

conductor
Feb. 19, '86. 1. An incandescing [arc]* for an electric lamp, of carbonized, fibrous or textile material, and of an arch or horseshoe shape, substantially as hereinbefore set forth.

[* Words enclosed in brackets erased in copy.]
[Matter enclosed between rules erased in copy.]

Erased Feb. 19, '85. 2. The combination of an incandescing arc of carbon for an electric lamp, of an arch or horseshoe shape, and a transparent hermetically sealed chamber, from which oxygen or other gases capable of combining with carbon at a high temperature are excluded.

3. The combination of an incandescing arc of carbon for an electric lamp, of an arch or horseshoe shape, included in and forming part of an electric circuit, and a transparent hermetically sealed chamber, from which oxygen and other gases capable of combining with carbon at a high temperature are excluded.

---

2. [4.]* The combination, substantially as hereinbefore set forth, of an electric circuit, and incandescing arc of 2824 carbonized paper included in and forming part of said circuit, and a transparent hermetically sealed chamber, in which the arc is inclosed.

Insert A,
Dec. 4, '84.

For signature and witnesses see original specification.

WM. E. SAWYER,
ALBON MAN,
By their attorney, WM. D. BALDWIN.

The above amendments are submitted in view of official suggestions.

Prescott's date of publication is antedated by Sawyer and Man's reduction to practice. The reference is, moreover, inapposite, as it apparently relates strictly to the manufacture of carbon to be used for a voltaic arc, and has nothing to do with incandescing lamps, and no suggestion whatever is made of the invention claimed.

Gardiner and Blossom show a signal lamp with a platinum-wire coil forming an incandescing arc. The form is apparently a mere accident, and the material differs from that of Sawyer and Man, in whose invention both the form and material are essential elements. This reference shows nothing as to a vacuum or air, or other special gases for electric lamps, the platinum being heated in an ordinary atmosphere.

A re-examination of the claims as amended is requested.

Respectfully yours, WM. D. BALDWIN,
Att'y for Sawyer and Man.

May 17, '80.

(Endorsement: Sub. spec. May 17, '80. Amendment Sawyer and Man electric lamp. Filed Jan. 9, '80. U. S. Patent Office, May 17, 1880.)

[* Figure enclosed in brackets erased in copy.]
[Matter enclosed between rules erased in copy.]

2825 Copied.

Room No. 118.

Department of the Interior,
U. S. Patent Office,
Washington, D. C., *May 20th*, 1880.

Electric lamps. Filed Jan. 9, '80. No. 547.

Sawyer and Man, care Baldwin, Hopkins & Peyton, Washington, D. C.:

There is believed to be no patentable novelty in the form of the incandescent carbon conductor, in view of Gardiner and Blossom's patent, the form of the platinum conductor therein shown being essentially an arch or horseshoe, and having all the advantages set forth by app'ts.

Carbon as a material for incandescent conductors is well known.

The 1st, 2d and 3d claims are rejected for the above reasons, the 4th claim will probably be involved in interference.

H. C. TOWNSEND, *Ex'r.*

SEELY.

(Endorsement: ${}^{1}{}_{3}{}^{5}{}_{7}{}^{5}$; 4 ; rej. May 20, '80.)

2826 Copied.

Room No. 152.

(Interference.)

Department of the Interior,
United States Patent Office,
Washington, D. C., *Sept.* 23, 1880.

(U. S. Patent Office, Sept. 25, 1880, ex'r of interferences.)

Sawyer and Man, care Baldwin, Hopkins & Peyton, present:

Please find below a copy of a communication from the examiner concerning your application, No. 547, Jan. 9, 1880, for electric lamps or lights.

Very respectfully,
E. M. MARBLE,
Commissioner of Patents.

2827 & 2828 Room No. —.

Your case, above referred to, is adjudged to interfere with others, hereafter specified, and the question of priority will be determined in conformity with the rules.

The statement demanded by rule 105 must be sealed up and filed on or before the 25th day of October, 1880, with the subject of the invention, and name of party filing it indorsed on the envelope. The subject-matter involved in the interference is, the incandescent conductor for an electric lamp, formed of carbonized paper.

Edison's 1st, Sawyer and Man's 4th claim.

The other party to this interference is T. A. Edison, Menlo Park, N. J. Application filed Dec. 11, 1879. Dyer & Wilber, Washington, D. C., asso. att'ys.

In declaring this interference the objections standing against Sawyer and Man's 1st, 2d and 3d claims are not removed.

H. C. TOWNSEND, *Ex'r.*

P. W. PAGE, *Ass't Ex.*

(Endorsement: Original notice. 5. $^{155}_{73}$; int. 146–30; Sept. 23, 1880.)

2829 Complainant's Exhibit Patent Office Proceedings No. 2.

Edison's File-wrapper and Contents. May 11, 1886. T. G., Ex'r.

Consolidated Electric Light Co.
vs.
Edison Electric Light Co. *et al.*
} H, 3553.

Department of the Interior,
United States Patent Office.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the files of this office of the file-wrapper, contents and drawing down to December 15, 1880, in the matter of the application filed by Thomas A. Edison, December 11, 1879, for improvement in electric lamps and method of making the same.

In testimony whereof, I, M. V. Montgomery, Commissioner of Patents, have caused the seal of the Patent Office to be [seal.] affixed this 22d day of June, in the year of our Lord, one thousand eight hundred and eighty-five and of the Independence of the United States the one hundred and ninth.

M. V. MONTGOMERY,
Commissioner.

2830 To the honorable Commissioner of Patents:

Your petitioner, Thomas A. Edison, of Menlo Park, in the State of New Jersey, prays that letters patent may be granted to him for the invention of an improvement in electric lamps and in the method of manufacturing the same set forth in the annexed specification. (Case No. 187.)

And further prays that you will recognize Lemuel W. Serrell, of the city of New York, N. Y., as his attorney, with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to receive the patent, and to transact all business in the Patent Office connected therewith.

THOMAS A. EDISON.

Menlo Park, N. J., December 8th, 1879.

2831 UNITED STATES OF AMERICA,
State of New Jersey, County of Middlesex. }

On this eighth day of December, in the year one thousand eight hundred and seventy-nine, before the subscriber, a notary public in and for said State, personally appeared the within-named Thomas A. Edison, and made solemn oath that he verily believes himself to be the original and first inventor of the within-described improvement in electric lamps, and in the method of manufacturing the same, and that he does not know and does not believe that the same was ever before known or used, and that he is a citizen of the United States and a resident of Menlo Park, N. J.

THOMAS A. EDISON.

Sworn to before me, the day and year above written.

S. L. GRIFFIN,
[L. S.] *Notary Public.*

2832 To all whom it may concern:

1. Be it known that I, Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, electrician, have invented an improvement in electric lamps and in the method of manufacturing the same, of which the following is a specification:

2. In a former application made by me for letters patent in the United States (case 186) an improvement in electric Feb. 17, '80. lamps is set forth, wherein a [filament of]* carbon is enclosed in a glass bulb and the atmosphere removed as nearly as possible, and the carbon is brought to incandescence by an electric current to form the lamp.

3. My present invention relates to an improvement in the process of manufacturing the carbon [filament Dec. 15. and in the means for securing the same to Feb. 17, '80. the conductors.]*

4. Insert "B," per am'd't Feb'y 17, '80. I make use of paper of the desired thickness as free as possible from foreign substances or adulterations and for this purpose I prefer and use "bristol-board." With suitable instruments, such as a punch and die, I cut out a narrow strip of this paper, preferably in the form of an elliptical bow or an arc of a circle, the ends of the strip being by preference wider than the other portions.

5. A number of these pieces of paper are laid flatwise in the bottom of a mold preferably of wrought iron, and there is laid on them a light weight in the form of a flat piece of gas-retort carbon or other device that will not be distorted by the heat. If several of these are laid one on the other in the mould, a piece of tissue paper is interposed between each one and the next.

6. A cover is used to close the mould, and the mould is raised very gradually to a temperature of about six hundred degrees Fahr. This allows the volatile portions of the paper to pass away,

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[* Words enclosed in brackets erased in copy.]

and at the same time the mould retains the paper in its proper shape, and the paper is prevented from curling up or becoming dis- 2833 torted, as it would be likely to do if the heat were applied suddenly, or the light weight dispensed with.

7. The mould is now placed in a furnace and heated almost to a white heat, and then removed and allowed to cool gradually.

8. The carbon filaments will be found to be smaller than the card-board blanks, and to be sufficiently strong and flexible for handling. The ends of the carbon are to be secured to the metallic conductors in any convenient manner.

9. The carbon filaments prepared as aforesaid are very uniform in their resistance to the electric current, and I make them thin and of a sufficient length to offer a great resistance to the passage of the current.

10. The clamps that connect the conductors to the ends do not require to be pressed with much force on the carbon, because the resistance to the passage of the current between the clamps and the carbon will be less than the resistance of carbon filament, hence but little heat will be developed at the clamps.

11. In ordinary electric lamps the large carbons do not offer much resistance to the electric current, and unless the clamps are very firmly pressed upon the carbon, the current meets with considerable resistance at the clamps and hence heat is developed at such clamps.

---

12. The clamps that I prefer are made of a steel spring tipped at the ends with platina or similar metal; the spring is bent into a circle or bow, and the ends crossed and turned back toward each other similar in shape to the figure 8 with the opening for the carbon between the spring ends at the upper part; the object of this shape is that the pressure of the clamps on the carbon may be increased by the expansion of the spring by the heat of the lamp instead of being lessened, as it would be if the wire was only bent into a single bow.

Substitute "B," per am'd't Dec. 15, '80.

13. The spring clamps are connected to the platina or similar conducting wires by clips, and the platina wires pass through the glass of the globe or bulb that contains the lamp. The air is to be exhausted from the bulb by any suitable 2834 means, and it is preferable to exhaust said air as perfectly as possible, say to the one eight hundred thousandth of an atmosphere.

14. The lamps are suspended or supported in any convenient manner, and the electric current from a magneto-electric machine, or other source of electricity is passed through the lamp, and brings the carbon filament to a high incandescence and the lamp is very durable, and a large number of such lamps can be placed in the electric circuit in multiple arc, or otherwise as desired.

[Matter enclosed between rules erased in copy.]

15. In the drawing—

Fig. 1 is a vertical section of the lamp complete.

Fig. 2 is a side view in large size of the clamping device.

Fig. 3 is a section of the line x x is still larger size.

Fig. 4 is the wire forming one of the clamps before it is bent up to shape.

Fig. 5 is the paper blank before it is carbonized, and

Fig. 6, is a section of the box.

16. The blank *a* is cut out of paper material such as "bristol-board," in the proper shape, the form shown in Fig. 5 is preferred, the same is laid in the metal mold *b*, and when several are laid one on the other, pieces of thin paper are introduced between. The weight *d*, is laid on these; it is to be heavy enough to prevent the paper curling up under the action of the heat, but it allows the paper to contract as the volatile matters are expelled by the heat. This weight *d*, is of gas-retort carbon. The cover *e* is placed on the mold and secured and the mold is heated as before described.

17. The carbon filament *i*, forms the lamp when rendered incandescent by the electric current passed through it.

18. The clamp is made of the wire *h*, at the ends of which are tips or small rivets *r*, of platina or similar material.

2835 19. The wire is bent up and crossed as shown, so as to act as a spring in clamping the end of the carbon filament that is placed within such clamp. The

Dec. 15, '80. wire passes through [is attached to]* a small stock, *o*, into which the conducting wire *t*, passes and is clamped.

20. The conductors for the two ends of the carbon are inserted into the glass and the latter intimately melted around them; the carbon and clamps are connected to the wires and the parts introduced within the neck of the bulb *m*, and the glass melted at *v*, the air is exhausted from the globe by the

Dec. 15, '80. tube *k*, which originally is [that passes away]* as shown by

Insert C, per am'd't Dec. 15, '80. dotted lines but which is [and the tube]* melted together ᴧ while the vacuum is maintained.

21. The lamp is ready for the conductors to be attached to it, and the carbon is rendered incandescent by the current that passes through the same. It is durable as there is nothing to combine with the carbon and it is substantially indestructible.

[* Words enclosed in brackets erased in copy.]

Insert "D," per am'd't Dec. 15, '80.

I claim as my invention,

Substitute "A," per am'd't Jan. 3, '80.

Insert E, March 11, '82.

First. The manufacture of carbons for electric lights from paper.

Second. The method herein specified of manufacturing carbons for electric lights, consisting in exposing the filament of paper to the action of heat in a mold to drive off the volatile portions and carbonize the paper, substantially as set forth.

Erase per am'd't Dec. 15, '80.

Third. A carbon for electric lights made as a filament, with the ends broader for the clamping devices that connect the conductors.

2836 Fourth. The clamp for the carbon of an electric lamp composed of a bow or elliptical spring with the ends crossing each other, and receiving between them the carbon substantially as set forth.

Signed by me, this 8th day of December, A. D. 1879.

THOMAS A. EDISON.

Witnesses:
S. L. GRIFFIN.
J. F. DOWNING.

(Endorsement: U. S. Patent Office, Dec. 11, 1879; case No. $187—\frac{16}{30}$. Dated Dec. 8, 1879; Thomas A. Edison, improvement in electric lamps and in the method of manufacturing the same.)

2837 Copied.

Room No. —.

Department of the Interior,
United States Patent Office,
Washington, D. C., *Dec.* 30, 1879.

Case 187.

T. A. Edison, care of L. W. Serrell, box 4689, N. Y. city.

Electric lamps and methods of making the same. Filed December 11, 1879.

Claim 1 is ambiguous, it not being clear whether the claim covers an article or a process. Claim 3 is too broad. The word filament does not distinguish applicant's carbon from others, except in degree.

C. L. BUCKINGHAM, *Ass't.*

H. C. TOWNSEND, *Ex'r.*

(Endorsement: 146-30; 1; rejection, Dec. 30, 1879.)

[Matter enclosed between rules erased in copy.]

2838 NEW YORK, *January* 2, 1880.

Hon. Com. of Patents.

SIR: In the matter of my application, No. 187, for patent on electric lamps, filed Dec. 11, 1879, I amend the specification by inserting after title.

("Case No. 187.")

The first claim is erased and the following substituted:

Substitute "C^2" per "A," am'd't Feb'y 17, '80.	"First. An electric lamp formed of carbonized paper."

The 3d claim is believed to be correct; no other meaning than "thread-like" is known to attach to the word "filament," and this claim is meant to apply to a thread-like carbon with broad ends, and that is believed to be new.

Respectfully yours, THOS. A. EDISON,
Per LEMUEL W. SERRELL, *Att'y.*

(Endorsement: Thos. A. Edison electric light. Case 187; amendment; U. S. Patent Office, Jan. 3, 1880. 146–30. "A." 2. Amendment Jan. 3, 1880. Cancelled.)

2839 To the Comm'r of Patents.

In the matter of my application for patent for improvement in electric lights, No. 187, filed December 11, 1879, I hereby appoint G. W. Dyer and Z. F. Wilber, of the firm of Dyer & Wilber

Associate attorneys to prosecute said application to make alteration and amendments therein, to receive the patent, and to transact all business in the Patent Office connected therewith in my place and stead.

Correspondence to be with them.

Signed at Menlo Park, N. J., this 24th of January, 1880.

T. A. EDISON.

(Endorsement: U. S. Patent Office, Jan. 30, 1880. 146–30; 3. Asso. power of att'y, Jan. 30, 1880.)

2840 Hon. Commissioner of Patents.

SIR: In the matter of my application No. 187 for a patent for "electric light," filed December 11, 1879, I amend as follows:

Cancel amendment of January 3, 1880.

Erase words "filament of" in 11th line, first page.

Erase "filament," line 18, page 1.

Insert after line 19, page 1, "I have found that it is desirable in an electric lamp that there should be a very great resistance in a very small amount of incandescing material.

[Matter enclosed between rules erased in copy.]

B. And that carbon prepared from paper by my process possesses the necessary high resistance.

By using such carbon I am enabled to use an exceedingly small carbon, so small that its dimensions are best expressed by applying to it the term filament, it being thread-like in size."

Erase first claim and insert.

C_2. "First. The incandescent conductor for an electric lamp formed of carbonized paper, substantially as set forth."

It is believed these amendments obviate the office objections.

DYER & WILBER,
Attorneys for Edison.

Feb. 17, 1880.

(Endorsement: U. S. Patent Office, Feb. 11, 1880. 146-30; 4; "B. C." Amendment Feb. 17, 1880.)

2841 (Copied.)

Room No. 152.

(Interference.)

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *September* 23, 1880.

T. A. Edison, care Dyer & Wilber, present:

Please find below a copy of a communication from the examiner concerning your application filed December 11, 1879, for electric lamps, etc., (case No. 187.)

Very respectfully,
E. M. MARBLE,
Commissioner of Patents.

Room No. —.

Your case above referred to is adjudged to interfere with others hereafter specified, and the question of priority will be determined in conformity with the rules.

The statement demanded by rule 105 must be sealed up and filed on or before the 25th day of October, 1880, with the subject of the invention, and name of party filing it, endorsed on the envelope.

The subject-matter involved in the interference is, the incandescent conductor for an electric lamp formed of carbonized paper.

Edison's first claim; Sawyer and Man's 4th claim.

2842 The other parties to this interference are Sawyer and Man, whose application was filed Jan. 9, 1880, No. 547.

William E. Sawyer, New York city.

Albon Man, Brooklyn, N. Y., care Baldwin, Hopkins & Peyton, associate attorneys, Washington, D. C.

H. C. TOWNSEND, *Examiner.*

P. W. PAGE, *Ass't Ex.*

(Endorsement: 146–30; 5; int. 155–73. Sep. 23, '80.)

2843 (Edison, No. 187.)

Room 152.

T. A. Edison, electric lamps. Filed December 11th, 1879.

Hon. Commissioner of Patents:

This application is now in interference with an application filed by Sawyer and Man, as to a part of the subject-matter contained therein only, there being claims and subject-matter not interfering with the claims made by Sawyer and Man, or with any claims which could be made upon the subject-matter shown or described by them.

The application can be legitimately divided.

I have, therefore, determined to take advantage of the provisions of rule 125, cancel by amendment the matter herein adjudged not to interfere, and to file a new application therefor, which application is this day filed and bears my serial number 264, and which is, a-to such matter, a continuation of this application, relating back thereto.

The present application is accordingly amended as follows:

Erase the words "and in the means for securing the same to the conductors," lines 18 and 19, page 1.

Erase from line five, page 4, to line 13, page 5, inclusive, and insert in lieu thereof:

> "In order that not only the improvement in the carbon may be understood, but that the manner of its embodiment
> B. in a complete lamp and its utility may be better understood, a complete lamp and the method of its manufacture will be illustrated and described."

In lines 25 and 26, page 6, erase "is attached to," and insert "passes through."

In line 10, page 7, erase "that passes away," and insert "which originally is."

In line 11, page 7, erase "and the tube," and insert "but which is."

2844 At end of line 11 insert:

C. "When a proper vacuum has been attained."

Before claims insert:

> "It is not intended to claim anything herein shown and described except the incandescent conductor made of paper as all such other matters of invention as are herein shown or

D. described are only shown as incidental to and illustrative of the manner of manufacture and use of the paper carbon, and form the subject-matter of another and separate application for a patent made by me."

Erase all claims except the first.

T. A. EDISON,
Per DYER & WILBER,
His Attorneys.

Washington, D. C., December 15th, 1880.

(Endorsement: U. S. Patent Office, Dec. 15, 1880. 152. 146–30. No. 187, 6. Amendment Dec. 15, 1880. "B. D.")

2845 Div. 16.

No. —. 146.
1879. 30.
(No. 187.)

Thomas A. Edison,
Of Menlo Park,
County of ——,
State of New Jersey.
Electric lamps and method of making the same.
Rec'd Dec. 11, 1879.
Petition, " "
Affidavit, " "
Specification, " "
Drawing, " "
Model, " "
Cert. dep., " "
Cash, $15, Dec. 11, 1879.
Add'l fee cert., ——.
Add'l fee, cash, ——.
Examined, ——.
Issue, ——.
Patented —— —, 187–.
Circular ——.
Dyer & Wilber, asso., Washington, D. C.
Lemuel W. Serrell, box 4689, New York city.

1879.

Contents.

Application papers:
1. Rej. Dec. 30, '79.
2. Am'd't Jan. 3, 1880, "A."
3. Asso. power of att'y, Jan. 30, 1880.
4. Amendment, Feb'y (C^2), 17, '80.
5. Int. 155–73, Sept. 23, 1880.
6. Dec. 15, 1880, Am'd't "B D."

2846 7.

8.

T. A. Edison

Carbon for Electric Light.

Filed Dec 11, 1879.

No. 286.
C. E. Light Co.
v.
McK Light Co.
} p. 2847

Fig: 1

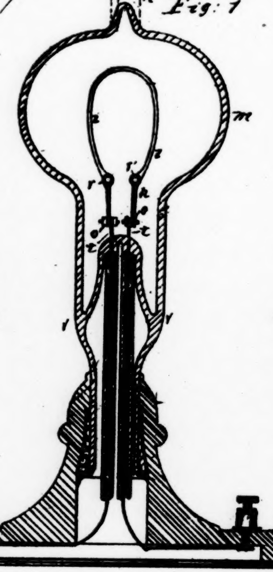

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Fig: 4

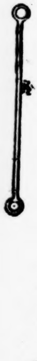


Fig: 5

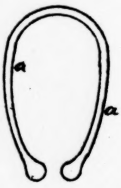


Fig 2

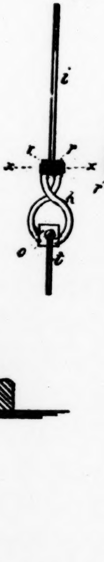


Fig: 3.

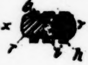
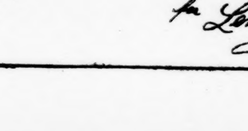


Fig: 6



Witnesses
Chas H Smith
William G Mott

Inventor.
Thomas A. Edison
per Lemuel W. Serrell
atty

T. A. Edison

Carbon for Electric Light.

Filed Dec 11, 1879.

No. 286.
C.E. Light Co.
v.
McK. Light Co. } p. 2849

Fig: 1

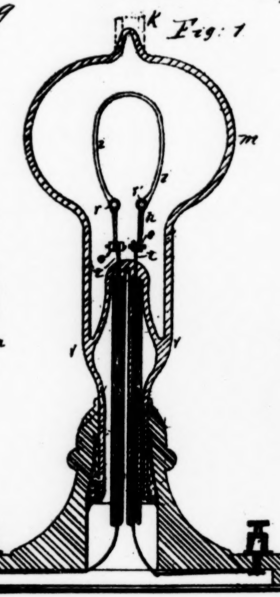

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Fig: 4

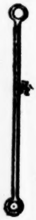


Fig: 5

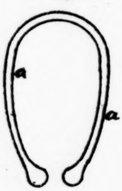


Fig 2

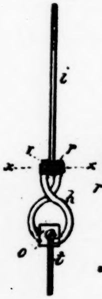


Fig: 3.

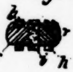
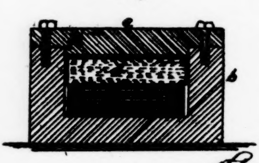


Fig: 6



Witnesses
Chas H Smith
William G Mott

Inventor.
Thomas A Edison
per Lemuel W Serrell
atty

2 Sheets—Sheet 2.

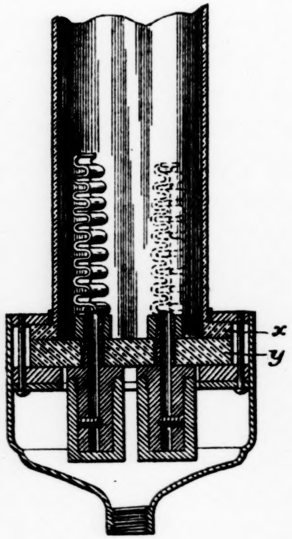
W. E. SAWYER & A. MAN.

ELECTRIC LIGHT.

No. 317,676. Patented May 12, 1885.

No. 286.
C. E. Light Co } p. 2850
McK Light Co.

Fig 5



Witnesses:
W W Evans
D.W. Edelin

Inventor.
William E. Sawyer
Albon Man, by
Amos Broadnax
Atty.

2 Sheets—Sheet 1.

W. E. SAWYER & A. MAN.

ELECTRIC LIGHT.

No. 317,676. Patented May 12, 1885.

No. 286.
E. Light Co } p. 2851
McK Light Co

Figure 2.

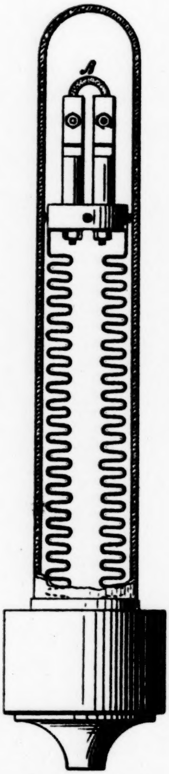


Figure 3.

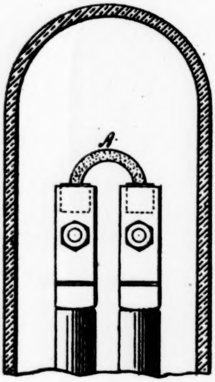


Figure 4.

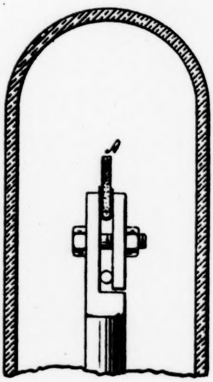
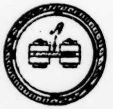


Figure 1.



Witnesses:
Geo. W. Miatt
Jas. G. Cooper

Inventors:
Wm. E. Sawyer
Albon Man
by their Atty
W. D. Baldwin

9.
10.
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16.
17.
18.
Title: Improvement in ——.
Ex'd: H. M. H.
E. A. M.

36 Electricity.
Electric lights.

(Endorsement: Application of T. A. Edison, 12187. 10, '85.)

(Here follows diagram marked p. 2847.)

2848 COMPLAINANT'S EXHIBIT PATENT OFFICE PROCEEDINGS NO. 4.

File-wrapper and Contents of Interference. May 11, 1886. T. G., Ex'r.

CONSOLIDATED ELECTRIC LIGHT CO.
vs. } H, 3553.
EDISON ELECTRIC LIGHT CO. *et al.*

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the files of this office of the file-wrapper and contents in the matter of the interference William E. Sawyer and Albon Man *vs.* Thomas A. Edison, for improvement in electric lamps or lights.

In testimony whereof I, M. V. Montgomery, Commissioner of Patents, have caused the seal of the Patent Office to be [L. S.] affixed this 19th day of June, in the year of our Lord one thousand eight hundred and eighty-five, and of the Independence of the United States the one hundred and ninth.

M. V. MONTGOMERY,
Commissioner.

(Here follow diagrams marked pp. 2849, 2850, & 2851.)

2852 DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *September* 23, 1880.

(U. S. Patent Office, Sept. 25, 1880, ex'r of interferences.)

To the examiner of interferences:

An interference is found to exist between the cases and in respect to the invention below specified to wit:

228—286

Cases.

Sawyer, W. E., New York city, and Man, A., Brooklyn, N. Y., No. 547, January 9, 1880; Baldwin, Hopkins & Peyton, Washington, D. C., attorneys.

T. A. Edison, Menlo Park, N. J., Dec. 11, 1879, (case No. 187); Dyer and Wilber, Washington, D. C., attorneys.

Claim.

The incandescent conductor for an electric lamp formed of carbonized paper; Edison's 1; Sawyer & Man's 4th claim.

(Endorsement: 7768; 1; declaration of interference Sep. 23, 1880.)

2853 In the United States Patent Office.

William D. Baldwin, Sept. 27, 1880, Washington, D. C.

U. S. Patent Office,
Nov. 11, 1880,
Ex. of interferences.

In the matter of the preliminary interference declared Sept. 22, 1880, between the interfering applications for electric lights of Sawyer and Man, filed Jan. 9, 1880 (case 547), and that of Thomas A. Edison, filed Dec. 11, 1879.

City and County and State of New York, *ss:*

William E. Sawyer and Albon Man, being severally duly sworn, depose and say: We conceived the invention of the subject-matter in controversy, to wit: an incandescent conductor for an electric lamp formed of carbonized paper some time during the month of March, 1878; communicated it to others immediately thereafter, and made numerous experiments in connection therewith continuously until March, 1879; in our experiments we used an incandescing arc of carbon or carbonized material in various 2854 forms; the model accompanying this application is one of numerous machines which were practically used by us, and our experiments were known to many persons.

W. E. SAWYER.
ALBON MAN.

Sworn to and subscribed before me this 28th September, 1880.

THEODORE DE WITT, Jr.,
Notary Public, Rockland County.

[L. S.]

Certificate filed in New York county.

(Endorsement: United States Patent Office, Nov. 11, 1880; examiner of interferences; Sawyer and Man *vs.* Edison; statement of Sawyer and Man, filed Oct. 25, 1880. E. K. W.)

2855 In the United States Patent Office.

In Re Interference SAWYER AND MAN *vs.* EDISON. } Carbons for Electric Lamps.

U. S. Patent Office, Nov. 11, 1870, ex. of interferences.

Statement of T. A. Edison.

Commissioner of Patents.

SIR: I first experimented with and used carbons made from paper in 1876.

I embodied the same in an incandescent electric lamp about November or December, 1878.

THOMAS A. EDISON.

Subscribed and sworn to before me this 18th day of Oct., 1880.

S. L. GRIFFIN,
[L. S.] *Notary Public, Middlesex Co., N. J.*

(Endorsement: United States Patent Office, Nov. 11, 1880; examiner of interferences; Sawyer and Man *vs.* Edison; statement of Edison, filed Oct. 25, 1880, approved Nov. 11, 1880. E. K. W.)

2856 Copy sent October 25, 1880. E. L. D.

Room No. 1.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *October* 25, 1880.

In Re Interference SAWYER AND MAN *vs.* EDISON. } Before the Examiner of Interferences.

Subject-matter: Electric lamp.

Sawyer and Man, Baldwin, Hopkins & Peyton, present:

Sawyer and Man will be required to amend their statement so as to set forth the date when they reduced the invention to practice.

Until Nov. 10, 1880, will be allowed for that purpose.

J. B. CHURCH,
Examiner of Interferences.

EDWARD KENT, JR.,
Acting Assistant.

2857 Copy sent Oct. 25, 1880. E. L. D.

Room No. 1.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Oct.* 25, 1880.

In Re Interference SAWYER AND MAN *vs.* EDISON. } Before the Examiner of Interferences.

Subject-matter: Electric lamps.

Thomas A. Edison, Dyer & Wilder, present:

Edison will be required to amend his statement so as to set forth the date when he disclosed his invention to others.

Until Nov. 10, 1880, will be allowed for the filing of the amendment called for.

J. B. CHURCH,
Examiner of Interferences.

EDWARD KENT, JR.,
Acting Assistant.

(Endorsement: 7768; 4; office to Sawyer & Man and Edison interference; prehearing p'p'd to Nov. 10, 1880; Oct. 25, 1880.)

2858 United States Patent Office.

In the matter of the interference.

In Interference SAWYER AND MAN *vs.* EDISON. } Before the Examiner of Interferences.

Electric lamps.

WASHINGTON, D. C., *Nov.* 5, 1880.

To the Commissioner of Patents.

SIR: Herewith we file an affidavit of Albon Man in compliance with the official letter of October 25th.

This affidavit is as full a compliance with the official letter as we can now furnish, in view of the facts therein stated.

It is impossible for us, within the time allowed, to furnish an affidavit of Sawyer, as he is absent from home, and we have been unable as yet to ascertain his whereabouts. It is hoped, however, that the accompanying paper will be sufficient.

Respectfully,

BALDWIN, HOPKINS & PEYTON,
Attorneys for Sawyer & Man.

(Endorsed: U. S. Patent Office, Nov. 5, 1880, Sawyer and Man *vs.* Edison.)

2859 United States Patent Office.

UNITED STATES PATENT OFFICE, *Nov.* 11, 1880.

Ex. of interferences.

SAWYER AND MAN *vs.* T. A. EDISON.	Electric Lamp Inteiference.

Additional Preliminary Statement on Behalf of Sawyer and Man.

CITY, COUNTY, AND STATE OF NEW YORK, *ss:*

Albon Man being duly sworn, deposes and says that he is one of the parties to the above-entitled interference; that the invention in controversy was reduced to practice by Wm. E. Sawyer and himself at least as early as the month of March, 1878; that said Wm. E. Sawyer is away from home, and will probably be absent several days, and that his precise address is unknown to this deponent and further saith not.

ALBON MAN.

Subscribed and sworn to before me November 4, 1880.

VICTOR LEVI,

[L. S.] *Notary Public, 25, New York County.*

(Endorsement: Amended statement of Sawyer and Man, filed Nov. 5, 1880, approved Nov. 11, 1880. E. K. W.)

2860 United States Patent Office.

(United States Patent Office, Nov. 11, 1880, examiner of interferences.)

In Re Interference SAWYER AND MAN *vs.* EDISON.	Carbons for Electric Lamps.

Statement of T. A. Edison.

Commissioner of Patents.

SIR: I first experimented with and used carbon made from paper in 1876.

I embodied the same in an incandescent electric lamp about November or December, 1878.

Disclosure thereof was made to others in both instances at the dates set forth.

THOMAS A. EDISON.

Subscribed and sworn to before me this 10th day of November, 1880.

S. L. GRIFFIN,

[L. S.] *Notary Public, Middlesex County, N. J.*

(Endorsement: Sawyer and Man *vs.* Edison, amended statement of Edison. Filed Nov. 11th, 1880. E. K. W.)

2861 (Copy sent Nov. 11, 1880. E. L. D.)

Room No. 1.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Nov.* 11, 1880.

In Re Interference SAWYER AND MAN *vs.* EDISON. } Before the Examiner of Interferences.

Subject-matter: Electric lamps or lights.

Sawyer and Man, care Wm. D. Baldwin, Washington, D. C.; Thomas A. Edison, care Dyer & Wilber, Washington, D. C.:

The parties hereinafter named are hereby notified that as to their inventions, adjudged to interfere with each other in the particulars specified in office letter of the 23d of September, 1880, a hearing will be granted on the 7th day of February, 1881.

The testimony of the respective parties must be closed previous to the duties hereinafter designated. The party first filing an application for a patent will be deemed the first inventor, in the absence of proof to the contrary.

Rebutting testimony, but no other, may be taken by parties on whom rests the burden of proof after the closing of the testimony of the party who first filed his application.

All testimony must be taken, forwarded and printed in
2862 accordance with the published rules of practice of the office.

Wm. E. Sawyer of New York city and Albon Man of Brooklyn, N. Y., filed application January 9, 1880.

Testimony-in-chief must be closed Dec. 11, 1880.

Attorney of record, Wm. D. Baldwin, of Washington, D. C.

Associate-, Baldwin, Hopkins & Peyton, Washington, D. C.

Thomas A. Edison, of Menlo Park, N. J., filed application Dec. 11, 1879.

Testimony must be closed January 3, 1881.

Attorney of record, L. W. Serrell, of New York city.

Associate-, Dyer & Wilber of Washington, D. C.

Rebutting testimony by Sawer & Man.

Must be closed Jan. 18, '81.

J. B. CHURCH, *Examiner.*

(Endorsement: 7768; 7; Nov. 11, '80.)

2863 Baldwin, Hopkins & Peyton, received Nov. 20, 1880, Washington, D. C.

New York, *Nov.* 18, 1880.

U. S. Patent Office.

Sawyer and Man }
vs. } Electric Lamp Interference.
T. A. Edison. }

It is hereby stipulated between counsel that the times for taking testimony, and for the hearing designated in the official letter of November 11, 1880, be hereby extended eight weeks, for mutual convenience.

BALDWIN, HOPKINS & PEYTON,
Attorneys for Sawyer and Man.
DYER & WILBER, *For Edison.*

(Endorsement: U. S. Patent Office, Nov. 20, 1880. 7768; 8; Sawyer and Man *vs.* Edison; stipulation; stipulation granted; times set as follows: Sawyer and Man to close Jan. 7, 1881, Edison to close Feb. 1, 1881; Sawyer and Man in rebuttal to close Feb. 15, 1881; day of hearing March 2, 1881. 22, 11, '80. F. MacArthur, assistant examiner.)

2864 Copy sent.

Room No. 1.

Department of the Interior,
United States Patent Office,
Washington, D. C., *Nov.* 22, 1880.

In Re Interference Sawyer and Man } Before the Examiner of
vs. } Interferences.
Edison. }

Electric lamps or lights.

Sawyer and Man, care Baldwin & Co., Washington, D. C.; Thomas A. Edison, care Dyer & Wilber, Washington, D. C.:

Please find below a communication from the examiner in charge of interferences in regard to the above-cited case.

Very respectfully, E. M. MARBLE,
Commissioner of Patents.

Per stipulation the times for taking testimony in this case are extended as follows:

Sawyer and Man's testimony-in-chief to close Jan. 7, 1881.

Edison's testimony-in-chief to close Feb. 1, 1881.

2865 Sawyer and Man's testimony in rebuttal to close Feb. 15, 1881.

Hearing March 2, 1881.

J. B. CHURCH, *Examiner.*

Electros.

(Endorsement: 7768; 9; office to Sawyer and Man and Edison interference; hearing postponed to March 2, 1881; Nov. 22, 1880.)

2866 Copy sent.

Room No. 1.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Nov.* 23, 1880.

In Re Interference SAWYER AND MAN
vs.
EDISON.

Before the examiner of interferences.

Subject-matter: Electric lights.

Sawyer and Man, care Baldwin, Hopkins & Peyton, present; Edison, care Dyer & Wilber, present:

Times are reset in accordance with stipulation as follows:
Sawyer and Man to close Feb. 7, 1881.
Edison to close March 1, 1881.
Sawyer and Man in rebuttal to close March 15, 1881.
Hearing April 4, 1881.

J. B. CHURCH.

F. McARTHUR,
Assistant Examiner.

(Endorsement: 7768; 10; office to Sawyer and Man and Edison interference; hearing p'p'd to April 4, 1881; Nov. 23, 1880.)

2867 In the United States Patent Office.

Application of WILLIAM E. SAWYER and ALBON MAN *vs.* Application of THOMAS A. EDISON. In Interference. Carbon for Electric Lights.

To the Commissioner of Patents.

DEAR SIR: Please to recognize Amos Broadnax of 57 Broadway, New York, as attorney in the above-entitled application and interference on behalf of said Sawyer and Man—the said Broadnax being hereby appointed as such attorney and all former power- of attorney made in the matter of said application and interference are hereby revoked.

THE ELECTRO DYNAMO LIGHT CO.,
By THOS. WALLACE, *President.*

Witness-:
F. L. GAYLORD.
W. G. BENHAM,
Sole Assignee of Sawyer and Man.

Dated, Dec. 4, 1880.

(Endorsement: U. S. Patent Office, Dec. 9, 1880, power of attorney to Amos Broadnax.)

2868 Copy sent.

Room No. 1.

Department of the Interior,
United States Patent Office,
Washington, D. C., *Dec.* 9, 1880.

In Re Interference Sawyer and Man *vs.* Edison. } Before the Examiner of Interferences.

Subject-matter: Electric lamps or lights.

Baldwin, Hopkins & Peyton, Washington, D. C.; Thos. A. Edison, care Dyer & Wilber, Washington, D. C.:

The power of attorney of Baldwin, Hopkins & Peyton in this case has been revoked in favor of Amos Broadnax, 57 Broadway, New York city.

J. B. CHURCH,
Examiner of Interferences.

(Endorsement: 7768; 11; office to Baldwin, Hopkins & Peyton and Edison; Dec. 9, 1880.)

2869 In the United States Patent Office.

William E. Sawyer and Albon Man *vs.* Thomas A. Edison. } Interference—Electric Lights.

Notice of Motion.

To Messrs. Dyer & Wilber, Washington, D. C., solicitors for T. A. Edison.

Gentlemen: Please take notice that on Wednesday, the 26th day of January, 1881, at the hour fixed by the rules in such cases, I will move to dissolve the above-entitled interference upon the ground that there is not interference between the claims of the contestants; and that in support of said motion I will use the papers on file in the case, including the papers composing the two applications.

Very respectfully,
AMOS BROADNAX,
Solicitors for Sawyer and Man.

Dated January 22d, 1881.

2870 (Endorsement: U. S. Patent Office Jan. 26, 1881:

SAWYER AND MAN
vs.
THOMAS A. EDISON.
Interference. Electric Lighting.

7768. *Notice of Motion to Des-olve.* 12.

Referred to the primary examiner for consideration as provided in rule 116.

J. B. CHURCH, *Examiner.*

26-1-'81.

Due and timely service of the within notice is hereby admitted.

DYER & WILBER,
For Edison.

This motion having been heard it is denied for the reason that while the claim of Sawyer and Man is in the form of a combination, and in terms embraces the carbon conductor enclosed in a transparent hermetically sealed chamber, the specification states that the invention relates especially to the conductor, and that the apparatus is old and well known, and constitutes no part of the subject-matter claimed.

From this it clearly appears that the gist of the alleged invention is in the peculiar conductor, and whether it is used in an old transparent chamber or not, is immaterial to the issue of this interference.

Limit of appeal 20 days.

F. L. FREEMAN, *Examiner.*

January 28, 1881.)

2871 NEW YORK, *January 26th*, 1881.

Honorable Commissioner of Patents:

SIR: In the matter of interference of Sawyer and Man *vs.* Thomas A. Edison on electric lighting, I found on my return from Boston this day, a notice of a motion made by attorney of Sawyer and Man for dissolving the interference and set for hearing this day.

I was not aware of any such interference, and did not know that I was attorney in connection therewith. I cannot make out the name of Sawyer and Man's attorney, and therefore take the liberty of writing and requesting that if any such motion is under consideration, that the hearing may be postponed to such time as will allow Mr. Edison to be represented; I have sent the notice and a copy hereof to Mr. Edison.

Respectfully yours, LEMUEL W. SERRELL.

(Endorsement: U. S. Patent Office Jan. 27, 1881.)

2872 In the United States Patent Office.

SAWYER AND MAN
vs.
T. A. EDISON.
} Electric Lamp Interference.

Upon motion to dis-olve the interference.

This motion having been denied by the primary examiner, an appeal is hereby taken to the Commissioner in person.

The ground of the motion is that there is no interference between the claims of the contestants, and the reason of appeal is that the examiner erred in not granting the motion to des-olve.

The office is respectfully requested to set a day for the hearing of this appeal.

Respectfully submitted.

AMOS BROADNAX, *Attorney.*

Dated February 3d, 1881.

(Endorsement: U. S. Patent Office, Feb. 4, 1881. Sawyer and Man *vs.* Edison. Appeal by Sawyer and Man.)

2873 Room No. 4.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *February 5th*, 1881.

Copy.

SAWYER AND MAN
vs.
THOMAS A. EDISON.
} Interlocutory Appeal.

You are informed that the hearing on the above appeal is fixed for February 14th, 1881, at 10 o'clock, a. m.

Respectfully, —— ——,
Chief Clerk for Commissioner.

Sawyer and Man, care Amos Broadnax, 57 Broadway, N. Y. city.

Thomas A. Edison, care Dyer & Wilber, present.

(Endorsement: 14; office to Sawyer and Man *v.* Edison. Notice of hearing by the Comm'r. Feb. 5th, 1881.)

2874 In the United States Patent Office.

WILLIAM E. SAWYER and ALBON MAN
vs.
THOMAS A. EDISON.
} Interference. Electric Lights.

Messrs. Dyer & Wilber:

Take notice that on February 14th, 1881, I will submit a motion to the examiner having charge of the above-entitled interference that the time for taking testimony be postponed until after the decision of the Commissioner upon the appeal now pending in this matter, as stated in the accompanying affidavit, which will be submitted in support of said motion.

Very respectfully. AMOS BROADNAX.

Dated February 8th, 1881.

WASHINGTON, D. C., *Feb.* 19, 1881.

Good service.

DYER & WILBER,
For Edison.

2875 In the United States Patent Office.

WILLIAM E. SAWYER and ALBON MAN
vs.
THOMAS A. EDISON.
} Interference. Electric Lighting.

CITY AND COUNTY AND STATE OF NEW YORK, *ss:*

AMOS BROADNAX being duly sworn, says: That he is attorney for Sawyer and Man in the above-entitled interference.

That on January 26th, 1881, he moved the primary examiner to dissolve the said interference on the ground that there is no interference between the claims of the applicants.

That on January 28th the said examiner denied said motion. That on February 4th, 1881, deponent filed an appeal *to* the Commissioner in person from the decision of said examiner denying said motion. That no time has yet been set for the hearing of said appeal. That the time limited by the office within which Sawyer and Man should put in their affirmative testimony expired on February 7th, 1881. That no testimony has been taken in the case by either party. That said motion to dissolve was made in good faith, and that said appeal is taken in good faith and not for the purpose of delay, but in the firm belief that there is no interference between the claims of the respective parties. That the two applicants do not in fact claim substantially the same patentable invention as required by rule 93 in such cases; deponent therefore verily believes that the interference as now decreed ought to be dissolved.

Deponent therefore moves the examiner having charge of this interference that the time for taking testimony be postponed until after the decision of the Commissioner upon said appeal, and
2876 that the time for taking testimony be then fixed by the office in case the Commissioner decides that the claims of the applicants do interfere.

Respectfully submitted. AMOS BROADNAX.

Dated February 8, 1881.

Subscribed and sworn to before me this 8th day of Feb., 1881.

WM. H. BROADNAX,
[L. S.] *Notary Public, Kings County, New York.*

Certificate filed in N. Y. Co.

2877 (Endorsement: U. S. Patent Office, Feb. 9, 1881, U. S. Patent Office.

SAWYER AND MAN *vs.* T. A. EDISON.	Interference. Notice of Motion.

The motion is granted and as the Commissioner has this day decided the appeal, until the 17th inst. is allowed for the presentation of a proper motion for an extension of time, if any good grounds exist therefor.

Appeal waived by Edison.

J. B. CHURCH, *Examiner.*

14–2–'81.

Copy of the within notice and affidavit served upon us this —— day of February, 1881.)

2878 UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Feb.* 14*th,* 1881.

In Re Interference SAWYER AND MAN *vs.* EDISON.	Before the Examiner of Interferences.

Subject-matter, electric lamps or lights.

Sawyer and Man, care A. Broadnax, 57 Broadway, N. Y. city;
Thomas A. Edison, care Dyer & Wilber, Washington, D. C.

The motion is granted and as the Commissioner has this day decided the appeal, until the 17th inst. is allowed for the presentation of a proper motion for an extension of time if any good grounds exist therefor.

Appeal waived by Edison.

J. B. CHUCH,
Examiner of Interferences.

(Endorsement: Office to Sawyer and Man and Edison. Interference. Motion granted and appeal waived; February 14, 1881. 7768–13.)

2879 Room No. 4.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *February* 14, 1881.

In the Matter of the Interference Between SAWYER and MAN *vs.* EDISON ELECTRIC LAMPS.	Interlocutory Appeal.

You are informed that for reasons on file, the decision of the primary examiner is affirmed.

Respectfully,

—— ——,
Chief Clerk for Commissioner.

Sawyer and Man, care Amos Broadnax, 57 Broadway, N. Y. city; Thomas A. Edison, care Dyer & Wilber, present.

(Endorsement: Office to Sawyer and Man *vs.* Edison; notice of decision by Commissioner; February 14, 1881.)

2880 United States Patent Office.

SAWYER and MAN
vs.
EDISON.
} Interlocutory Appeal.

Electric Lamps.

Application of Sawyer and Man filed January 9, 1880.

Application of Thomas A. Edison filed December 11, 1879.

Amos Broadnax for Sawyer and Man.
Messrs. Dyer & Wilber, for Edison.

This is an appeal from the decision of the primary examiner upon motion to dissolve the interference on the ground that there is no interference between the claims of the contestants.

Edison's claim in interference is "the incandescent conductor for an electric lamp formed of carbonized paper."

Sawyer and Man's claim is "the combination, substantially as hereinbefore set forth, of an electric circuit, and incandescing arc of carbonized paper included in, and forming part of said circuit, and a transparent hermetically sealed chamber, in which the arc is enclosed."

In their specification Sawyer and Man say "Our invention more specially relates to an incandescent conductor." In their preliminary statement Sawyer and Man say: "We conceived the invention of the subject-matter in controversy, to wit, an incandescent conductor for an electric lamp formed of carbonized paper, some time during the month of March, 1878."

This is an identification of the invention in the language
2881 of the issue, without it, however, I have no doubt that the
4th claim of Sawyer & Man's application not only does cover, but was intended to cover the subject-matter in interference. It should be observed that it is not necessary that the claims should be in the exact language in all cases where an interference exist-. The thing to be determined is, is the subject-matter, the substance of the invention claimed by both or all parties.

I agree with the examiner that the gist of the alleged invention is in the peculiar conductor, and that an interference exists between the claims of the parties.

His decision is accordingly affirmed.

E. M. MARBLE,
Commissioner.

February 14, 1881.
V. D. S.

(Endorsement: U. S. Patent Office; Commissioner's decision; Sawyer and Man *vs.* Edison; recorded vol. 22, p. 47. February 14, 1881.)

2882 UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *February* 13, 1881.

In Re Interference SAWYER AND MAN *vs.* EDISON.	Before the Examiner of Interferences.

Subject-matter: Electric lamps or lights.

Sawyer and Man, care Amos Broadnax, 57 Broadway, N. Y. city;
Thomas A Edison, care Dyer & Wilber, Washington, D. C.:

No day of hearing is fixed in the within motion and as the filing of a motion to dissolve does not *ipse facto* suspend proceedings in the case, rule 117, a motion showing good cause for delay must be made before an extension can be granted.

J. B. CHURCH,
Examiner of Interferences.

(Endorsement: 7768; 15; office to Sawyer and Man and Edison; Feb. 23, 1881.)

2883 In the United States Patent Office.

WILLIAM E. SAWYER and ALBON MAN *vs.* THOMAS A. EDISON.	Interference. Electric Lighting.

Messrs. Dyer and Wilber:

GENTLEMEN: Please to take notice that on Tuesday, March 1st, 1881, at one o'clock in the afternoon of that day I will submit this motion to the examiner of interference in the United States Patent Office, for such an extension of time to put in the testimony in this case as to him may seem reasonable; and that in support of this motion, I will submit an affidavit of which the annexed is a copy.

Very respectfully, AMOS BROADNAX.

Dated February 25th, 1881.

Good service.
February 26, 1881.

DYER & WILBER,
For T. A. EDISON.

2884 In the United States Patent Office.

WILLIAM E. SAWYER and ALBON MAN *vs.* THOMAS A. EDISON. } Interference. Electric Lighting.

Motion for Time to Take Testimony.

CITY AND COUNTY OF NEW YORK, *State of New York,* } *ss:*

Amos Broadnax being duly sworn says: That he is attorney for William E. Sawyer and Albon Man in the matter of the above-entitled interference. That on January 26th, 1880, deponent moved the primary examiner in charge of said interference to dissolve the same. That on January 28th, 1880, said motion was denied, and that the decision was on February 15, 1881, sustained upon appeal to the Commissioner in person.

Deponent says that said motion was made, and appeal taken in good faith, upon the ground that there was and is no interference between the claims of the applicants, to which opinion deponent adheres; that said motion was not made for the purpose of delay or for the purpose of avoiding the interference; but was made solely that deponent might have an opportunity to amend the specification and claim of Sawyer and Man for the purpose of putting the claims of the applicants in interference that the issue might be fairly made and settled before the taking of the testimony.

Deponent has no desire to delay the interference and would have put in the affirmative testimony of Sawyer and Man within the time fixed by the office, but for the reason alone stated, viz: that he desired to amend the specification and claims before taking the testimony. But deponent's motion having been overruled
2884½ he prays for such time to take testimony as to the examiner may seem just and reasonable.

Deponent further says that he did not come in this case as attorney until December 9th, 1880, and has since moved in this case as fast as his professional engagements, and the sickness and death of one of his children, would permit.

Wherefore deponent prays for reasonable time to put in the testimony on behalf of Sawyer and Man.

Respectfully submitted.

AMOS BROADNAX. *Attorney.*

Dated February 25th, 1881.

Subscribed and sworn to before me this 25th day of February, 1881.

WM. H. BROADNAX,
[SEAL.] *Notary Public, Kings County, N. Y.*

Certificate filed in N. Y. Co.

(Endorsement: Sawyer and Man *vs.* Edison; 7758; 16; interference; motion for time to take testimony. The within motion is granted and the time fixed as follows: Sawyer and Man testimony-in-chief to close March 26th, 1881. Edison testimony to close April 16, 1881. Sawyer and Man's rebuttal to close April 26th. Hearing May 10–81. J. B. Church. 2, 3, '81.)

Due and timely service of the within notice and affidavit is hereby admitted.

2885 Copies sent.

Room No. 1.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *March* 2, 1881.

In Re Interference SAWYER AND MAN *vs.* EDISON. } Before the Examiner of Inferences.

Sawyer and Man, care A. Broadnax, 57 Broadway, New York city, and Thomas A. Edison, care Dyer and Wilber, Washington, D. C.:

Please find below a communication from the examiner in charge of interferences in regard to the above-cited case.

Very respectfully, E. M. MARBLE,
Commissioner of Patents.

The motion is granted, and the times for taking testimony
2886 in this case are fixed as follows:

Sawyer & Man's testimony-in-chief to close March 26, '81.
Edison's testimony-in-chief to close Apr. 16, '81.
Sawyer & Man's testimony in rebuttal to close Apr. 26, '81.
Hearing May 10, '81.

J. B. CHURCH,
Examiner of Interferences.

(Endorsement: 7768; 17; office to Sawyer and Man and Edison; intf.; hearing p'p'd to May 10, '81; March 2, '81.)

2887 Copies sent.

Room No. 1.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *April* 18, 1881.

In Re Interference SAWYER AND MAN *vs.* EDISON. } Before the Examiner of Interferences.

Electric lamps or lights.

Sawyer and Man, care A. Broadnax, 57 Broadway, N. Y. city;
Thomas A. Edison, care Dyer & Wilber, Washington, D. C.:

Please find below a communication from the examiner in charge of interferences in regard to the above-cited case.

Very respectfully,
E. M. MARBLE,
Commissioner of Patents.

2888 Per stipulation, the times for taking testimony in this case are extended as follows:

Sawyer and Man's testimony-in-chief to close May 7, '81.
Edison's testimony-in-chief to close May 28, '81.
Sawyer and Man's testimony in rebuttal to close June 7, '81.
Hearing June 21, '81.

J. B. CHURCH,
Examiner of Interferences.

(Endorsement: 7768; 19; office to Sawyer and Man and Edison; intf.; hearing p'p'd to June 21, '81; April 18, '81.)

2889 Copies sent.

Room No. 1.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *May* 20, 1881.

In Re Interference SAWYER AND MAN *vs.* EDISON. } Before the Examiner of Interferences.

Lamps or Lights.

Sawyer and Man, care A. Broadnax, 57 Broadway, New York city;
Thomas A. Edison, care Dyer & Wilber, Washington, D. C.:

Please find below a communication from the examiner in charge of interferences in regard to the above-cited case.

Very respectfully,
E. M. MARBLE,
Commissioner of Patents.

2890 Per stipulation, the times for taking testimony in this case are extended as follows:

Sawyer and Man's testimony-in-chief to close June 7, '81.
Edison's testimony-in-chief to close June 28, '81.
Sawyer and Man's testimony in rebuttal to close July 7, '81.
Hearing July 21, '81.

J. B. CHURCH,
Examiner of Interferences.

(Endorsement: 7768; 21; office to Sawyer and Man and Edison; intf. hearing p'p'd to July 21, '81; May 20, '81.)

2891 COMPLAINANT'S EXHIBIT PATENT OFFICE PROCEEDINGS No. 3.

Edison's Petition to Amend Preliminary Statement. May 11, 1886.
T. G., Ex'r.

CONSOLIDATED ELECTRIC LIGHT CO. *vs.* EDISON ELECTRIC LIGHT CO. } H, 3553.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the files of this office of the petition for permission to amend preliminary statement and accompanying affidavits filed in behalf of Edison in the matter of the interference, Sawyer and Man *vs.* Edison, for improvement in carbons for electric lamps.

In testimony whereof I, M. V. Montgomery, Commissioner of Patents, have caused the seal of the Patent Office to be affixed this 19th day of June, in the year of our Lord one thousand eight hundred and eighty-five, and of the Independence of the United States the one hundred and ninth.

[L. S.]

2892

M. V. MONTGOMERY,
Commissioner.

SAWYER AND MAN *vs.* T. A. EDISON. } Interference. Carbons for Electric Lamps.

To the Commissioner of Patents:

In the above-entitled interference, I respectfully ask leave, under rule 110, to amend my preliminary statement by striking out "Nov. or Dec., 1878," and inserting instead thereof "September, 1887."

THOMAS A. EDISON,
Per DYER & WILBER, *His Att'ys.*

To Amos Broadnax, Esq., att'y for Sawyer and Man.

SIR: Please take notice that the above petition, and the accompanying affidavits and exhibit will be filed immediately, and that the petition will be heard at such a time as the Commissioner of Patents may set.

DYER & WILBUR, *Attorneys.*

June 20, 1881.

2893 STATE OF NEW YORK, *City and County of New York,* } *ss:*

I, Thomas A. Edison, on oath declare and say as follows:

I am the Thomas A. Edison who is a party to the interference of Sawyer and Man with myself upon the subject of incandescent conductors for electrical lamps, made of carbonized paper.

When I made the preliminary statements in this interference I was excessively absorbed in business, my time being devoted to the making of numerous inventions in connection with my system of electric lighting, and in the introduction of the same commercially, having under my direct charge over one hundred men looking to me for orders and instructions, and besides engaged in my telephone interferences, and being overrun with visitors day and night. My memoranda of exhibits were several thousand in number and had been much confused by the disturbance of them in finding material for my telephone interference. When, therefore, I made my preliminary statements I did so under all the disadvantages mentioned, and relied almost wholly upon my memory of occurrences, and absolutely forgot the fact of the use of the lamp in 1877, which I desire to include in my preliminary statement, and did not recall the same until Saturday, June 11th, 1881, when, in conversation with Charles Batchelor, he recalled the same to my recollection, and in testimony that day I stated that I thought I had the lamp of 1877, before mentioned, at Menlo Park, and would make search for it, which I did on the next day and found the same, and produced it in testimony of Monday, June 13th, 1881, and it is marked as an exhibit as "Edison's Exhibit First Incandescent Lamp."

I have a distinct and positive recollection of using such lamp in September, 1877, with an incandescent conductor of carbon- 2895 ized paper, and such recollection is made certain by paper exhibits of electric lights, dated November and December, 1877.

I declare that the facts sought to be inserted by amendment in my preliminary statement were omitted through inadvertence or mistake, and that the desired correction of the preliminary statement is essential to the ends of justice.

The lamp referred to as used in 1877 is the earliest existing embodiment of my invention in this interference, and without its use I shall be denied testimony which I am advised is most important. I append a sketch of said lamp.

THOMAS A. EDISON.

Subscribed and sworn to before me this 18th day of June, 1881.

WM. H. MEADOWCROFT,
Notary Public, N. Y. Co.

[L. S.]

(Here follows diagram marked p. 2894.)

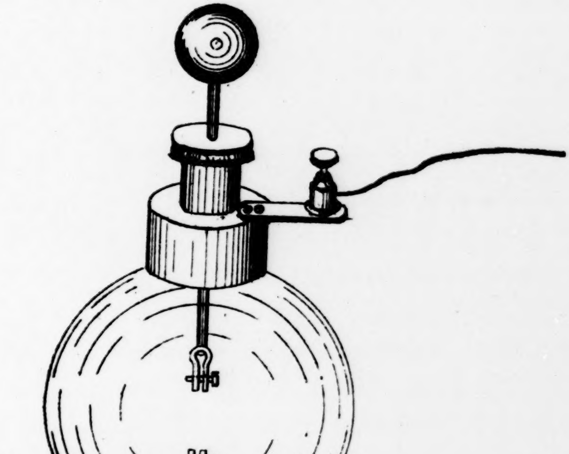
No. 286.

C. E. Light Co.

v.

McK Light Co.

p. 2894



2896 STATE OF NEW YORK, }
City and County of New York, } *ss:*

I, Charles Batchelor, on oath declare and say as follows:

I have been associated with Thomas A. Edison for the past eleven years, and have assisted him in experimenting upon and developing all of his important inventions made in that time. At the time the preliminary statements of Mr. Edison in the interference of Sawyer and Man *vs.* Edison on paper carbons for incandescent electric lamps were prepared, I was excessively busy overcoming difficulties we had met with in the details of manufacturing the lamps in the lamp factory at Menlo Park, and was not consulted in regard to the experiments on paper carbons, and did not know what said statements contained until I was informed on Saturday, June 11th, 1881, by Col. Dyer, Mr. Edison's counsel. In discussing the matter on the morning of that day with Col. Dyer and Mr. Edison I was relating the experiments made by Mr. Edison on paper carbons for incandescing electric lamps, as I recollected them, and I stated that we had used paper carbon in an incandescing electric lamp about September, 1877. Col. Dyer replied that such could not be the case since that fact was not set forth in the preliminary statement. In the discussion that followed both Mr. Edison and myself recollected that a lamp made of a "Gassiot cascade" had been used in the experiments of that year. I assisted in the search for the lamp the next day at Menlo Park and found the same. I recognized it as being the apparatus used in September, 1877, for the reason that the changes in construction which had to be made to adapt it for the experiments were made personally by myself at the suggestion of Mr. Edison. I constructed clamps for receiving the ends of the carbons, and also provided the apparatus with binding posts to secure the ends of the conducting wires, and in the experiments I prepared the paper carbons and put them into the lamp personally.

2897 After we made the experiments in September, 1877, I don't recollect that the lamp was used in any other experiments, but I think it must have been laid away among other apparatus and not afterwards noticed.

I know that at the time the preliminary statements of Mr. Edison were prepared he was very busy and under constant strain. He often worked with me all night at the lamp factory, and had besides under his direct charge the arrangement of a large number of other details connected with his system of electric lighting, on any one of which he could have devoted his whole time. He was also greatly annoyed by a large number of visitors.

CHARLES BATCHELOR.

Subscribed and sworn to before me this 18th day of June, A. D. 1881.

WM. H. MEADOWCROFT,
Notary Public, N. Y. Co.

[L. S.]

2898 STATE OF NEW YORK, } ss:
County of New York, }

Z. F. Wilber, being duly sworn, deposes and says that he is of the firm of Dyer & Wilber, attorneys and solicitors of patents; that he has had charge of the prosecution of the applications for patents relating to electro lighting of Thomas A. Edison for the past year and a half nearly.

That he drew up the preliminary statement for Mr. Edison in the interference, Sawyer and Man *vs.* Edison, upon the carbon made of paper

That at that time (viz., October and November, 1880,) Mr. Edison was exceedingly busy, having a large force of men employed whom he had to supervise, being engaged constantly in experiments and tests, and engaged also in the telephone interferences, so that it was almost impossible for him to give any attention to other matters, and almost impossible for him to obtain the conferences necessary to a proper conduct of this business. His records, drawings, etc., of which he has a vast number, were disarranged by the searches made through them for data and exhibits for the telephone interferences.

Under such circumstances the preliminary statement filed in this case was prepared.

The error therein was one entirely of "inadvertence or mistake," and one exceedingly liable to occur under such circumstances. I was entirely unaware that an error had been committed until the morning of the 15th of June, 1881.

Z. F. WILBER.

Sworn to and subscribed before me this 20th day of June, 1881.

WM. H. MEADOWCROFT,
[L. S.] *Notary Public, N. Y. Co.*

Ex.--M. McK.
J. A. W.

2899 (Endorsement: U. S. Patent Office, June 21, 1881. 7768; 23; interference. Sawyer and Man *vs.* Edison, carbons for electric lamps. Petition for leave to amend preliminary statement and accompanying affidavits and exhibits. Received a copy of the within petition and accompanying papers this 20th day of June, 1881.

AMOS BROADNAX,
Att'y for Sawyer & Man.
DYER & WILBER,
Att's for Edison.

The hearing of the within motion is fixed for June 29, '81, at 10.30 a.m., J. B. Church, ex., 21-6-8. The within motion is hereby granted. Limit of appeal, 5 days, J. B. Church, ex'r. Jan. 19, 1882. 12,193 D, 85.)

2900 Copy sent.

Room 1.

Department of the Interior,
United States Patent Office,
Washington, D. C., *June* 20, 1881.

In Re Interference Sawyer and Man vs. Edison. } Before the Examiner of Interferences.

Sawyer and Man, care Amos Broadnax, 57 Broadway, N. Y.; Thomas A. Edison, care Dyer & Wilber, Washington, D. C.:

Please find below a communication from the examiner in charge of interferences in regard to the above-cited case.

Very respectfully,
E. M. MARBLE,
Com'r of Patents.

Per stipulation, the times for taking testimony in this case
2901 are extended as follows:
Sawyer and Man's testimony-in-chief to close July 7, 1881.
Edison's testimony-in-chief to close July 28, 1881.
Sawyer and Man's testimony in rebuttal to close Aug. 7, 1881.
Hearing, Aug. 22, '81.

J. B. CHURCH,
Examiner of Interferences.

(Endorsement: 7768; 24; office to Sawyer and Man and Edison; intf. Hearing p'p'd to Aug. 22, '81; June 20, '81.)

2902 Copy sent.

Department of the Interior,
United States Patent Office,
Washington, D. C., *June* 21, 1881.

Sawyer and Man *vs.* T. A. Edison. } Interference. Carbons for Electric Lamps.

Subject-matter: Electric lamps or lights.

Sawyer and Man, care Amos Broadnax, 57 Broadway, N. Y. city; Thomas A. Edison, care Dyer & Wilber, Washington, D. C.:

The hearing of the motion filed June 21, '81, is fixed for June 29, '81, at 10.30 a. m.

J. B. CHURCH,
Examiner of Interferences.

(Endorsement: 25; 7768; office to Sawyer and Man and Edison; intf. Hearing of motion set for June 29, '81, at 10 a. m. June 21, '81.)

2903 Copies sent.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *June* 29, 1881.

In Re Interference SAWYER AND MAN *vs.* EDISON. } Before the Examiner of Interferences.

Subject-matter: Electric lamps or lights.

Sawyer and Man, care A. Broadnax, 57 Broadway, N. Y. city;
Thomas A. Edison, care Dyer & Wilber, Washington, D. C.:

The hearing of motion in this case indefinitely postponed for stipulation of the parties.

J. B. CHURCH,
Examiner of Interferences.

(Endorsement: 7768; 28; office to Sawyer and Man and Edison, intf. Hearing of motion postponed indefinitely. June 29, '81.)

2904 Copy sent.

Room No. 1.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Aug.* 9, 1881.

In Re Interference SAWYER AND MAN *vs.* EDISON. } Before the Examiner of Interferences.

Electric lights or lamps.

Sawyer and Man, care A. Broadnax, 57 Broadway, N. Y. city;
Thomas A. Edison, care Dyer and Wilber, Washington, D. C.:

Please find below a communication from the examiner in charge of interferences in regard to the above-cited case.

Very respectfully,
E. M. MARBLE,
Commissioner of Patents.

Per stipulation the time- for taking testimony in this case are extended as follows:

Sawyer and Man's testimony in rebuttal to close Sept. 6, '81. Hearing Sept. 21, '81.

J. B. CHURCH,
Examiner of Interferences.

(Endorsement: 7768; 30; office to Sawyer and Man and Edison, intf. Hearing postponed to Sept. 21, '81. Aug. 9, '81.)

2905 Copies sent.

Room No. 1.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Sept.* 27, 1881.

In Re Interference SAWYER AND MAN *vs.* EDISON. } Before the Examiner of Interferences.

Electric lamps or lights.

Sawyer and Man, care Amos Broadnax, 57 Broadway, N. Y. city;
Thomas A. Edison, care Dyer and Wilber, Washington, D. C.:

Please find below a communication from the examiner in charge of interferences in regard to the above-cited case.

Very respectfully, E. M. MARBLE,
Commissioner of Patents.

Per stipulation the times for taking testimony in this case are extended as follows:

Sawyer and Man's testimony in rebuttal to close Oct. 18, '81. Hearing Nov. 2, '81.

FRANK MACARTHUR, *Acting Ex.*

(Endorsement: 7768; 32; office to Sawyer and Man and Edison, intf. Hearing postponed to Nov. 2, '81. Sept. 27, '81.)

2906 Copies sent.

Room No. 1.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Oct.* 21, 1881.

In Re Interference SAWYER AND MAN *vs.* EDISON. } Before the Examiner of Interferences.

Electric lamps or lights.

Sawyer and Man, care Amos Broadnax, 57 Broadway, New York city; Thomas A. Edison, care Dyer & Wilber, Washington, D. C.:

Please find below a communication from the examiner in charge of interferences in regard to the above-cited case.

Very respectfully, E. M. MARBLE,
Commissioner of Patents.

Per stipulation the times for taking testimony in this case are extended as follows:

Sawyer and Man's testimony in rebuttal to close Nov. 17th, 1881. Hearing Dec. 2, 1881.

J. B. CHURCH,
Examiner of Intf's.

(Endorsed: 7768; 34; office to Sawyer and Man and Edison. Intf. hearing p'p'd to Dec. 2, 1881. Oct. 21, 1881.)

Copies sent.

2907

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Dec.* 5, 1881.

In Re Interference SAWYER AND MAN *vs.* EDISON. } Before the Examiner of Interferences.

Subject-matter: Electric lamps or lights.

Sawyer and Man, A. Broadnax, 57 Broadway, New York city:

This case coming up for hearing on the 2nd inst., it was suggested by counsel for Edison that testimony had been taken on the part of Sawyer and Man, but not filed, therefore, at the request of counsel for Edison, the said Sawyer and Man are allowed until the 10th inst. to file such testimony, together with printed copies thereof as required by the rules of this office, if they would have the same considered.

J. B. CHURCH, *Ex.*

(Endorsed: 7768; 37; office to Sawyer and Man, Dec. 5, 1881.)

2908

Copies sent.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Dec.* 13, 1881.

In Re Interference SAWYER AND MAN *v.* EDISON. } Before the Examiner of Interferences.

Subject-matter: Electric lamps or lights.

Sawyer and Man, care A. Broadnax, 57 Broadway, New York city;
Thomas A. Edison, care Dyer & Wilber, Washington, D. C.:

Per stipulation Sawyer and Man are allowed until Dec. 24, 1881, for filing testimony and brief.

J. B. CHURCH,
Examiner of Interferences.

(Endorsed: 7768; 39; office to Sawyer and Man and Edison; intf. hearing p'p'd to Dec. 24, '81. Dec. 13, '81.)

(Here follow diagrams marked pp. 2909 & 2910.)

2 Sheets—Sheet 1.

W. E. SAWYER & A. MAN.

ELECTRIC LIGHT.

No. 317,676. Patented May 12, 1885.

Figure 3.

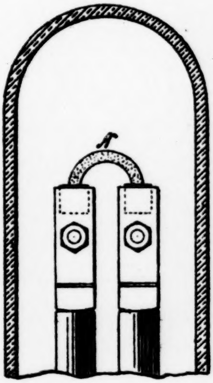


Figure 2.

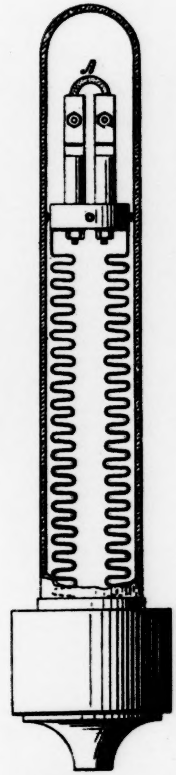
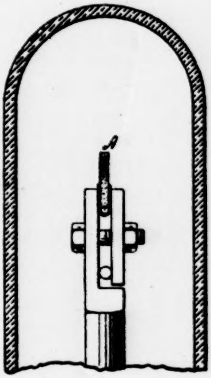
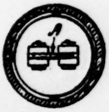


Figure 4.



No. 286
C. E. Light Co
v.
McK Light Co
p. 2909

Figure 1.



Witnesses:
Geo. W. Miatt
Jas. G. Cooper.

Inventors:
Wm E. Sawyer
Albon Man
by their Atty
Wm D. Baldwin

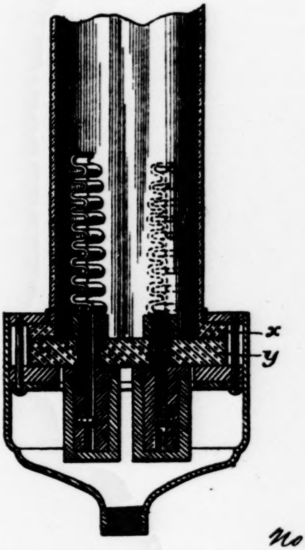
2 Sheets—Sheet 2.

W. E. SAWYER & A. MAN.

ELECTRIC LIGHT.

No. 317,676. Patented May 12, 1885.

Fig 5



No. 286
C E Light Co. } p 2910
McK Light Co

Witnesses:
W W Evans
D.W. Edelin

Inventor.
William E. Sawyer
Albon Man, by
Amos Broadnax
Atty.

2911 In the United States Patent Office.

SAWYER AND MAN
vs.
THOMAS A. EDISON.
} Interference. Electric Lights.

Testimony on Behalf of Sawyer and Man.

Amos Broadnax, counsel for Sawyer and Man, to Dyer & Wilber, attorneys for T. A. Edison.

GENTLEMEN: Please take notice that on the fourteenth day of March, 1881, at two o'clock in the afternoon of that day, at my office, No. 57 Broadway, in the city of New York, I will proceed to take the depositions of Albon Man, 118 Putnam avenue, Brooklyn, New York; William E. Sawyer, 200 West Forty-second street, New York city; William Sawyer, Earle's hotel, New York city; George W. Sawyer, American house, Boston, Massachusetts; William H. Church, 150 Clinton street, Brooklyn, New York; Lawrence Meyers, Plainfield, New Jersey; Jacob Hays, 13 East Fifty-fourth street, New York city; Hugh McCullock, Washington, D. C.; Mr. Arnoux of the firm of Arnoux & Hochhausen, 127 East Twentieth street, New York city; H. L. Judd, 87 Chambers street, New York city; Frank Holebrook, School of Mines, Columbia college, New York city; E. L. Hays, 243 Broadway, New York city; and Amos Broadnax, 57 Broadway, New York city; to be used upon the hearing of this interference on behalf of Sawyer and Man, and you are invited to be present and cross-examine.

Very respectfully, AMOS BROADNAX.

Dated March 8, 1881.

2912 In the United States Patent Office.

WILLIAM E. SAWYER and ALBON MAN
vs.
THOMAS A. EDISON.
} Interference. Electric Lighting.

NEW YORK, *March* 14, 1881.

Parties meet pursuant to the foregoing notice.

Present: Amos Broadnax, counsel for Sawyer and Man, and Dyer & Wilber, for Edison.

ALBON MAN, a witness produced on behalf of Sawyer and Man, being duly sworn and interrogated by counsel, deposed as follows:

1 Q. What is your name, age, residence and occupation?

A. My name is Albon Man. I am a lawyer by profession; I reside in Brooklyn, New York; and I am 54 years of age.

3 Q. State whether you are the Albon Man, joint inventor with William E. Sawyer, one of the parties to this interference.

A. Yes, sir; I am the same person.

3 Q. In a letter from the Patent Office, dated Washington, Sep-

tember 23, 1880, addressed to Sawyer and Man, care of Baldwin, Hopkins and Peyton, signed by Commissioner of Patents, the subject-matter involved in this interference is stated to be "The incandescent conductor for an electric lamp formed of carbonized paper." Please to state whether or not you and William E. Sawyer are the joint inventors of that subject-matter, and state when it was that you made the invention.

2913 A. We are the joint inventors. We made the invention in the winter of 1878; the first conception of it I should say was in the month of January; cannot be certain as to the exact day or month earlier than the early part of the month of March, 1878. At that time we were at work at a place in Centre street, in New York, near Pearl street, and there and then made our first experiments in the use of carbon made from paper for the incandescing portion of the electric light. The subject-matter had been one of discussion between us for some time before the experiments were attempted.

4 Q. State, if you please, how you made the carbons and of what form they were after they were made.

A. We made the carbons in two different ways—or three. The first were carbonized by the heat of the electric current, the paper being fastened between two conductors and filled with plumbago in some cases and in some cases with mineral salts. The first experiment was in the open air, subsequent experiments in a reservoir of hydrocarbon gas, and probably, although not positively, in a reservoir of hydrogen, also in a reservoir of nitrogen; the reservoirs being of glass and sealed up; the metallic conductors to which the paper was affixed passing through to the interior of the reservoir in which the gases were contained. Another method of manufacture was to place the paper in an iron box in powdered gas carbon, close the box and heat the whole in fire. The form of the papers were various; some of them simple straight strips of paper; some of them were strips of paper cut into an arch form and inserted edgewise between the metal conductors; some of them were bent in an arch form and inserted flatwise between the conductors. "A" in drawing Figs. 1, 2 and 3 of the application for patent represents the form where the paper was cut into an arch. Where the paper was straight, without being cut into arch form, it was sometimes tied to the conductors with wire and sometimes inserted in slits in the tops of the conductors and packed with powder carbon to

2914 make connection with the conductor; sometimes fastened between clamps formed by binding screws passing through the heads of the metal conductors.

5 Q. State, if you please, when it was that you first made carbon burners for sealed electric lamps in the manner you have described in your last answer.

A. Early part of the month of March, 1878.

6 Q. In making your carbon burners in a metal box as you have described, please to state what kind of a box you used, and how you prepared the paper, and placed it in the box, and secured it before putting it into the fire.

A. I had two or three boxes; one was of Russia sheet iron; another of cast iron; and another of sheet tin, which was burnt up; I sifted the powdered gas carbon into the bottom of the box for some little thickness (about ¼ or ½ in depth of carbon), pressed it down with a smooth follower, laid the paper on top of the carbon, sifted in more carbon on top of it, put in more layers of paper, pressed the whole down, repeating the operation until I got as many papers as I wished to carbonize, filled up the box with powdered carbon, tied down the cover with wire, and put it in the fire, keeping it there two or three hours; in one instance I remember leaving it in the fire all night.

7 Q. What were the conditions of the carbons when you took them from the boxes?

A. Thoroughly carbonized. It was quite fragile.

8 Q. And of what form?

A. Same form as paper; some in straight strips; some in bent pieces and some in flat arches. I have been so far describing what we did in the month of March, and from that time on forward to about the latter part of May or the first of June, 1878.

9 Q. Were these pieces of paper that you say you put in the iron box to carbonize cut to the form that you wanted the burner to be before you put them in the box for carbonization?

2915 A. Some of them were and some of them were not; some were cut after carbonization into the form we desired.

10 Q. Please to state what form you made the paper before carbonization, and what form you made the carbon burners after carbonization.

A. In some cases we cut the paper into the form of a flat arch before the carbonization; in some cases the paper was bent into the form of an arch and inserted edgewise into the carbon before carbonization, and in some cases we cut flat arches out of the carbon made from the paper, and in some cases we left the paper simply a straight strip so that when carbonized it would be a proper shape to put straight across between the conductors.

11 Q. Then, as I understand you, you would have in the one case an arch of paper presenting a flat surface as the end of the arch, and in the other case the flat surface would be the top and sides of the arch?

A. Yes; in the one case the flat surface of the paper represents the arch, and in the other the edge of the paper represents the arch.

12 Q. Please to describe now what, if any, preparation you gave to the paper before carbonizing it.

A. Before carbonizing the first time we filled the paper sometimes with a solution of white loaf sugar and sometimes with Canada balsam, and after carbonizing the first time we soaked the carbon produced in solution of loaf sugar sometimes, and sometimes in Canada balsam, and recarbonized it; repeating the operation several times in some instances; in other cases we did not treat the paper at all before carbonization; this was in the preparation of the carbon which was made in the furnaces; in the preparation of the carbon made with the electric current, in order to make the paper a conductor,

we coated it with graphite or plumbago, and sometimes soaked it in solutions of different metallic salts and dried it; the latter
2916 process did not seem to work well; paper filled with plumbago worked the best.

13 Q. State, if you please, when it was that you first used the carbon burners you have been describing in the sealed electric lamp.

A. In March, 1878.

14 Q. Can you state at what time in March, 1878?

A. Between the 1st and 15th; I can't give the date.

15 Q. How did you secure the carbon section in the metallic conductor that carried the current into the chamber of the lamp?

A. In several ways; sometimes it was held in position by being placed between the ends of the metallic conductors, resting upon a small ledge or inequality in the conductor, and kept in place by the spring of the two conductors towards each other; in some cases the ends of the conductors were split or slotted, and the carbon or paper inserted in the slit; in some cases the carbon was held by binding screws put through the ends of the conductors; in some cases by binding screws put through the ends of the conductors to close them together where they were split; in some cases by binding screws and clamps, as represented in the drawing accompanying this application for patent.

16 Q. I understand you to say, in answer to question 15, that in some cases the carbon section of the conductor was held by the spring of the two ends of metal conductors towards each other; were there any instances in which you held the two ends of the carbon section between the divided ends of the conductor by the spring of the metal upon the carbon where the ends of the conductors were divided?

A. I have already stated that there was, or intended so to state; and that we improved the electrical connection between the metal and the carbon by packing powdered carbon between the two at the connection; I should also add that we bound the carbon in some instances to the metal conductors with fine wire, and
2917 sometimes we wound wires around the clamps that held the carbon, to bind it in place.

17 Q. Please to state what further treatment you gave the carbon before you put it into the lamp?

A. After it was placed between the metal conductors we put it in a sealed reservoir of hydrocarbon gas, or a reservoir through which hydrocarbon gas was passing; the reservoir being of glass so that we could observe what was going on; we then turned on the current of electricity gradually and heated up the carbon while it was in the bath; first to about a good white heat, and afterwards to high incandescence; continuing it so long as to perfect the carbon by rendering it uniform in resistance by deposit of carbon from the gas which went on under these conditions, at the point or points of highest resistance first, and subsequently over the whole carbon; I have been speaking thus far of only what took place up to the 1st of June or last of May, 1878; we had no convenience for working from that time up to September, and our experiments were renewed in September, and continued on until late in March, 1879; early in the month of October, 1878, we prepared paper carbons in the manner I have described by carbonization, in the furnace at the corner of Elm and Walker streets in this city, and perfected them substantially as I have described, and used them during the month of October and the following months until the latter part of March, 1879, in electric lamps, at that place, successfully, and exhibited them to great numbers of people; the form of the carbons which we then used was that of a circular washer such as is shown in the lamp accompanying the application of this patent as a model; after the carbon was inserted in the clamps, the lower section of the circle between the conductors was cut away; we used different kinds of paper of great variety, but principally ordinary blotting paper; we used willow carbon; boxwood carbon; maple carbon; 2918 dogwood carbon; these I am speaking of were used both in the form of an arch and in straight pencil; some of them were rubbed down and worked out by hand after being treated, and some of them were not; we turned these circles also out of all kinds of carbons on the lathe, and treated them all as I have described electrically to perfect them.

18 Q. Please to state what part or parts of the invention and experiments were made of which you have been testifying previous to the 15th of March, 1878, and state what was done after that and down to the month of October or November, 1878, in the order, as near as you can, of its being done.

A. We prepared the paper carbon first electrically, and subsequently by carbonization in the furnace in March, 1878; and from that time on to May continued our experiments with it; we treated it during this period in the hydrocarbon bath; improved it by soaking in sugar, etc., and recarbonization. In September, 1878, we commenced the use of oils in connection with the electric current in the preparation of carbon. In October, 1878, we carbonized the complete paper circles or washers, and also straight pencils of paper with better success than before; that is, having better appliances for the work. I think the first lamps we exhibited with paper were in October, 1878; we had others before that, but did not exhibit them; we first had an electric lamp fitted with a carbon burner, made of paper, in March, 1878.

19 Q. That lamp that you say you had fitted with a carbon burner, made of paper in March, 1878, did you apply the electric current to it and test its practical operation?

A. I did.

20 Q. And was it successful?

A. To a certain degree, yes; it was not what lamps have since been made, or what we have subsequently made; not as good as those we made in October. But it was a very satisfactory experiment, and one that I considered well worth continuing and 2919 working up, and one which I did work up. The difficulties were not with the carbon, but with the other appliances of the lamp, its atmosphere, etc.

21 Q. Then, as I understand you, there was no objection to the burner made of the paper carbon?

A. Yes, there were objections at first; it was too fragile; it was not good enough conductor for the electro-dynamic machine which we used. The burner had too high resistances. When carbonized with the current it was liable to crack and to break from contraction. But it had advantages at the same time, which we were trying to secure and were working for. When made of pure cellulose it was a pure carbon, which we were trying in every way to obtain. This is why we kept working at it and finally succeeded in overcoming all its objections.

Counsel for Sawyer and Man gave notice to counsel for Mr. Edison that upon the hearing of this cause he will use the office letter referred to in question 3 of the preceding examination in evidence.

22 Q. State, if you please, what further preparation, if any, you gave the paper before carbonizing it.

A. We consolidated it by pressure in hydraulic press and also in moulds, before carbonizing, and cemented and pressed several sheets together, sometimes.

Cross-examination of ALBON MAN, March 15, 1881, by GEORGE W. DYER, Esq., counsel for Mr. Edison:

23 X Q. What part did you take in the preparation of the application of Sawyer and Man, involved in this interference?

A. I united in making the application with Mr. Wm. E. Sawyer, and in giving the information to the attorneys by whom the application was prepared.

2920 24 X Q. Was the application, as prepared and executed by Mr. Sawyer and yourself, satisfactory to you?

A. It did not cover all I wanted it to, nor was it altogether in the form I wished.

25 X Q. Wasn't it within your power to have it made to suit you?

A. It might have been, but I thought it advisable to have it sent in as it was.

26 X Q. Why advisable to have it sent in in an unsatisfactory condition?

A. For one reason, to get it into the Patent Office immediately; for another, I was informed it could be amended after it should be filed.

27 X Q. Why was it desirable to file it immediately?

A. In order to keep others from obtaining patents for what are considered to be our invention.

28 X Q. By others, do you refer to any one in particular?

A. I think one in particular, and others, of whom we were informed, attempts were to be made to acquire patents.

29 X Q. Who was the one you had in mind?

A. Mr. Edison, the other party to this interference.

30 X Q. Before you made your application in this interference, had the subject of Mr. Edison's inventions in electric lights, and his experiments with lamps, using carbonized paper, been written about in the newspapers considerably?

A. I can't be positive as to dates nor particulars, but I should think it had.

31 X Q. Have you any present recollection of reading any such newspaper articles before your application was filed?

A. I read almost everything I saw in newspapers on that subject, and I think probable I might have read concerning Mr. Edison, what he had done or intended doing.

32 X Q. Were you a party to any proposition to withhold the filing of your application in this interference upon the receipt of a certain sum of money?

2921 A. No, sir.

33 X Q. And never authorized Mr. Cheever to speak for you in that particular?

A. No, sir; I took great pains to see that it was properly filed.

34 X Q. Referring generally to your testimony with regard to the first experiments in the use of paper carbon for electric lamps, did the suggestion for the use of paper for carbon for such purposes come from you or from Mr. Sawyer?

A. I can't tell, we talked over the matter generally, and I can't say which first spoke of it; we were at work on the subject, discussing the matter every day.

35 X Q. Were the forms of carbon represented by your Exhibit No. 1 already attached to Mr. Church's deposition any of them your suggestion, and if so, which; and please designate Mr. Sawyer's suggestions?

A. I can't say now which suggested particular forms because we were working together and was a matter of hourly discussion between us.

36 X Q. When did you and Mr. Sawyer first come together?

A. In January, 1878.

37 X Q. Where and under what circumstances?

A. First at my house in Brooklyn, by the introduction of a gentleman by the name of Hayes; the circumstances were, this gentleman having heard me talking of electricity and electrical lights, and having formed the acquaintance of Mr. Sawyer, he brought him to see me; possibly Mr. Church was with him when he came to see me.

38 X Q. If after that you made a business connection with Mr. Sawyer, when was it?

A. Within a very few days I made an arrangement with Mr. Sawyer to furnish him money to go on with experiments in producing incandescent lamps. Shortly afterwards, and in the month of March, I found that I was continually making suggestions
2922 to Mr. Sawyer, devising apparatus and taking as much part
in producing the lamps as he was, and that Mr. Sawyer could evidently not be the inventor of my apparatus, and we were so mixed up as not to know who made the original suggestions at that

time as to what we were doing. Our agreement was therefore then modified; that we should go on to work together, each submitting to the other any ideas that occurred to him, and if upon joint discussion and modification it seemed desirable to go on with any particular thing we would do so, and take out the patents in our joint names. Thus we did.

39 X Q. Was it the spirit of that agreement that there should be joint applications for improvements in electric lamps where the subject-matter had been discussed between you?

A. Not unless it was our joint work; if our joint work, yes.

40 X Q. Still I understand under this modified agreement you furnished the money for the experiments?

A. I did.

41 X Q. Did you take a lease of the shop or rooms on Centre street where experiments were first made?

A. I paid for them, but cannot remember whether he or I made the arrangements.

42 X Q. Have you any memorandum or account which would enable you to fix certainly the day when you moved into the place on Centre street? If so have the kindness to produce it at a convenient time.

A. I have, and will produce it. We moved there on the 6th or 7th of February, of that there is no doubt.

43 X Q. Calling your attention to the early experiments at the place in Centre street, state how many lamps you made at that place to the best of your recollection.

A. I can't give the number; have no recollection other than that there was a considerable number of different lamps. The largest
number I should limit it at would be thirty or forty, and
2923 smallest twenty. The same lamps being taken down and
modified several times.

44 X Q. Where did you get the lamps?

A. Made them.

45 X Q. What were they made of?

A. A great variety of things, we used for adaptation a great number of forms of glasses which we bought from a great many places; round-bottom soda bottles; Florence flasks; glass tubes closed by metal at both ends; glass tubes like test tubes of a variety of sizes; seed bottles, oil-sample holders, etc.

46 X Q. What kind of bottles or tubes did you use in the first instance?

A. Florence oil flasks.

47 X Q. What electrical power did you have at Centre street?

A. One of Arnoux & Hochhausen's large machines which they call "light" machines; a smaller one of Arnoux & Hochhausen's; one of Weston's and one of Fuller's, I think.

48 X Q. Do you know the power capacity of these different machines?

A. No, sir.

49 X Q. How many lamps were you in the habit of running upon the same circuit?

A. The largest number, I think, was eight; usually ran but one.

50 X Q. How long did you ever run eight lights continuously at that shop?

A. I should think probably a week.

51 X Q. Night and day, right along?

A. No; we ran none continuously for a week; but ran them for several hours continuously; we were troubled for power.

52 X Q. Calling your attention to the use of paper, how was your attention called toward paper for carbonization?

A. We had great difficulty in getting carbon at all suita-
2924 ble for our purpose, and after we got it we had to shape it by
hand; we had been getting mostly regular electric light carbons, and also carbon used in galvanic batteries. Among others, we got hold of some in thin sheets or strips; we undertook to cut out from those sheets forms shown in Figs. 1, 2, 3, 4 and possibly 5 of Sawyer Exhibit No. 1. They were very difficult to manufacture, and we would not get one in a great number which was good enough to use; we therefore attempted to manufacture the carbon for ourselves, and I think that thin sheets of carbon first suggested to our minds the use of paper in sheets and carbonized in place. Another thing which led to it perhaps was the desirability of using very small carbon, very thin or tenuous, irrespective of its shape, and paper seemed to furnish the readiest means of getting at this; besides furnishing a pure carbon, a great desideratum with us, *i. e.*, certain kinds of paper.

53 X Q. Calling your attention to the very first experiment with the paper carbon, what kind of paper did you use?

A. Very first experiment was made on Sawyer's writing desk in the open air with common writing paper covered with black lead-pencil marks, and the two wires of the machine brought down upon the sheet to make the connection.

54 X Q. What was the result of that experiment?

A. The filling of the paper with black lead was imperfect; we could only get sparkling on the surface of the paper; our machine had not great electrical force, and it had too much resistance. We then got some pure graphite to use instead of lead pencil, to get a better conduction. Experimented in a similar manner with that. The paper was burnt up—that is, destroyed.

55 X Q. What was next experiment in the same direction?

A. After we had succeeded in getting the current through the
paper we then took paper similarly prepared and put it in
2925 the lamp, where it would not be destroyed. The lamps were
filled with hydrocarbon gas; the air had been exhausted.

56 X Q. Was this a sheet of paper coated with graphite or plumbago referred to in the previous answer?

A. Yes, sir; a form cut out of a sheet of blotting paper, coated and filled with graphite or plumbago.

57 X Q. Put in a bottle?

A. Yes, into one of our lamps—probably a Florence flask filled with hydrocarbon or burning gas—common illuminating gas.

57½ X Q. Use a cork stopper?

A. No; cemented to the neck of the bottle was a brass ring over which screwed a brass cap, through which cap one of the conductors was insulated, and the other conductor fastened to the cap.

58 X Q. What was the size of this piece of paper?

A. Should think about 1/8 in. in width and long enough to reach from the two holders, perhaps 3/4 of an inch long, and thickness of ordinary blotting paper, or a little thinner, on acount of being pressed and pounded.

59 X Q. How did you coat or fill it with graphite or plumbago?

A. We soaked it in water in which graphite was suspended and took it out and put it in powdered graphite; rubbed it with graphite till it was polished like a stove; then rubbed graphite in it, as much as we could; then dried it; then pressed it; then used it as I have indicated. Don't recollect whether it was pressed before or after it was dried.

60 X Q. Now, how did you carbonize it? With what amount of current and of how long duration?

A. With the current—how much I don't know. Had great difficulty in getting current through it with small machine we had been using; had to force the machine in order to get it through by short circuiting and by making and breaking the current. This was tried a large number of times by us before we could accom-
2926 plish the object of getting the paper carbonized, and therefore I can't remember the length of time which the current was on.

61 X Q. Please give an account of the first experiment when you did succeed in carbonizing the paper suitably?

A. My previous description of the preparation of the paper is applicable to this experiment. We had placed the paper at first straight across the tops of the holders. Its shrinkage when carbonized would break it; so we placed it in this experiment in a loop between the holders and rising above. We succeeded in carbon-zing the paper in this way so as to get a light for a short time and only for a short time, lasting only three or ten minutes. We tried afterward—or before, I can't be certain—paper soaked in mineral salts to make it a conductor. We succeeded in getting current through it and possibly carbonized it; I can't say positively; I considered it a poor way to do, as the oxygen of the salts would consume the paper, and the minerals left were an impurity in the carbon. I considered the graphite method of obtaining carbon a practical method under proper conditions and with great care. We succeeded sometimes, but rarely; much oftener failing.

62 X Q. In regard to those carbons which you said gave light from three to ten minutes, what was the cause of the light failing?

A. The shrinkage of the carbon, I think, and the impurity of our gases, and our insufficient means of experimenting. The result would be that the carbons would burn up or break—the light would, at all events, go out.

63 X Q. Please to describe when and how you made carbon which was satisfactory?

A. When we began to carbonize the paper in boxes as I have described in my direct examination.

64 X Q. When was that?

A. It was in Centre street, some time about the middle of March—perhaps earlier—perhaps later.

2927 65 X Q. Who was engaged beside yourself and Mr. Sawyer upon these experiments?

A. We were the chiefs—we gave direction to them, and did most of the work ourselves. Mr. Sawyer's father aided us in it.

66 X Q. They were, I understand you, carried on by day?

A. Yes, sir; although I took home some of the prepared paper and carbonized it at my house.

67 X Q. As I understand you the first box you employed was made of sheet iron?

A. No, sir; I think a box made of cast or wrought iron, which old Mr. Sawyer got up from some old thing around the shop.

68 X Q. How large a box was it?

A. About 3 x 4, 2 in. high.

69 X Q. What kind of a box was it which you took home?

A. That one.

70 X Q. In what way did you heat it after you got it home?

A. Put it into a cooking-range fire.

71 X Q. How long did you leave it there?

A. In one instance all night; in another instances until I had retired.

72 X Q. Would the box be heated red hot?

A. Yes, sir; the whole thing and contents heated red hot.

73 X Q. Was the first carbonizing which you regarded as successful done in your house?

A. Don't know whether there or in Centre street. We used the same box for carbon-ing horn.

74 X Q. Put horn and paper in together?

A. My impression is that we did.

74¹ X Q. Was this paper, in the experiments last described, subjected to the previous and subsequent manipulations described in your testimony-in-chief?

A. Yes, sir; some of it was, at least.

2928 74² X Q. That which was satisfactory, I understand you say?

A. Both that which was treated in other ways than by carbonization, and that which was not otherwise treated and by carbonization, was a satisfactory quality of carbon, but I considered that which was treated with sugar, balsam fir, oils, etc., and recarbonized and treated with the electrical current in hydrocarbon bath, as improved by the treatment.

74³ X Q. What proportion of those carbonized in the boxes while you were at Centre street were good, and what proportion were bad?

A. Some were good and many were bad.

74⁴ X Q. Referring now to the experiment you made with carbonized paper in an electric lamp while you were at Centre street, when was the first experiment in which light was produced in the carbonized-paper conductor in an electric light?

A. To the best of my recollection between the 6th and 15th of March.

74^5 X Q. How long did that experiment last?

A. But a few moments at a time.

74^6 X Q. What was the result at the end of a few minutes of operation?

A. That the carbon was consumed or broken—current ceased to pass through it.

74^7 X Q. Did all experiments with carbonized-paper conductors at Centre street result in the same way?

A. No; I think not.

74^8 X Q. What was the most satisfactory experiment you made at that place?

A. With paper carbonized in the furnace.

74^9 X Q. How long did the carbonized paper conductor last in this experiment?

A. Until we took down the lamp taking the carbon out practically uninjured. I can't say exactly how long. We were trying
everything we could think of at that time. We ran the
2929 lamps for a time, and took them down to examine the carbon, to see the effect, and to see if we had got the lamps
sealed; took them down often—daily, or every two or three days.

75 X Q. What was form of paper carbon in this instance?

A. That of a flat arch.

76 X Q. How was it secured to the holders?

A. Between a clamp constituting a part of the holder on the one side, and the holder on the other side of the paper. My impression is, held by a binding screw, but it may have been by binding around the two pieces of the holder by wire; am quite sure it was by binding screw, although not positive. The holders were made of gas-retort carbon—the upper ends of them.

77 X Q. What was size of this carbon arch?

A. Its whole length slightly more than $\frac{1}{2}$ in., rising in the center, in an arch form, above the tops of the holders three-sixteenths to $\frac{1}{8}$ of an in. In width somewhere from one-twelfth to one-twentieth of an in. In parts which were above the holders, the part held within the clamping of the holders was somewhere about $\frac{1}{8}$ in. square. The distance between the holders—clear space—about $\frac{3}{8}$ of in. Paper may have been a little longer than I have said.

78 X Q. Did this arch in position present its broadest surface vertically or horizontally?

A. Vertically; *i. e.*, the line across its broadest surface was vertical.

79 X Q. It was then cut in form before carbonization?

A. Can't say. It was cut in shape either before or after carbonization, but I can't say which. Best impression is it was cut before.

80 X Q. What tools did you employ for cutting out such arch forms after carbonization?

A. A variety; mostly with a knife between sheets of paper glued or fastened to it.

2930 81 X Q. In this particular instance of experiment how many lamps were in the circuit?

A. One, I think.

82 X Q. How much horse power did you employ in driving your electric engine?

A. Can't say, because power was furnished by the persons from whom we hired the room. Power was furnished by them for the whole building.

83 X Q. What kind of paper was that carbon conductor made from?

A. White blotting paper.

84 X Q. Single, or of several thicknesses?

A. I should think several thicknesses pressed together.

85 X Q. Was that conductor coated with powdered carbon?

A. No, sir; the paper was carbonized in box in furnace; was thicker after carbonization than we wanted; was worked down with emery paper after being worked in shape with knife and filing. This refers to paper shaped after carbonization. The burners shaped before carbonization were simply cut in shape with knife or scissors, and were ready for use after carbonization, except rubbing them down on the emery paper.

86 X Q. Do you remember positively the carbon conductor was in a state of incandescence for 15 minutes?

A. Yes, I should think for a couple of hours at a time.

87 X Q. What was the most satisfactory experiment which was made at the Howard-street shop?

A. I don't recollect putting up any paper lamps at the Howard-street shop. Was not there so much as at either of the other places. Seems to me we had paper carbons while there, but can't be certain about it.

88 X Q. How many carbon conductors of all kinds do you think were made at the Centre-street shop?

2931 A. Can't say. A great number, perhaps many hundreds.

89 X Q. You made these from every material you could think of or find?

A. Almost everything which seemed to offer a prospect of getting pure carbon.

90 X Q. What was the proportion of the different materials out of which you made carbon conductors?

A. Greater portion from French carbon.

91 X Q. How many lines of experiment were you pursuing at that Centre-street shop?

A. Can't say.

92 X Q. Several?

A. Yes, sir.

93 X Q. Who composed the working force in that shop?

A. William E. Sawyer, Mr. William Sawyer, Mr. Geo. Sawyer and myself, and Mr. William Sharp. Not certain that Mr. Sharp was at that shop but one day. He worked at the shop in Brooklyn mostly.

Another man we employed was in the shop a part of the time—working in his own shop also; name was Keating.

94 X Q. Know where Sharp lives?

A. Is now, I think, in Connecticut, in workshop of Wallace & Sons, at Ansonia.

95 X Q. Know where Keating is?

A. No; have made enquiries, but can't find him.

96 X Q. Is Mr. George Sawyer a brother to Wm. E. Sawyer?

A. Yes; he tended the door and ran errands.

97 X Q. What time did you give to experiments at Centre-street shop?

A. Was there every day. Sometimes five or six times a day; and from about 4 o'clock in the afternoon till dark. Meanwhile attended to my regular business.

98 X Q. How much time did Sawyers give to that shop?

A. I think all their time.

99 X Q. Know where Wm. E. Sawyer is?

2932 A. No; received letter from him yesterday stating he was going to Boston last evening. Letter received day before yesterday to the same effect.

Redirect examination:

100 R. D. Q. Please to look at this drawing which I hand you and state whether or not during your experiments and practice in making and using electric lamps you made and used an arrangement like that shown by this drawing, in which "A" represents a carbon section, "B B" metallic sections, and "C" a piece of platinum, and "D" a slit in the top of the metallic section of the conductor.

A. Yes, we did.

101 R. D. Q. State when you used that.

A. First at 43 Centre street, and first without the slit "D" the end and carbon resting down on piece of platinum "C." Afterwards used it with the slit.

102 R. D. Q. How much of time did you use this arrangement for holding carbon section?

A. I think during all the time we were there some of our lamps were so arranged.

103 R. D. Q. State whether slit "E" was cut into the end of the conductor and made to pinch upon the carbon section so as to hold it without the aid of screws?

A. Yes, sir; that was the object of it.

Counsel for Sawyer and Man offers the above drawing in evidence, and the same is marked Sawyer Exhibit No. 3, W. H. B.

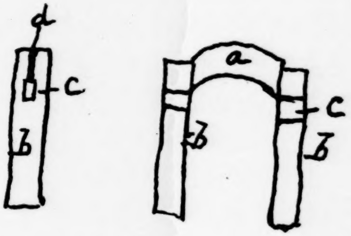
(Here follows diagram marked p. 2933.)

104 R. D. Q. State when it was you terminated your experiments at No. 43 Centre street.

A. Last of May or first of June, 1878.

105 R. D. Q. When did you resume, if at all?

Albon Man



No. 286.
C.E. Light Co
v.
McK Light Co
} p. 2933

March 16th 1881
Sawyer's Exhibit No. 3.
Wm. H. B.
Notary Public

2934 A. In latter part of August or 1st of Sept., 1878, at corner of Centre and Howard streets (Arnoux & Hochhausen's).

106 R. D. Q. Was that an experimental shop?

A. Yes.

107 R. D. Q. How long did you continue your experiments there?

A. Until the latter part—probably the last week of September, 1878.

108 R. D. Q. What electric lamps did you make there and what kind of carbon did you use for burners in them?

A. Made a considerable number—can't say how many—all sealed incandescent lamps; we never made any other.

109 R. D. Q. Did you use carbonized paper there in your lamps?

A. I think we did; but can't be positive.

110 R. D. Q. Previous to your going to corner of Howard and Centre streets, did you consider the invention of the carbonized paper burner completed?

Objected to by counsel for Edison, on the ground of being new matter, and otherwise incompetent.

A. Yes, sir.

111 R. D. Q. After you went to the corner of Centre and Howard streets, in the building with Arnoux & Hochhausen, did you do anything further to perfect the invention of the carbonized burner?

Objected to as not proper matter for re-examination, no cross-examination having been had.

A. I don't know that we did; we went on to manufacture it afterwards.

112 R. D. Q. Did you manufacture them afterwards and use them; if you did, state when and where?

Same objection taken.

2935 A. Whether we manufactured at the corner of Centre and Howard streets any of the paper carbons I can't be certain. We had some there, and it is possible that we made some while there; but after we went to the corner of Elm and Walker streets we manufactured them and put them in use immediately upon going there. We did one thing to them there that we had not done before, which was to cut the paper in perfect rings or washers before carbonization.

113 R. D. Q. State, if you recollect, how long you continued a paper carbonized burner in a state of incandescence at any one time?

A. All day, and until late in the evening. This, at the corner of Walker and Elm.

114 R. D. Q. And what was its condition when you turned off the current?

A. Same way as when we put it on, except possibly improved.

115 R. D. Q. When was that?

A. That particular one, I should say, was in the month of December, 1878.

116 R. D. Q. And was the carbonized paper burner made in the same way that those were made at No. 43 Centre street?

A. Yes, same as that in which some were made at No. 43 Centre street. There were other trials much before this, in October, but we only ran them during the day.

117 R. D. Q. Do you know William H. Church?

A. Yes, sir.

118 R. D. Q. Was it through Mr. Church that William E. Sawyer was introduced to you?

A. Yes; I think he was the moving party in the introduction.

119 R. D. Q. Was Mr. Church present much of the time during the experiments you have been testifying about?

A. Yes, sir, almost every day; and all day at a time.

120 R. D. Q. Was he there as a looker-on or a participator?

2936 A. Mr. Church was interested through Mr. Sawyer in our experiments, and he knew what we were doing.

121 R. D. Q. Did you explain to him, from time to time, what you were doing?

A. Talked to him continually about it.

122 R. D. Q. State who, besides Mr. Church, was present during the experiments you have described as being made at 43 Centre street?

A. A number of people came in there to look at the light, but only Mr. Church, Mr. Sawyer and myself and Mr. Sawyer's father, knew what we were doing; we kept our operations secret as far as we could.

ALBON MAN.

MARCH 15, 1881.

Met pursuant to adjournment.

Present, counsel as before.

WILLIAM H. CHURCH, witness produced on behalf of Sawyer and Man, having been duly sworn, testified as follows:

1 Q. What is your name, age, residence and occupation?

A. William H. Church; am 48 years of age; am selling electric lights for the United States Electric Light Company.

2 Q. State whether you are acquainted with Albon Man and William E. Sawyer, one of the parties in this interference?

A. I am acquainted with them both.

3 Q. State how long you have been acquainted with William E. Sawyer and Albon Man?

A. I have known William E. Sawyer since early in the year 1877, and Mr. Man since January, 1878; perhaps met him in December of 1877, or even a little prior to that.

2937 4 Q. State, if you please, where and how you made the acquaintance of these gentlemen?

A. Made the acquaintance of Mr. Sawyer first at the office of Mr. Schuyler in the Coal and Iron Exchange building in Cortlandt street; he was then engaged upon an electric motor for running light machinery; I saw a great deal of him during that year, almost every day.

5 Q. How did you make the acquaintance of Mr. Man?

A. Hearing that Mr. Man was greatly interested in the subject of electricity, I called at his house, and presented to him Mr. Sawyer's views upon the electric lighting, in which he took a lively interest, and I soon after that called again accompanied by Mr. Sawyer, and the subject was more fully discussed, and resulted in an arrangement between himself and Mr. Sawyer to enter into experiments for the purpose of developing the subject.

6 Q. When you called upon Mr. Man at his house, was that the beginning of your acquaintance with him?

A. Yes, sir.

7 Q. And that you think was in January, 1878?

A. Yes, sir.

8 Q. Did you have a letter of introduction to him?

A. I think I called with a neighbor of his, a Mr. Mayes.

9 Q. When you called on Mr. Man at his house, as you have stated, was it your object in calling there to present to him Mr. Sawyer's plan of electric lighting?

A. Yes, sir; that was my only object in calling.

10 Q. And you afterward introduced Mr. Sawyer and Mr. Man to each other?

A. I did.

11 Q. State as near as you can when it was that you introduced these gentlemen to each other?

2938 A. I should think the first or second Saturday in the month of January, 1878; it was on a Saturday evening.

12 Q. Was it at the house of Mr. Man?

A. Yes, sir; his present residence, 118 Putnam avenue, Brooklyn, N. Y.

13 Q. Have you any data in writing by which you can fix the date exactly?

A. I have nothing with me, but I think I have an old memorandum book which I carried with me, which I think will fix the date exactly.

14 Q. Will you please to produce that book and ascertain from it, if possible, the exact date when you introduced Mr. Sawyer to Mr. Man?

A. I will.

15 Q. Please to state whether or not that introduction between Mr. Man and Mr. Sawyer resulted in an agreement between them to develop Mr. Sawyer's plan of electric lighting?

A. It did in the following week; after the interview they arranged to commence.

16 Q. State, if you know, when and where they did commence?

A. They took a little shop in Centre street, No. 43 or 42 Centre street—I think probably 43—upon the west side of Centre street. I should think it was in the last part of January, 1878, some time.

17 Q. Please to give the history of what they done there in the

fabrication and operation of electric lamps. How, as far as you know, they did it. Please to begin at the beginning?

A. They put wires around the shop, which was a good-sized room, and connected in the wires glass globes resembling inverted bottles, in which was held pieces of carbon, and these pieces of carbon were changed as their experiments progressed, first of one form, and then of another, and the bottles were filled with gasses; they tried how many they could put and sustain from the circuit from a machine which they had procured. They finally had a small dynomo
2940 machine for experimental purposes placed in the shop.

18 Q. Please to describe the different forms of carbon you saw them use in their lamps, and in making your descriptions, please to make sketches of the different forms of carbon, as you recollect them?

A. Some were in straight pieces like No. 1 (see diagram); some in arch form like No. 2; some in circular form like No. 3; another like No. 4; Nos. 2, 3 and 4 were of paper; there was a No. 5 of paper; Nos. 3 and 4 were covered, I think, with plumbago, and were held in the holders, which were straight pieces of brass; figures 1, 2, 3, 4, 5, 6 and 7, of this drawing represent the forms of carbons, and a-outline of the manner in which they were put in the lamp, as I recollect them.

Counsel for Sawyer and Man offers the drawing in evidence for the purpose of illustrating and explaining the testimony of the witness, and the same is marked "Sawyer Exhibit No. 1."

(Here follow diagrams marked p. 2939 and 2941.)

19 Q. Referring now to the diagram which you have just made, please to state what Fig. 1 represents?

A. A straight pencil of carbon.

20 Q. What does Fig. 2 represent?

A. An arch shape of carbon.

21 Q. What Fig. 3?

A. Also an arch shape of carbon.

22 Q. And Fig. 4?

A. A straight piece of carbon with the ends bent down to wire around the ends of the holder.

23 Q. What Fig. 5?

A. An arch shape of carbon.

24 Q. And what Fig. 6?

A. The entire circle from which the arch Fig. 5 was taken out, the section "E" being taken out in form Fig. 5. I do not know whether it was taken out after or before being put in the lamp. I think, however, before being put in the lamp.

2942 25 Q. Figs. 2 and 5, as I understand it, represent the side of the carbon arch. That is the broadest surface of the arch?

A. Yes, they each represent the same view.

26 Q. Figs. 3 and 4, as I understand, represent the edge of the paper or carbon arch?

A. Yes.

William H. Church

Fig 1

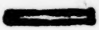


Fig 2

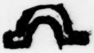


Fig 3

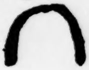


Fig 4

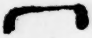


Fig 5

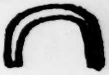
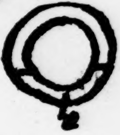


Fig. 6



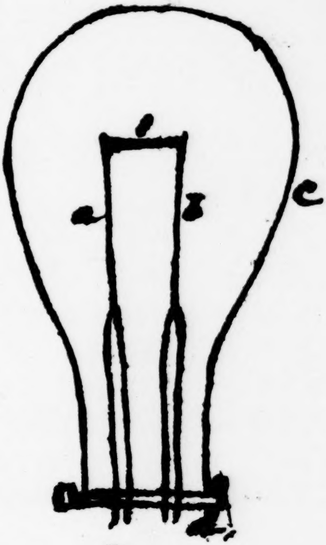


Fig. 7

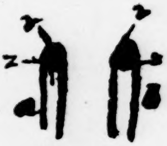


Fig. 8.

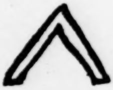


Fig. 9.

No. 286
C. E. Light Co.
v.
McK Light Co.
p. 2939

Sawyer Exhibit No. 1.
March 15th 1881.
H. H. B.
Notary Public.

William H. Church

Fig 1

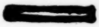


Fig 2

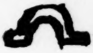


Fig 3

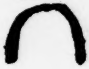


Fig 4

Fig 5

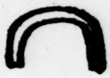
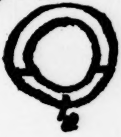


Fig. 6



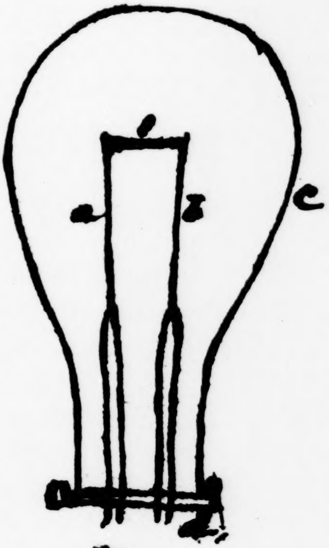


Fig. 7

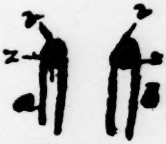


Fig. 8.

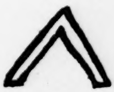


Fig. 9.

No. 286.
C.E. light C.
v.
McK. light C.
} p 2941

Sawyer Exhibit No. 1.
March 15th 1881.
N. H. B.
Notary Public.

27 Q. Referring now to Fig. 7, what does "*a*" and "*b*" represent?

A. The metal conductors.

28 Q. And Fig. 1 represents the section of carbon in the circuit?

A. Yes, sir.

29 Q. Were all of these different forms of carbon made of paper?

A. Yes, sir.

30 Q. Please to state what the letter "*c*" represents in Fig. 7?

A. The chamber of the lamp, and "*d*" represents its base.

31 Q. Please to state when it was that you first saw these different forms of carbon made of paper?

A. It was the latter part of February or the first of March, 1878.

32 Q. Did you see all of these different forms at that time?

A. No, it was as late as May that I saw Figs. 5 and 6. The shop in Centre street was given up about the 1st of June, and I saw them all previous to this in that shop, except Fig. 5, which I think I saw in September after I had returned from the country.

33 Q. How was the carbon section, represented by the Fig. 1, held by the conductors "*a*" and "*b*" in Fig. 7?

A. By the spring of the two ends against the carbon.

34 Q. Were all of the different forms of carbon illustrated by the drawing held berween the metal ends of the circuit, the same as that represented by Fig. 1 in Fig. 7?

2943 A. In Figs. 3 and 4 the ends were wired upon the ends of the conductors.

35 Q. How was Fig. 2 held in the metal ends of circuit?

A. I think the metal ends of the conductors were divided or slit, as shown by Fig. 8 "*v, v*," the ends of the carbon being clipped into the slitted ends of the conductor, or a piece of platinum represented by "*z, z*." The letters "*a, b*," in this figure represent the metal ends of the circuit as in Fig. 7.

36 Q. State whether or no these carbons were in some cases held in the metal ends of the conductors by clamping screws and clamps?

A. I believe they were in the experimental holders, they were so, I know, in the lamp.

37 Q. State, if you know, whether or not the chamber of the lamp, represented by "*c*," was a sealed chamber, having the air exhausted out of it?

A. It was.

38 Q. I understand you to say that you saw Sawyer and Man use the chamber represented by Figs. 7 and 8. The carbons represented by Figs. 1, 2, 3 and 4, in the last of February and during the month of March?

A. I would say from the 1st of March till the middle of May I saw these carbons used in such chamber. Sometimes one and sometimes another, changes being frequently made, the chamber of the lamp being exhausted of air or filled with gas.

39 Q. State, if you know, how these paper carbons were made. I mean how was the paper carbonized?

A. They used a small metal box; the one I recollect seeing was of sheet iron, in which there was pulverized carbon and layers of the paper in the form described, alternately placed. And then the box was closed and fastened and put into the fire. I saw this one evening at Mr. Man's house. He came out of his private laboratory, showing me the box and explaining what he was doing. I subsequently saw him bring to the shop one morning a box, 2944 which he said he had left in the fire all night, and which he could not get open. It was subsequently opened by one of the workmen, but not in my presence. I, however, saw the carbons after they had been taken out of the box. I, indeed, saw these same carbons treated in oil, being put in oil and a current of electricity being run through them. This decomposed the oil and made a deposit of carbon upon the carbons already made, making them very tough, and making them of a grayish color.

40 Q. State, if you know, whether or not the paper previous to its being carbonized was treated with any kind of substance or material, and if so, state how it was prepared?

A. I saw a substance which I thought was sugar of lead, but never inquired what it was; also saw bottles of balsam which were used in the experiments, but I don't recollect how these materials were used; I did not see the paper prepared.

41 Q. Please to state when it was that you first saw the paper carbons used in the lamp—not experimentally, but in the lamp as perfected?

A. In September, 1878.

42 Q. Where was that?

A. Howard street, corner of Centre street, at first, and afterwards I saw it continuously from that time on through the winter in Walker street, corner of Elm.

43 Q. Referring now to the drawing, Sawyer Exhibit No. 1, please to state whether the several figures on that drawing represent all the different forms of carbons made of paper which you saw used by Sawyer and Man between the 1st of March and the 1st of June, 1878, and if not, please to make a drawing of such other forms as they used?

A. I saw a V-shape carbon of paper, as shown by Fig. 9 of the sketches made by me in the Sawyer Exhibit No. 1, in addition to those I have already described.

2945 Cross-examination by GEORGE W. DYER, Esq., counsel for Mr. Edison:

1 X Q. I call your attention to the lamps referred to in your 41st and 42d answers, being the lamps you say you saw perfected and in use in September, 1878, from that time on during the winter. How many different lamps did you see at that time at the places named?

A. Quite a number; it would be difficult to give the number of separate, distinct lamps; sometimes the same lamp was taken down and put up again and again; but for a guess, I should say 25 or 30, probably. But this is a guess.

2 X Q. How many different lamps can you state from recollection that you saw at that time at the places named?

A. They put up one lot of lamps in which there were six or

William H. Church.

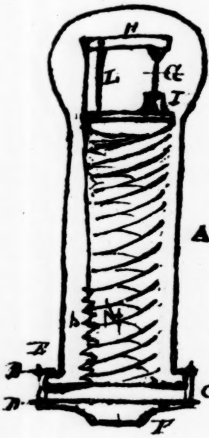

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Fig. 1

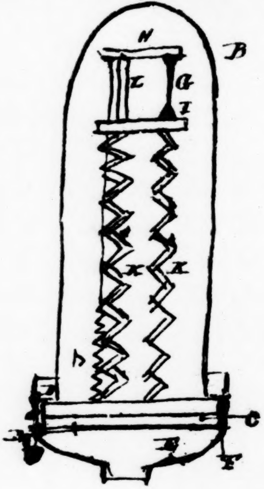
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Fig 2

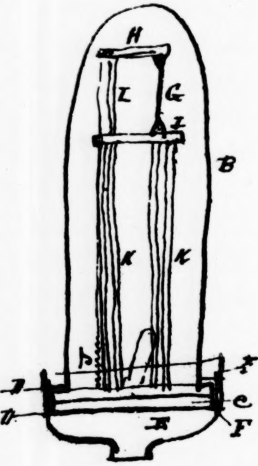
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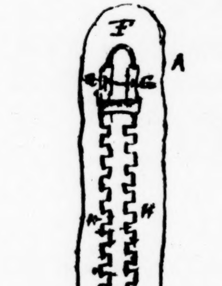
Fig: 3.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D
E

Fig. 4.

No. 286
C.E. Light Co.
v.
McK. Light Co. } p. 2946

Sawyers Exhibit No. 2.
March 15. 1881.
T. K. B. Notary Public

eight of a kind. Then another lot varying from that of about as many more or perhaps a dozen. Then still another form of as many more—say a dozen. Each of these lamps—some at least—were taken down and refilled again, or perhaps two or three times, to observe their working. There was still another kind I think of; being four different lots. But the last did not have a paper carbon, but a straight pencil. Mr. Sawyer called it the feeder lamp.

3 X Q. Please state when and where the first lot you mentioned were put up?

A. In Centre street, No. 42 or 43, as designated this morning. The first lot was in September, in Howard street. One lamp put up in May was rather crude.

4 X Q. When was the shop in Centre street given up?

A. In May, 1878.

5 X Q. When was the shop in Howard street taken?

A. From memory, I should say July, 1878.

6 X Q. When was the room taken corner of Walker and Elm streets?

2947 A. In October.

7 X Q. How long was that kept?

A. Spring of 1879. Should think the month of April.

8 X Q. The first lot put up in September, in Howard street, were they all alike?

A. Yes, as I remember.

9 X Q. Of what was the shell composed; what was the size and form?

A. Shell was wholly of glass. It was about eight inches or more high, with a cylindrical body and globular top. The body being about 2½ inches in diameter.

10 X Q. What was contained within this shell?

A. This lamp contained a radiating conductor in the form of a coil from the bottom up to about where the bulb commenced, terminating in a flat piece, extending partially across the shell; above this the carbon was sustained. The means for holding the carbon for its regulation, were quite similar to those shown in Fig. 1, patent No. 205,144, but with these differences: A little spring at the back to regulate the pressure on the carbon by pressure against one end of a pivoted top piece, the other end of which pressed the carbon down upon its seat.

11 X Q. How was the bottom of this shell closed, and with what material?

A. Was closed with—1st, a flat cap made of glass which was ground to fit the bottom of the chamber, and was held to its place by screws passing through metal rings against the flange of the chamber.

12 X Q. Please make a sketch of this lamp you have been describing, so that the same may be attached as an exhibit in this case?

A. I have made such a sketch, and the same is appended and marked Fig. 1, Sawyer's Exhibit No. 2.

(Here follows diagram marked p. 2946.)

13 X Q. Designate by letters the different parts you have testified about?

A. "A" is the body; "B" the bulb; "C" the cap, or glass
2948 plate; "D" the metal rings; "E" the screws holding the
metal rings together; "F" socket to screw upon a bracket or holder; "G" the carbon; "H" pivoted top piece; "I" the receptacle for the other end of the carbon; "J" spring attached to pivoted top piece; "H" to regulate the pressure on the carbon; "K" a coil of conductor for bringing in the current and radiating the heat from the base of the lamp, or to prevent the radiation of heat to the base of the lamp; "L" is standard to sustain the top piece "H."

14 X Q. What was the necessity of a spring to regulate pressure upon the carbon?

A. As I understood, the carbon when heated would expand, and if a rigid pressure was placed upon it, it might bend. The object was to relieve the carbon from any liability to bend or break.

15 X Q. What was the size of the carbon in this lamp?

A. Should think about $\frac{5}{8}$ inches long, and about size of pencil lead in ordinary pencil; size was not always the same.

16 X Q. What was size of radiating conductors "K"?

A. One-eighth of an inch in diameter.

17 X Q. Was the carbon fastened at each of its ends?

A. I don't think it was fastened at either end; a recess received each end, top and bottom.

18 X Q. What was that carbon made of, speaking of your own knowledge?

A. I could say.

19 X Q. How many of these lamps were in the same circuit?

A. Three.

20 X Q. How was the electrical power applied to this circuit of lamps?

A. My recollection of the things which occurred at Howard
2949 street is not so clear as of things which occurred later. I
don't know how much power was used at Howard street, or what kind of power it was.

21 X Q. Was this electrical power applied to all three of the lamps at the same time?

A. It was, but I don't know how much power was applied.

22 X Q. What was contained in the chamber of this lamp of which you have made a sketch, in the nature of gases?

A. I don't know about the gases. I thought it was pure nitrogen gas, but am not sure about it. I think there was a little bag of sodium put in the chamber.

23 X Q. How long did you see this circuit of lamps burning at any time at Howard street?

A. Never watched it more than an hour at a time.

24 X Q. How many times did you ever see them burning at Howard street, to your recollection?

A. Can't say; but am certain it was several times.

25 X Q. Do you know whether the carbons were changed or re-

placed during the period when they were in operation in Howard street?

A. Don't know they were changed and do not believe they were; could not be without taking the lamps apart.

26 X Q. Will now call your attention to the second lot of lamps referred to in your answer to cross-question two. Where was this second lamp put up, and when?

A. In Walker street corner of Elm; was in November, 1878.

27 X Q. How many of those lamps were there which were alike?

A. Should think all were alike, and I think about a dozen of them.

28 X Q. How were these lamps constructed?

A. Something like the patent drawing 205,144. Figure 2, Sawyer's Exhibit No. 2, represents these lamps, and is made a part of my testimony.

Examination adjourned until 10 o'clock a. m., March 16, 1881.

2950 MARCH 16, 1881.

Same parties present.

Cross-examination continued:

29 X Q. Please describe the construction shown in said sketch, and letter the various parts.

A. The letter "B" represents the chamber of the lamp. "C" represents the brass cap covering the bottom of the lamp. "D" represents the plates with screws to hold the cap against the flange of the chamber. "E" a metal cup to cover the bottom of the lamp. "F" the screws that hold the plates against the flange of the lamp before the metal cup is put on. "G" the carbon pencil. "H" the cross-bar against which the upper end of the pencil makes a contact. "I" the seat in which the pencil makes its lower contact. "J" the rod with spring which regulates the pressure of the top piece "H" upon the end of the carbon. "K K" the radiating conductors. In this instance the screws "F" are permanently fixed for the purpose of holding the plates.

30 X Q. What was the material of which the chamber was composed?

A. Glass.

31 X Q. Of what size?

A. Eight or nine inches high, about two inches in diameter.

32 X Q. What was size of radiating conductors "K K"?

A. Don't know the number of wire of which they were made, but should say a little less than one-eighth inch in diameter—coiled in a spiral—forming a helix.

33 X Q. With what gases was the chamber filled?

A. Don't know, but I thought at the time nitrogen. A bag of sodium was put in, I think, to improve the atmosphere of the lamp.

34 X Q. What was the size of the carbon pencil?

A. About same size as in figure 1.

35 X Q. Of what material was it constructed?

A. Don't know. Lamps were often changed as to their carbon.

2951 36 X Q. How much electric current was thrown upon the circuit?

A. Don't know; but remember Mr. Sawyer had a large coil of wire he used to put in to increase the resistance—this when there was only one lamp operated.

37 X Q. Please describe the next lot of lamps referred to in your answer to cross-question 2.

A. I am not certain that this third lot was not operated before my second lot; I am not confident of it. I have made a drawing, figure 3 of Sawyer Exhibit No. 2, which represents the third lot of lamps. "B" represents the glass chamber. "C" the glass cup against the glass flange of the chamber. "D" the metal plates to hold the cap against the flange. "F" the screws passing through these metal plates. "E" the metal cup covering the bottom of the lamp. "G" the carbon. "H" the top piece against which the carbon makes its contact. "I" the lower piece. "K" the radiators, which were straight in this lamp, as I remember, being composed of little flat pieces—perhaps of three-eighths inch in width. "L" the standard to which the cross-piece "H" was pivoted. "J" the small wire with spring attached, to regulate the pressure through the cross-piece "H" on the upper end of the carbon. The straight radiators were made of thin brass strips so as to form all together about three-eight-s of an inch across. This is better described in No. 210,809 of patents, dated December 10th, 1878.

38 X Q. Fix the time as nearly as possible when this kind of lamp was produced; the other lot was in November, 1878.

A. This was about the same time; perhaps a little earlier or later. Another lot was about the same time, which was the fourth lot.

39 X Q. Referring to figure 3, what were the dimensions of this lamp?

A. About the very same size; perhaps the very same size.

40 X Q. What gases was it filled with?

2952 A. Didn't know much about the filling. I supposed it was filled with same gases as preceding, and I think it had the bag of sodium in it.

41 X Q. What was the size of carbon G in this instance?

A. About same as in preceding lamp.

42 X Q. Know what it was made of?

A. No, sir.

42½ X Q. Know how much current was employed in circuit of these lamps?

A. Had it on a 4-horse engine used to run an Arnaux & Hochhausen dynamo machine.

43 X Q. How many lamps did you see in circuit run by this 4-horse-power engine?

A. I should think 6; might have been 7 or 8. Don't think more than 7 or 8. Have watched 6 lights very often.

44 X Q. How long did you see these 6 lights burning continuously at one time?

A. Two hours and a half. Usually watched them about an hour. Seen the current turned in gradually from the light of a very small taper up to a full incandescent light; the best incandescent light, by all odds, I have ever seen.

45 X Q. Make a sketch of fourth and last lot of lamps referred to in cross-question 2.

A. I have made the sketch, figure 4 of Sawyer Exhibit No. 2, and lettered it. "A" represents the glass chamber, which was about 8 inches high, and $1\frac{1}{4}$ inches in diameter, with a flange at the bottom against which the glass plate "B" is pressed. "C" are the metal rings to hold this plate "B" against the flange, and "D" are screws passing through the metal rings. "E" is a metal cap covering the whole. "F" is a carbon arch. "G G" are pieces to which it is attached. "H" are the radiating conductors which are formed in uniform Greek form.

46 X Q. Do you know when this type of lamp was produced?

2953 A. My wife was taken ill last of November and died 11th day of December; it was after the 16th of December I came to New York. Then I think I saw this lamp for the first time.

47 X Q. What gases was chamber filled with?

A. Don't know. Don't remember whether it had a bag of sodium in it or not.

48 X Q. How many of these lamps did you see in a circuit together?

A. About the same number, *i. e.*, about half a dozen more or less.

49 X Q. What amount of current on the circuit?

A. Same engine as was referred to in a previous answer was used.

50 X Q. What was size of radiating conductor in this instance?

A. About $\frac{1}{16}$ inch thick and about $\frac{3}{8}$ inch in width, made of sheet brass. One of these lamps is described in the application for patent involved in this interference, filed Jan. 9, 1880, figure 2.

51 X Q. What was the size of the carbon "F" in this instance?

A. Of arch shape; looked like a black wire of about the size of an ordinary pencil lead, possibly a trifle larger.

52 X Q. What was distance across from one of its feet to the other?

A. Little less than half an inch, I should think, inside measurement.

53 X Q. What do you remember was the height of the arch?

A. About a true semicircle, and a trifle over one-fourth of an inch high, as nearly as I can estimate from memory.

54 X Q. Do you know of what this carbon was composed, in this instance?

A. No, sir; but I suppose were made of carbons I saw worked up before I went away.

55 X Q. How long did you see these lamps burning con-
2954 tinuously in a circuit on any occasion?

A. Should think about an hour; others were present.

56 X Q. Referring now as to what you have testified about the making of paper carbons in the shop on Centre street during March, April and May, 1878, did you yourself see any of the forms illustrated in Exhibit No. 1 cut out of paper?

A. Did not see them cut, but seen them after they had been cut.

57 X Q. What kind of paper did they appear to have been cut from?

A. I should say out of white blotting paper. I did not handle them, but merely saw them; according to my opinion they were blotting paper. All may not have been of blotting paper, for what I know.

58 X Q. Did you yourself see any of these forms put into a box for carbonization, and afterwards taken out of the same box in a carbonized condition?

A. I saw the pulverized carbon which I understood was to go into the box; and I saw the paper which was to go in the box; and I saw a paper after it had been taken from the box; but didn't see a paper put into the box and the box heated, and carbon taken from the box.

59 X Q. Do you know, of your own knowledge, that you saw at any time at the shop at Centre street, any carbonized-paper conductor for an electric lamp?

A. Yes, I saw pieces of carbon formed of paper of Figs. 1, 2, 3 and 4 Sawyer Exhibit No. 1, tried in Centre street, during the experiments made there.

60 X Q. How do you know these were formed of paper?

A. I saw some of them formed entirely with the plumbago put upon it and stretched across and fastened to the conductors and carbonized in the lamp. In giving a former answer (to cross-question 58) I referred particularly to Figs. 5 and 6, which were never 2955 carbonized in a lamp on account of their shape. Figs. 2, 3 and 4, particularly 3 and 4, did not rest upon my mind, as I regarded them as experiments which were not successful.

61 X Q. Please state when the first instance was of your own knowledge that a paper-carbon conductor of the character of 5 and 6, Exhibit No. 1, was used in an electric lamp.

A. To my knowledge, in December, 1878, and not far from the middle of December.

Examination-in-chief resumed:

62 Q. Referring now to the paper carbons which you say you saw in the shop in Centre street, as illustrated by Sawyer Exhibit No. 1, please to state whether at the time you saw these paper carbons, or papers to be carbonized, and the box in which the paper was carbonized, you were told by Mr. Sawyer or Mr. Man that the carbons you saw were made of paper and were carbonized in the box that you saw.

Objected to by counsel for Edison on the ground of hearsay testimony.

A. Yes, sir.

63 Q. Which of them told you those carbons were made of paper?

Same objection.

A. I think Mr. Man; I am not sure but that they both told me. Remember particularly Mr. Man telling me so.

64 Q. What was the appearance of the box, did it look as though it had been in the fire?

A. Yes. He brought over one one morning which he could not open. He said it had been in the fire all night.

2956 65 Q. Did you see that box opened?

A. No; I saw it after it had been opened.

66 Q. Did you see the paper forms and the powdered charcoal and box together or near each other?

A. Yes, saw them all together on the bench.

67 Q. Was any one working with them?

A. Yes, sir.

68 Q. Who?

A. Think Mr. William Sawyer.

69 Q. Did he tell you what they were, and what he was going to do with them?

A. No, sir.

70 Q. Referring now to the four different sets of lamps which you have described in your cross-examination, and especially to the carbon burners which you say you saw used in those lamps, please to state whether at the time you saw those lamps any one told you that the carbon burners in them were made of carbonized paper, and if so, please state who told you so?

Same objection taken.

A. Could not tell who told me; I have no vivid recollection of being told by any particular one of the carbon that happened then to be in use being made of paper. The material from which the carbons were made were of great variety, as I was told at the time.

71 X Q. At the time you saw these lamps in use was it your understanding then that some of the carbons in the lamps were made of carbonized paper?

Objected to on the ground that the understanding of the witness is not competent testimony, unless it appears that it was derived from his personal knowledge.

A. Yes.

72 Q. How did you get that understanding at that time?

2957 A. From seeing the carbonized paper in the shapes designed for the lamps; from seeing them worked over, and seeing them treated?

73 Q. Do you mean to be understood as saying that you got that understanding from the fact that you saw the forms of the carbons cut in paper, and that you saw the powdered charcoal and the carbonizing box and carbons of the same form, and from the fact that you were told at the time that they were paper?

Objected to on ground of hearsay evidence.

A. Yes, sir.

WILLIAM H. CHURCH.

2958 & 2959 MARCH 17, 1881.

Parties met pursuant to adjournment.
Present, counsel as before.

WILLIAM SAWYER, witness produced on behalf of Sawyer and Man, was called and sworn:

1 Q. State your name, age, residence and occupation.

A. My name is William Sawyer; age, 59 years; reside at Earle's hotel in the city of New York; am a machinist.

2 Q. State, if you please, where you were employed in the spring of 1878.

A. At 43 Centre St., in the city of New York.

3 Q. By whom were you employed?

A. By Mr. A. Man and my son, Wm. E. Sawyer.

4 Q. About what time in the spring or latter part of the winter did you go in their employ?

A. In February or March of the same year.

5 Q. Please state what you were employed to do for your son and Mr. Man.

A. Employed in constructing what we call an incandescent electric lamp; about our first was in producing a carbon suitable for our purpose, *i, e.*, to be used in a lamp; amongst others were other materials; we experimented upon different papers in various manners.

6 Q. Please state what you yourself had to do with making carbons for the electric lamps—of carbonized paper.

A. Merely to assist them in their work.

7 Q. Did you, as an assistant to them, cut the paper into the form that you wanted the carbon to be, and then put it in a box and carbonize it?

Question objected to as being leading.

A. I assisted in that; yes.

2960 8 Q. Describe how you made carbons—or carbonized paper for electric lamps.

A. Our first attempt was by paper—say blotting paper—by putting graphite or plumbago, and then rubbing and working in this graphite till it is permeated with it. We then applied the two poles of an electric machine to it to see if we could get the current through. It went through imperfectly, but not satisfactorily. We then put that paper into the lamp, filled with common illuminating gas. Then we sealed the lamp and applied the electricity. The result was we got an imperfect current. We took the lamp apart, examined it and virtually went through the same operation again. That was the first attempt at carbonizing paper.

9 Q. What shape were the pieces of paper which you tried to

carbonize in that way; please to look at Sawyer Exhibit No. 1 and state if you recognize any of the forms shown on that drawing as being the same as those used by Sawyer and Man to make carbons for their lamps?

A. I recognize Nos. from 1 to 7 inclusive.

10 Q. As I understand you, they used straight strips of paper?

A. Our first attempt was with them.

11 Q. And some arched pieces of different forms?

A. Yes, sir.

12 Q. After they got through with their efforts to carbonize the paper with the current of electricity, what other way did they adopt to carbonize the paper?

A. By putting it into powdered carbon and subjecting it to heat; sometimes saturated paper with a solution of acid, or with solution of powdered carbon and water.

13 Q. In preparing the paper for carbonization, did they first wet it?

A. As a general thing, in a solution of some sort of carbonaceous matter.

2961 14 Q. What did they put the pulverized carbon in?

A. In an iron box?

15 Q. Always in an iron box?

A. Not always; my impression is, in a tin box first, but that was melted out; afterwards in an iron box, which I got out, or made.

16 Q. How did they arrange the paper to be carbonized in the box with the pulverized carbon?

A. With alternate layers of carbon and paper; first carbon, then paper; carbon again, then paper, till box was filled; and pressed down with a follower in the box, so as to get it as compact as possible; last layer was carbon.

17 Q. After you got the box filled, did they put a cover on it, and how was it fastened?

A. A cover was put on and fastened down with wire.

18 Q. Did you see the paper and carbon put in the box?

A. Yes; my impression is I put them in myself; I know I put some of them in.

19 Q. Did you see the box put in the fire and heated?

A. Not the first, but I did afterwards; the first box that was filled Mr. Man took home and brought it back in the morning; he could not open the box on account of the iron having been fused, and I put a pressure on it and opened it.

20 Q. Did you put the lid on the box and wire it down?

A. Yes; we together did; he assisted.

21 Q. Did you open that same box the next morning?

A. I did.

22 Q. Were the wires still on it the same as you had put them on the night previous?

A. Still on; but in different places fused together, so as considerable effort was required to cut them without destroying the material inside.

2962 23 Q. After you got the box open, did you take out the carbonized paper?

A. We took them; I at least saw them taken out.

24 Q. What condition were they in?

A. Various; some perfect, others broken or destroyed.

25 Q. Did you put any of these carbons that were in that box in a sealed lamp and try them?

A. Yes, sir.

26 Q. How did it do?

A. With varied success.

27 Q. What do you mean?

A. Some would run longer than others; some would fail; some would do very well; some would fail from imperfections of the lamp; from sealing, or, as we judged, from imperfect contacts, or mechanism.

28 Q. State, as near as you recollect, how long the best of them was used in the lamp in a state of incandescence.

A. I should judge anywhere from one to three or four days, or perhaps a week, at different times; have not distinct recollections of the exact time any one burned; I can positively state it was more than one day or two.

29 Q. How long have you seen any one of the best of them burn continuously?

A. We would put on the current and run it as long as the machine ran, and then take it off. That would be, say from 4 to 5 hours at a time, as nearly as I can recollect, and then when the engine commenced again we would put it on, the power being furnished by the building in which we rented the room.

30 Q. After you had run it that way and took it off, how did they appear?

A. Some would seem to be in perfect order and some imperfect—principally owing to defective mechanism in the lamp.

31 Q. How often was the iron box charged with carbon and paper and carbonized, as you have described in Centre street?

2963 A. Can't state the number of times, but was used quite a number of times.

32 Q. Did you see it (the box) put in the fire and the paper carbonized after the instance you mentioned of Mr. Man taking the box home?

A. Yes; put it in myself and took it out.

33 Q. Saw the papers put in and saw the carbons taken out?

A. Yes.

34 Q. Was the result about the same?

A. Yes, sir.

35 Q. All this, I understand, took place in Centre street?

A. Yes.

36 Q. When was it that you quit work in Centre street?

A. Can't say.

37 Q. Where did you go from Centre street?

A. To Nos. 2 and 4 Howard street.

38 Q. When did you go to Nos. 2 and 4 Howard street?

A. I think in the summer of 1878.

39 Q. Do you recollect what time in the summer?

A. Should judge, as near as I can recollect, in June.

40 Q. Did you use any carbons made of carbonized paper there?

A. We might have done it, but my impression is we did not. I think after we left Centre street we began on a different kind of carbon, but afterwards returned to paper.

41 Q. After you got through at corner of Howard and Centre streets, where did you go?

A. Corner Walker and Elm.

42 Q. When did you go to the corner of Walker and Elm streets?

A. October, 1878, I think.

43 Q. Can you recollect what time in October?

A. Couldn't state positively; probably some time between the 1st and 15th of the month.

2964 44 Q. Do you recollect whether or not you returned to the use of carbonized-paper carbons corner of Elm and Walker streets?

A. I do; yes.

45 Q. Were the carbons of carbonized paper that you used corner Walker and Elm made in the same way that they were at 43 Centre street?

A. Virtually so, but we added at different times several other treatments; by solidifying the paper; pounding it; and subjecting it to hydraulic pressure.

46 Q. Was the results of the carbonization about the same as in Centre street?

A. Was better.

47 Q. Do you recollect of cutting the carbon burner to the desired form out of the carbonized paper after its carbonization?

A. Yes.

48 Q. How did you do that?

A. Done by a knife and file; that is, was worked down to the form we wanted them by these tools; were delicate things to handle; used to stick them to a piece of glass with balsam or cement and cut them down. By merely warming the glass we could take them off and by subjecting the glass to a blaze—heat, we could take all the superfluous or foreign coating from the carbon.

49 Q. How much of the time did you use carbons made of carbonized paper while at the corner of Walker and Elm streets?

A. I think we were at work upon them several weeks.

50 Q. Did you see them put in the lamps and illuminated?

A. Yes; I put them in.

51 Q. State how long you saw any one of the carbons made of carbonized paper illuminated continuously at the corner of Walker and Elm streets, as near as you can recollect.

2965 A. My answer is about as before. We ran them from day to day.

52 Q. Did you take occasion to examine them after they had been thus illuminated?

A. Yes, some seemed as perfect as when they went in, others were fractured.

53 Q. How many lamps did you have in circuit in Elm and Walker?

A. The highest number I think was eight.

54 Q. Was that as many lamps as your electro-dynamo machine would supply with the necessary current to illuminate the lamps?

A. Don't think it was, but the size of our engine limited us. We didn't have power enough to run the dynamo machine up to its capacity.

55 Q. What was the size of the engine?

A. Nominally 6-horse-power engine and 6-horse-power boiler. I don't think it was a 6-horse-power boiler, however.

56 Q. You say you had as many as eight lamps in circuit at one time?

A. Yes, to the best of my recollection.

57 Q. State, if you know, how many of those lamps were filled with carbonized-paper burners.

A. Can't say positively, but think all were furnished with such burners.

58 Q. Did you put the carbonized-paper burners in the lamps yourself?

A. Yes.

59 Q. In Centre as well as Walker street?

A. Yes, I made them all.

60 Q. Please to look at the drawing making part of the patent granted to Wm. E. Sawyer and Albon Man, June 19th, 1878, No. 205,144, and state, if you please, whether you recognize that as an illustration of either of the lamps to which you have been referring in your examination.

A. I do.

2967 61 Q. In which of the shops to which you have referred in your examination were lamps like that made?

A. I think in Howard street; and I know corner of Elm and Walker streets.

62 Q. Look at drawing making part of the patent granted to Wm. E. Sawyer and Albon Man, December 10th, 1878, No. 210,809, and state whether the drawing making part of the patent last mentioned represents either of the lamps to which you have been referring in your examination.

A. Yes, I recognize it.

63 Q. In which shop was that made?

A. I think corner of Walker and Elm. I know we made them there.

64 Q. Please look at drawing which I hand you making part of the application for the patent involved in this interference, and state whether that drawing rep*rep*resents any one of the lamps to which you have referred in your examination.

A. I recognize it fully.

65 Q. Can you state where lamps of that style were made?

A. Corner Walker and Elm streets.

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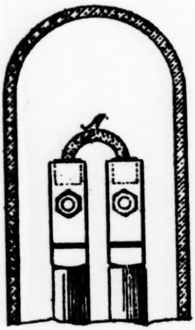
Sawyer & Man

Carbon for Electric Light.

Filed Jan. 9, 1880.

Fig: 2

Fig: 3



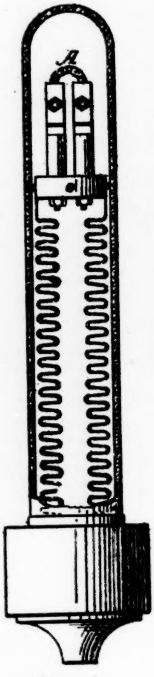
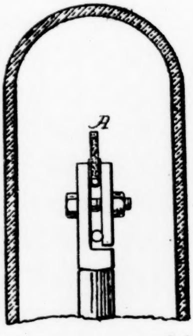


Fig: 4



Sawyer Exhibit No. 4.
March 17-1881.
N. H. B
Notary Publi

No. 286
C. E. Light Co.
v.
McK Light Co
} p. 2966

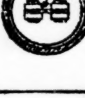


Fig: 1

Witnesses:
Geo. W. Miatt
Jas. G. Cooper.

Inventors,
Wm. E. Sawyer
Albon Man
by their Atty
W. C. Baldwin

Sawyer Exhibit No. 4
March 17-1881

66 Q. What kind of a lamp was it in which you used the paper-carbon burners at No. 43 Centre street?

A. Like Fig. 7, Exhibit Sawyer No. 1.

The drawing marked Sawyer Exhibit No. 4, and referred to by witness in answer to question 64 is admitted by counsel for Edison to be a copy of the drawing making part of the application of Sawyer and Man, involved in this interference.

(Here follows diagram marked p. 2966.)

This drawing is offered in evidence and marked Sawyer Exhibit No. 4.

Counsel for Sawyer and Man gives notice to counsel for Mr. Edison that upon the hearing of this interference he will use 2968 in evidence the filed papers making part of the application for patent on behalf of Sawyer and Man, and also on behalf of Mr. Edison, and also the patents which are of record in the Patent Office, No. 210,809, dated December 10th, 1878, and No. 205,144, dated June 18th, 1878, both of which were granted to Sawyer and Man, numbered and dated as aforesaid.

67 Q. Referring now to the lamps shown in the patent No. 205,144 to which I have referred, state whether you saw any carbons made of paper used in that lamp.

A. I don't recollect that I did.

68 Q. State if you recollect of seeing carbons made of paper used in the lamps illustrated in the patent 210,809 to which we have referred.

A. Don't recollect that I did.

69 Q. State if you recollect of seeing carbons made of paper used in the lamps shown by the drawing Sawyer Exhibit No. 4.

A. I do recollect it.

70 Q. State whether or not that substantially represents the lamps in which you used the paper carbons at the corner of Walker and Elm streets, New York.

A. I do.

71 Q. How soon after you moved to corner Elm and Walker streets was it that you commenced to use this lamp with the paper-carbon burners?

A. Immediately.

Cross-examined by GEORGE W. DYER, Esq., counsel for Mr. Edison:

72 X Q. About the box which you got up for carbonizing paper at Centre street, when did you get it up and how was it constructed? Answer fully.

A. We commenced work on this paper immediately after 2969 we went into the shop; a box was constructed out of either American or Russian sheet iron, to the best of my recollection; box was oblong and rectangular; judge it was three or four inches—probably four—long, and about two and a half or two and three-quarters inches wide, and about two inches deep; it was cut out of a single piece of sheet metal making the bottom and sides and ends—sides and ends being turned up at right angles; it was secured at the corners by lapping over and pounding together, or brought up in close contact; a counterpart of the same, made of sheet metal, but not so deep as the first, slipped down over it, constituted the cover.

73 X Q. How long was that box used?

A. I don't think more than once; think Mr. Man fused it together the first time it was used.

74 X Q. Describe the next box you got up.

A. Was about the same as this one; indeed, we made several like it. I think I improvised one of these boxes out of a piece of cast iron.

75 X Q. When was the cast-iron box made? And describe it.

A. Couldn't say when it was made, but about that time. Its shape was circular—a section of a hollow tube—about two and a half inches in diameter, inside dimensions; was made of cast-iron tubing, such as might be found in any junk-shop; the top and bottom were made of flat pieces of cast-iron metal to cover the ends, the ends fitted so tightly that powdered carbon would not sift out; the ends were secured by winding wire lengthwise over the whole.

76 X Q. Is this the box that was principally used after this?

A. No; this one was only used once.

77 X Q. How many ones did you make after that before you got the one used principally?

A. Did not use any "principally;" we would generally destroy the boxes in using them once or twice; we made new ones whenever they were needed.

78 X Q. Were those you made subsequently any different from the ones made out of pipe?

2970 A. We never made but that one out of pipe; we made no others of cast iron.

78 X Q. You said, in answer to a question in the examination-in-chief, that you yourself saw one or more of these boxes of carbonization packed and unpacked after they came from the furnace; when you opened such box what did you see in the interior?

A. Powdered carbon and the pieces that we put in.

80 X Q. Were the boxes just as full when unpacked as when packed?

A. Don't think they were.

81 X Q. How much waste was there of the powdered carbon in the box?

A. Couldn't say; didn't measure it or weigh it?

82 X Q. Apparently how much?

A. The best I can say is some waste; part of it looked like ashes.

83 X Q. In what part of the box did you find the ashes?

A. On the top or at the edges.

84 X Q. How large were the papers for carbons you put in such boxes?

A. Generally cut out for our immediate purpose; sometimes we would change the shape, as I described in my examination-in-chief; I should judge the straight ones were from ¼ in. to ⅜ in. in length; these were about ⅛ in. in width, I think, and about thickness of ordinary blotting paper; those of the arch form were about the same in width and length (that is, across the base); the straight ones extended about ¼ in. over the loop.

85 X Q. Were these all cut out of ordinary blotting paper?

A. No.

85½ X Q. What was the thickness of them?

A. Ordinary blotting paper was used when we used such paper, except that the blotting paper could be compressed, whereas the other could not; with the means we had at hand I did not
2971 measure them, and do not state this as an expert.

86 X Q. How much would these papers shrink in becoming carbonized?

A. Don't know.

87 X Q. You say that some of the paper carbons were used at the Centre-street shop in a lamp like Fig. 7 of Exhibit No. 1; is that so?

A. Yes; used them in two ways.

88 X Q. Was this lamp a bottle, and if so, what kind of a bottle?

A. No.

89 X Q. What was it?

A. If I am right about it they are called Florence flasks in the market.

90 X Q. How was the mouth of it stopped?

A. As a general thing by a glass stopper; then, again, by a metallic stopper; tried them both ways; also used cork stoppers.

91 X Q. How did you fill these flasks with illuminating gas?

A. By a centre hole in the stopper; then we put our tube in there and put on the force of the gas and drove the air out, this tube not being close-fitting in the hole; and also by exhausting the air from the flask and applying a close-fitting tube.

92 X Q. How did you stop this tube-hole after you had finished putting in the illuminating gas?

A. By a plug.

93 X Q. By pulling tube out, then putting a plug in?

A. Yes; there was no other way.

94 X Q. When you exhausted the air from the flask, how did you do that?

A. By applying an air pump in some instances; in others we used quicksilver.

95 X Q. Explain how you applied the air pump and how you removed it?

A. Mr. Man did that; he took the flasks out and exhausted the air out of them by an air pump; will not state that this was
2972 on this particular form of flask; can't state what particular form of globe it was on; we had more than a dozen or twenty forms.

96 X Q. Do you know of your own knowledge that the air was

ever exhausted from one of these flasks, bottles or lamps used at the Centre-street shop?

A. I know we attempted it with quicksilver, whether we exhausted it or not is another matter.

97 X Q. How did you attempt it with quicksilver?

A. By filling the tube with quicksilver and by letting it run out through a plug; also used water in connection with it, I think, how I can't tell; Mr. Man and Ed. (Wm. E. Sawyer) always did this, and I stood by and assisted in various ways; just how it was done I cannot now explain.

98 X Q. You mean to be understood that you have forgotten about this part of the experiment?

A. I do not; some of the minor details do not strike me forcibly.

99 X Q. Did Mr. Man and Wm. E. Sawyer in using quicksilver for exhausting the air put the quicksilver first into a flask, bottle or lamp, then put in the mouth-piece with a tube in it and then pour out the quicksilver through the tube?

A. Can't state that positively, but my impression is it was filled through a tube, let out through a tube. My impression is the quicksilver as it went in forced out the air.

100 X Q. How long was this tube?

A. I couldn't state.

101 X Q. Can't you tell whether it was an inch or a foot or six feet long?

A. Cannot answer.

102 X Q. When the quicksilver went into the flask, bottle or lamp, how was the carbon conductor protected from destruction?

A. I don't think in this particular flask, Fig., Exhibit 1, we ever exhausted the air except by introducing gas. I don't think they ever used the quicksilver to exhaust the air where a paper carbon was employed; in all such instances they filled the lamp 2973 with illuminating gas. The lamp they used quicksilver in, is, I believe, Fig. 7, Exhibit 1. We used other carbons besides paper in this lamp and held them (the other carbons) by the spring of the post——

The former question X Q. 102 objected to by counsel for Sawyer and Man, on the ground that it is not cross-examination, and on the ground that the witness has already stated that he did not understand the detail of the exhausting of the air out of the lamps, or making the vacuum in the lamps.

Witness resuming, says he has no further answer to make to the question.

103 X Q. In these experiments at Centre street, what kind of apparatus produced the electricity employed?

A. We had at that time an Arnoux & Hochhausen machine, which was the one used. Afterwards we had other machines at Centre street. I believe we had a Weston. Had no others to my recollection, except a machine to charge up with, which was of the same kind as the other one, *i. e.*, an Arnoux & Hochhausen machine.

104 X Q. What machine was used in the experiments where light was produced in electric lamps with paper-carbon conductors?

A. Arnoux & Hochhausen.

105 X Q. Give the dimensions, as near as you can, of some parts of that machine.

Objected to as not cross-examination, and not bearing on any matter in issue.

A. My impression is that it is one of Arnoux & Hochhausen's No. 2 machines—the armature runs in water.

106 X Q. Do you know about its resistances?

Same objection.

A. I do not; am not an expert in that matter.

2974 Redirect examination:

107 Q. In answer to cross-question 100 you say you couldn't state how long the tube was used in putting quicksilver into the lamp chamber, and further on you say, in answer to question 101, you could not tell whether it was a foot or six feet long?

A. That was what Mr. Dyer said. Presumably it did not exceed a foot.

108 Q. Have you any distinct recollection as to how long it was?

A. I have not.

109 Q. X Q. 101 was as follows: "Can't you tell whether it was an inch or a foot or six feet long," and you answer is, "Cannot answer." Do you mean by that answer that you couldn't tell how long the tube was, or you couldn't tell whether it was one inch long or a foot long or six feet long?

A. Couldn't tell how long it was, but presumably not exceeding a foot in length.

110 Q. Have you any distinct recollection as to how the air was exhausted from the chamber of the lamp?

A. Have not.

111 Q. Did you have an air pump in the shop for that purpose?

A. I have no recollection of one being brought into the shop.

112 Q. Was the lamp taken away from the shop for the purpose of exhausting the air out of it?

A. It was.

113 Q. Then you don't of your own knowledge know how the air was exhausted from the lamp or whether it was exhausted?

A. From my own personal knowledge, no.

114 Q. But you saw the lamp after it was sealed and saw it burning?

A. Yes.

115 Q. Did you seal any of them yourself at the shop in Centre street?

A. I did.

2975 116 Q. And the air was exhausted after the lamp was sealed?

A. Yes.

117 Q. Referring to the lamps exhibited by figure 7, Exhibit Sawyer No. 1, how many holes were made in the glass stopper?

A. In some cases we had three and in some four.

118 Q. The conductors went through two of the holes?

A. Yes.

119 Q. And when the lamp was filled with gas it was either put in through a tube in a central hole, the tube being smaller than the hole, to allow the gas or atmosphere to escape through the hole around the outside of the tube, or in cases where there were four holes in the stopper of the lamps, the gas was put into one hole and escaped through another?

Objected to as outrageously leading under the circumstances.

A. That was the arrangement as nearly as I can remember.

Cross-examination resumed:

120 X Q. What kind of sealing was that referred to in your answer to question 115?

A. We used the glass stopper; sometimes we used nothing but the ground stopper. Then, again, we used Canada balsam on the stopper. Some other kinds of lamps had a flat piece of glass to come right against the nose or bottle that we used—that was brought right up in contact and bolted to a wooden or metal flange on top of the flange on the muzzle, as shown in the patents already referred to.

2976 121 X Q. How did you seal the holes in the stoppers?

A. Was done by a plug—some by simple plug, others by a nut and bolt, one inside and the other outside, jammed up.

WM. SAWYER.

2977 Amos Broadnax, witness produced on behalf of Sawyer and Man, being duly sworn, says:

My name is Amos Broadnax; am fifty-three years old; reside in the city of Brooklyn, New York; am an attorney and counsellor at law; am attorney for Sawyer and Man in this interference.

Immediately after November 5th, 1878, I was at the shop of Sawyer and Man on the corner of Walker and Elm streets, in this city, in consultation with them about certain applications for patents which I was then preparing for them; that while there I saw illuminated an electric lamp substantially like that illustrated by the drawing, Sawyer Exhibit No. 4; the lamp was fitted with a section of carbon in the lighting circuit, that being the illuminating part of the lamp. The section of carbon was U or arch shape, resembling the letter U inverted. The carbon was held between the divided ends of the metallic part of the circuit in the lamp by clamps, like that shown in the drawing. Mr. Sawyer told me that the section of carbon in that lamp being the illuminating part of it was made of paper, and expressed the determination to get a patent for it. Whether the carbon was made of paper or not, I do not know. I did not see it made nor did I have the carbon in my hand. The lamp was sealed up and in place and illuminated. I was probably in the shop half an hour—certainly not more than that—talking with Mr. Sawyer about his lamp and his carbon. While I was there Mr. Sawyer arranged the light so as to throw a shadow of it on a screen, to show me that that form of burner cast no shadow.

So much of the above as relates to what Mr. Sawyer told him is objected to.

Mr. Broadnax adds that he was solicitor for the Electro Dynamic Light Company at that time, and was consulting Mr. Sawyer upon the subject of patents for which he was then applying, and 2978 fixes the date which he has mentioned of the time he called there by the date of the application for the patent 210,809, which application was prepared and filed by me.

Cross-examination by George W. Dyer, Esq.:

1 X Q. At the time of this visit to the Walker-street shop, about which you have testified, were these applications of Mr. Sawyer for patents for which he was then applying connected with incandescent electric lamps?

A. Yes, sir; they were.

2 X Q. How many of the invention were there?

A. There was an application for carbon to be used in incandescent electric lamps, which was afterward divided in an interference. There was also one for a switch; one for a commutator, too; was one also for an electro-dynamic generator, and, I think, another for a switch. Don't recollect any more.

3 X Q. How many applications did you prepare*d* for Sawyer and Man, together or individually, or William Sawyer, connected with the electric lights, after your visit to the shop before spoken of, and January 9th, 1880?

A. An electric motor I forgot to mention as part of my former answer.

A. I prepared between the times mentioned a switch, filed December 5th, for Sawyer and Man; also an application for carbons for burners, Nov. 22, 1878, for Sawyer and Man. An application for William E. Sawyer, a dynamic-electric generator. I have never prepared any application for William Sawyer. Filed also an application for switch Nov. 22, 1878. I recollect no others.

AMOS BROADNAX.

It is understood by the respective counsel that if Sawyer 2979 and Man wish to take further testimony, it shall be done after reasonable notice to Mr. Dyer, counsel for Edison, and if an enlargement of time shall be required for this purpose, no objection will be made to the same.

2981 NEW YORK, *April* 12, 1881.

Parties met pursuant to agreement.

Present: Counsel as before.

Counsel stipulate that no objection shall be *be* taken to the testimony about to be put in, on the ground that sufficient notice has not been given either as to the time or names of the witnesses.

LAWRENCE MYERS, witness produced on behalf of Sawyer and Man, being duly sworn, in answer to interrogatories propounded by Mr. Broadnax, testifies as follows:

1 Q. Please to give your name, age, residence and occupation.

A. My name is Lawrence Myers; am 48 years of age; reside at Plainfield, N. J.; my occupation is negotiating railroad bonds.

2 Q. Please to state whether you are acquainted with Wm. E. Sawyer and Albon Man; and if so, how long you have known them?

A. I am acquainted with both of them. Have known Mr. Man over twenty-five years; Mr. Sawyer about three years.

3 Q. Please state whether you are acquainted with a certain electric lamp known as the Sawyer and Man lamp?

A. The lamp they had up to the latter part of January, 1879, I was acquainted with, but don't know anything since.

4 Q. State whether or not you have seen that lamp in operation, and state where and when?

A. From the 13th December, 1878, to the 20th January, 1879, nearly every day, except Sundays, at 94 Walker street (on corner of Walker and Elm streets), in city of New York.

5 Q. Is that the first time that you saw the lamp in operation?

A. I saw the lamp in operation previous to that in Centre street, somewhere near the Tombs, but I can't say exactly where; I saw it there only once. 2983

6 Q. State, if you recollect, what form of burner was used in the lamp that you saw in operation in Centre street?

A. I do not recollect the form of burner; was the first electric light I ever saw, and was struck with the light, but don't recollect the form of the burner.

7 Q. Where did you next see the lamp in operation?

A. Corner Walker and Elm streets, at the place I have mentioned.

8 Q. State, if you please, what form of burner was used in the lamp that you saw at the corner of Walker and Elm streets?

A. There were several forms used; the principal ones were like those shown by this sketch. (Witness here makes a pen and ink sketch.) In this sketch, "*a*" in Fig. 1, represents a straight pencil of carbon; in Fig. 2, "*a*" "*a*" represent two straight pieces of carbon united at the top; in Fig. 3, "*a*" represents an arch-shaped carbon; and in all of the figures "*b*" represents larger pieces of carbon in which the burners "*a*" were held.

Lawrence Myers.

Fig 1

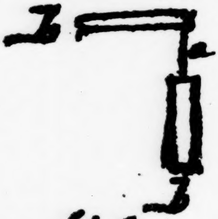


Fig 2

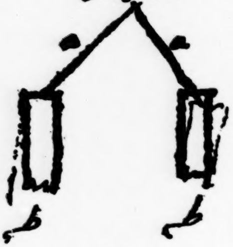
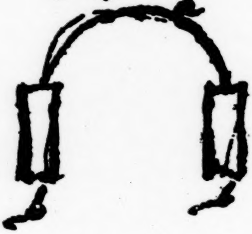


Fig 3-



No. 286.
C.E. Light Co.
v.
McK Light Co.
p 2980

Sawyer Exhibit No. 5.
April 12. 1881.
W. H. B.
Notary Public.

Lawrence Myers.

Fig 1

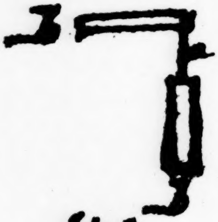


Fig 2

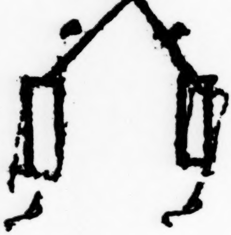
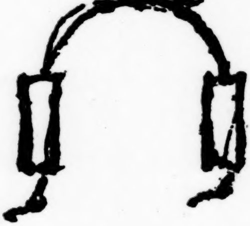


Fig 3-



No. 286.
C.E. Light Co.
v.
McK. Light Co. } p. 2982

Sawyer Exhibit No. 5.
April 12. 1881.
W. H. B.
Notary Public.

Sketch offered in evidence as part of the witness' testimony, and the same is marked Sawyer Exhibit No. 5, Apr. 12, 1881, W. H. B., notary public.

(Here follow diagrams marked pp. 2980 and 2982.)

9 Q. Look at the drawing I now hand you, marked Sawyer Exhibit No. 4, March 17, 1881, and state whether you recognize that as representing one of the lamps you saw used by Sawyer and Man, corner of Walker and Elm streets, at the place referred to by you in previous answer?

A. Figs. 2 and 3 I recognize, and Fig. 4 is a side view of the same thing.

10 Q. State what these carbon burners were made of, if you know?

2984 A. Some were made of willow; some cut out of block of carbon, and rubbed down with sand paper, and many other things, but I can't say exactly what.

11 Q. Did you see any of these made?

A. Saw them making them from various things; put them in a kind of crucible in a furnace; *b*ut molasses, etc., on the material; don't know what all.

12 Q. Did you see Mr. Sawyer or Mr. Man cutting out these carbons to the form represented by the sketch and put them in the lamp?

A. I did; I saw Mr. Sawyer principally; I don't know that I saw Mr. Man put them in the lamp.

13 Q. State, if you know, whether any of these carbon burners that you saw in use there were made of carbonized paper?

A. I do not know.

Cross-examination of witness by Mr. DYER, of counsel:

14 X Q. Why did you go to Walker street every day to see these lamps?

A. Was requested to do so by the directors or trustees, whatever they were called, of the Electro-Dynamic Light Co.

15 X Q. Did you have, or propose to have, an interest in the invention?

A. I did have; was stockholder in the company.

16 X Q. How large were the carbon conductors which you have illustrated in your sketch, Exhibit No. 5, I mean the light-giving portion?

A. About the size of a good-sized knitting needle; I refer to those in Figs. 2 and 3 particularly; that in Fig. 1 was usually as small as he could make it; it varied, however; was sometimes as large as the others.

17 X Q. State, in detail, just what you saw Mr. Sawyer do when you saw him put carbons in lamps.

A. Seen him take a block of carbon and saw out the arch, sand paper or file it down to the size he wanted it, and put it into 2985 the holder and secure it there; file out these two pencils in Fig. 2, weld them together and put them into the holder; make the pencil in Fig. 1 and put it into the holder.

18 X Q. In each of these instances, after he had put the carbons into the holders, did he put them into lamps?

A. Yes.

19 X Q. After that was done did you see him do anything with the lamps?

A. Saw him put them on the brackets, connected by wires with the dynamo machine, and light it; that is the lamp.

Re-examination by Mr. BROADNAX:

20 Q. How did the lamps operate?

A. I think every one of them gave a good light.

21 Q. This place that you speak of, as being on the corner of Walker and Elm streets, in this city, was that the workshop of the Electro-Dynamic Light Co.?

A. Yes, sir.

22 Q. And Sawyer and Man were there directing the work being done there?

A. Yes, sir.

23 Q. Were you an officer of the company?

A. I was a trustee; I mean a director.

24 Q. During the time you spent at the shop, to which you have referred, was William Sawyer employed there; I mean the father of Wm. E. Sawyer?

A. Yes; during the whole of the time working on the lamps.

LAWRENCE MYERS.

2986 NEW YORK, *April* 12, 1881.

WILLIAM E. SAWYER, a witness produced on behalf of Sawyer and Man, being duly sworn and interrogated by Mr. BROADNAX, testified as follows:

1 Q. What is your name, age, residence and occupation?

A. My name is William E. Sawyer; my age 31 years; my residence is Hotel Devonshire; my occupation is an electrician.

2 Q. Please state whether you are the Wm. E. Sawyer, one of the parties to this interference.

A. I am.

3 Q. The subject-matter of this interference, as given by the Patent Office is: "The incandescent conductor for an electric lamp formed of carbonized paper;" please state whether or not you, in conjunction with Albon Man, have at any time made and used such a conductor.

A. We have; a great many times.

4 Q. State, as near as you can recollect, when it was that you and Mr. Man first made such a conductor.

A. Almost immediately after we went to 43 Centre street; should think about the 6th or 7th of March, 1878; might have been a little earlier or later.

5 Q. Give the circumstances that gave birth to that invention?

A. Before I became associated with Mr. Man I was associated with a Mr. James Flannagan at the coal and iron exchange, where I made a number of experiments in electric lights; I had a theory that the most perfect incandescent lamp would be one having the highest resistance and the least transverse mass, and I filed an application in the Patent Office for a chalk or some similar material held between two conductors, and containing in a little groove, running across from conductor to conductor, a powdered graphite or carbon to carry out this idea; I don't remember the exact
wording of the specification, but the patent was never
2987 granted, but is probably on file in the Patent Office now;
I spoke to Mr. Man of this idea, and sat down at my desk, 43 Centre street, and drew pencil marks on some ordinary foolscap writing paper, rather heavy, and I took two small copper wires and held them with my fingers on that while the generators were running; when he brought the wires very close together we could only get a little spark; then Mr. Man and I went around to a place where they deal in pure graphite, and got some samples; I'm not exactly sure what kind of paper we used, but think we laid the same kind of a piece of paper, or piece of blotting paper, and drew a heavy line with a pencil so as to make a creasing; then we filled the crease with powdered graphite and then brushed it off of the top so as to leave only what was in the crease; we had some trouble getting the current through that, but when we succeeded we charred or burnt the paper; I recollect that in looking at that I suggested to Mr. Man the charred parts that were left were so fine that it would probably make a good carbon; Mr. Man then took a piece of blotting paper; at first they were simply straight strips one-eighth to three-sixteenths in width and one-half to perhaps 1 inch in length. Mr. Man worked over them, rubbing and pounding them with graphite till he got them full of it. But the resistance was higher than what we had laid in the crease of the paper, and it was some time before we succeeded in making the current go through it. Of course this destroyed the paper. Am not sure at whose suggestion, but to prevent that we put the strip in a sealed globe filled with ordinary illuminating gas. I should not think it took over a minute to carbonize them. That blackened the globes. We treated those carbons in globes, *i. e.*, we passed the current through the carbons while a stream of illuminating gas was flowing through the globes. We concluded that that was a rather expensive way
of making carbons. Concluded that the best way to do
2988 it was to burn it out, the way as we done in carbonizing any
material. We had no facilities there, there being neither a stove nor a furnace. Mr. Man and father hunted around, found two old pieces of thick cast iron. One looked as it might have been the foot of some heavy piece of furniture or machinery. Had a hollow in it. The other, if I recollect rightly, was merely a flat piece of iron. We cut out pieces of blotting paper, and I believe

an old drawing we had. Mr. Man packed them into that with some common powdered gas-retort carbon which he got from Charles T. Chester in Centre street. Mr. Man took the box home (should say the made-up trap), and brought it over the next morning with the paper carbonized. I would take those, treating them and putting them in lamps. Most of the experimenting after that was done by Mr. Man himself. My own idea was that a much harder carbon would be better than those thin, fragile paper carbons, but Mr. Man preferred the paper. I think he does till this day.

6 Q. After you had the paper carbons made, state whether you treated them electrically in the presence of hydrocarbon for the purpose of consolidating and enlarging them.

A. Yes, I did.

7 Q. In making the carbons of the form you wanted them to use in your lamps, did you do that before or after the paper was carbonized?

A. Almost entirely before. When we wanted to expose the broadside to the light we had to cut them out before, but when exposed edgewise we could bend them after they were carbonized.

8 Q. Of what form did you make the burners of carbonized papers?

A. Generally in the form of a half circle or circle, but experimented with all conceivable shapes. Anything that would suggest itself as capable of allowing for the expansion and contraction of carbon.

9 Q. Can't you specify some of the different forms besides a circle and a half circle?

2990 A. We also used a straight piece; a V-shaped piece. These sketches which I hand you represent some of the forms of carbon which we made of paper. (Witness makes a sketch.)

Sketches offered in evidence as part of the witness' testimony, and is marked Sawyer Exhibit No. 6, April 12, 1881, W. H. B., notary public.

(Here follows diagram marked p. 2989.)

10 Q. Referring to this sketch you have made, state whether the letter "*a*" represents the enlarged part of the carbon that was used to hold the burner by in the supporting conductors.

A. It does in Figs. 1, 2 and 3; in the others it does not.

11 Q. How were the carbons represented in Figs. 4 and 5 held in the connecting conductors?

A. By clamping the ends; frequently we slit the ends of the conductors, which were sometimes of carbon and sometimes of metal.

12 Q. Do Figs. 1, 2 and 3 represent a side elevation of the carbon held in the lamp, and the others a kind of perspective?

A. Figs. 1 and 2 represent a side elevation; Fig. 3 was made with the flat side up, as shown in Fig. 6, in which "*b*" is an oblong square piece of carbon, screwed to metallic upright "*c*" by screw "*d*"; "*e*" is a piece of carbon cut in the shape shown, with a square slot through the lower jaw, through which an oblong carbon,

William E Sawyer

No. 286.
C.E. Light Co.
v.
McK. Light Co } p. 2989

Fig 1

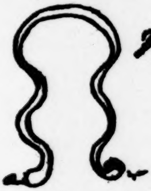


Fig 2

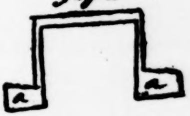


Fig 3

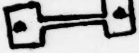


Fig 5

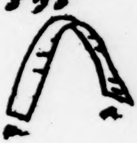


Fig 4

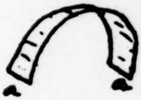


Fig 6

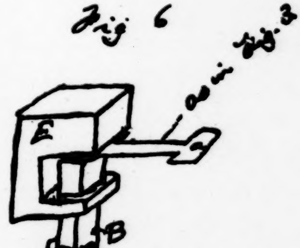
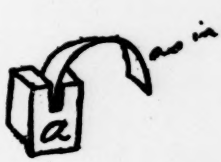

as in Fig. 3
E
B
D
C

Fig 7



Sawyer Exhibit No. 6
April 12. 1881
W.H. B.
Notary Public

Fig. 8

"*d*" passes. The connection with the carbonized incandescent part was made by the pressure of the weight of "*e*" on "*b*."

13 Q. Fig. 6, as I understand you, represents but one conductor, and one side of the connection between the conductor and the carbon section?

A. Yes; the other end of the incandescent conductor was held in precisely the same way; object was to get a very light though sure contact; the carbon- shown in figures 4 and 5 were held as
2991 shown in figure 7; in some made in that form I think, my father made a square cavity, which was packed with powdered carbon after the burner was put in; some of them were held as shown by the drawing Sawyer Exhibit No. 5; the wire shown in the bottom of the clamp, figure 4, was only used occasionally when the carbon was thin and the clamp imperfect in shape to bring the clamp up against the carbon burner.

14 Q. Does this drawing, Sawyer Exhibit No. 4, represent the lamp substantially in which you used those paper-carbon burners?

A. That represents the lamps as finally used, but it was only one of the many forms of lamps we used; and it particularly represents one of the lamps I took down at 94 Walker street, in the winter of '79–'80, to give to a friend of mine, Mr. Arnoux, of Arnoux & Hochhausen, on the Monday morning after the announcement of Mr. Edison's discovery, to show to him that we had previously invented that; this was, I think, on the 20th of December, 1879, that the Herald published that account about Edison; as soon as I got to my shop on Monday morning, which was about 9 o'clock, I took this lamp to Mr. Arnoux, and requested him to hand it to Mr. Shanks of the Tribune, to keep as an evidence that Mr. Edison was not the original inventor—to satisfy him; and I did it thus early that it could not be said that we possibly could have had time to manufacture it after Edison's announcement; this lamp was taken down in January or February of the same year, eleven months previous, having been broken; it might have been as early as December, 1878; Mr. Lawrence Myers saw this lamp in operation, and I think, saw it broken; it was taken down, I know, during Mr. Myers' stay there.

15 Q. Referring now to the paper carbons, some of which are represented in the sketch Sawyer Exhibit No. 6, state whether or not you put them in a sealed lamp and tested their practicability?

A. Yes, sir; we did.

2992 16 Q. Did you try any of the carbons illustrated by the drawing, Sawyer Exhibit No. 6, and, if so, which of them?

A. The carbons shown in figures 1, 2 and 3, and the half circle, were positively used; were sealed up and run; the great trouble with them was when we raised the temperature till we could get a bright light they would break; for this reason I preferred the harder carbons; we finally made them hard enough by treating them in hydrocarbon gas by the Sawyer-Man process.

17 Q. How long did they last in the lamp?

A. Untreated by the Sawyer-Man process would last from one second to ten minutes, if run up to give a good bright light; if run at a low temperature, they would run anywhere from an hour to one hundred hours; it depends entirely upon the temperature.

18 Q. State, as near as you can recollect, how long the best of the paper carbons you made at 43 Centre street would last in the lamp when raised to a temperature high enough to give a good bright light, after having been treated by the Sawyer-Man process.

A. Run at a power of about 25 candles they would last from 5 to 100 hours; once in a while we would get a lamp so perfect in every respect that it would seem to undergo no change after a long use; but generally they would fracture in from 5 to 20 hours, run at that temperature; the difference in the duration of the burners was due to both imperfections in the lamp and in the carbon; where the fracture alone occurs it must be due either to imperfection in the carbon or the effect of unequal expansions; when consumption occurs it is due to the imperfect charging of the lamp.

19 Q. State, as near as you can recollect, about how long you and Mr. Man continued your experiments at 43 Centre street.

A. Should think about two months; all the time we were there.

2993 20 Q. After you got through there, did you resume your experiments at any other place?

A. We moved from there to 2 Howard street, where I don't think we made any experiments on lamps, not having facilities for such experiments; we then moved in the fall of the year to 94 Walker street; I have got memoranda to show all these things; we moved to 94 Walker street during the 18th and 19th of October, 1878.

21 Q. State what, if any, experiments you made with carbonized paper carbons at 94 Walker street.

A. We employed an assistant who is dead now (Edwin L. Myers), and Mr. Man and I divided our work, Mr. Man experimenting with carbons and partly assisted by Mr. Myers; Mr. Myers conducting the charging of the lamps, and myself designing the different apparatuses connected with lamps, such as switches, dynamo machines and electrical measurements, etc., etc. I knew that Mr. Man continued carbonizing paper and live willow twigs and a good deal of such work generally; but I took no active part in it myself. He made the carbons and I used them. I don't think I ever did another thing in the manufacture of those carbons after I came in Walker street. We divided up our work and I had a general knowledge of what was going on. Almost every day, Mr Man would have some new carbons to offer. Made a good many by taking artist crayon (called the French willow carbon). He carbonized all kinds of woods. Mr. Lawrence Myers brought him in, I think, a willow twig which he carbonized. Among other forms of carbon Mr. Man made one of willow twig like Fig. 8, Sawyer Exhibit No. 6. What Mr. Man did not do in carbonizing different things can't be imagined, for he did nothing else but work on that about all the time.

22 Q. Please state whether or not you began and perfected the invention of the paper-carbon burners while you and Mr. Man were at 43 Centre street?

A. Yes, sir.

23 Q. State as near as you can recollect when it was, while
2994 you were at 43 Centre street, that you got the invention of
the carbonized paper burner perfected.

A. It was within two or three weeks after we got in 43 Centre street.

APRIL 13, 1881.

Parties met pursuant to adjournment.

Same counsel present as before.

Cross-examination of WM. E. SAWYER by GEO. W. DYER, Esq., of counsel for Mr. Edison:

24 X Q. Can you give the date when you moved to 43 Centre street?

A. About the first of March, 1878.

25 X Q. Who were the premises hired from?

A. From the engineer of the building. Am not positive; think his name was Porter.

26 X Q. What power did you use in that building in your experiments?

A. The regular power furnished to the building was shafting motion in the shop when I took it.

27 X Q. What kind of electric engine did you use at that place?

A. Had several engines there; Arnoux & Hochhausen had put one of their machines for electric lighting down in the engine-room, and they gave us permission to run wire from the shop down in the engine-room; then, afterwards, I had a Hochhausen electro-plating machine, which I bought, and another Hochhausen machine like the plating machine, but wound with a finer wire, which I borrowed; then there were two or three machines set in there for us to try; I think all of these were Weston machines (electro-plating) but we could not do anything with these Weston machines.

28 X Q. What was the electric power or capacity of each of these Arnoux & Hochhausen machines?

A. The light machine in the engine-room had a high electro-
motive force, comparatively had, I should judge, two ohms
2995 internal resistance; I never measured this, but judge from
another machine of the same make which I now have; that was the very first machine of that design which Arnoux & Hochhausen ever made; when put in there it was incomplete; they put it in for trial, to satisfy themselves of its capabilities; I think this machine was about equal to the intermediate size which they were making a year or two ago; I don't think they make just such a machine now; they said that the machine gave a light by the arc of 20,000 candles, but I should judge it only gave about 5,000 candles; the plating machines had a low electro-motive force; I don't think had more than one-half ohm's resistance; would give no voltaic arc at all; was driven at 1,500 revolutions a minute; the third machine was charged up by the plating machine; the armature was wound with fine wire, and was driven at a speed of about 4,000 revolutions a minute; only the armature coil being connected

with the lamps; is nothing to be said about the Weston machines; could not do anything with them; I mean they did not have electromotive force enough to overcome the resistance of the lamps.

29 X Q. How long did you occupy that shop?

A. I went from there to Washington, and gave it up, after being there two months and not over three; should think about two months—perhaps three months.

30 X Q. What force did you have in that shop?

A. Nobody employed in the shop but my father, William Sawyer, we had work done outside; we had some of the mechanical parts of the lamps made outside to save time in the shop; not very much done outside of the shop.

31 X Q. By whom was this outside mechanical work done?

A. Is difficult to answer; my father would have it attended to; one man in the same building did a good deal of it; Pearce & Jones, of William street, did some work; generally, father would go 2997 in some shop, take a man off his work, and put him on a little job; I can't tell you the date Pearce & Jones did work; it was while I was with Mr. Man; I get it from an account with Mr. Man, in which the dates do not appear; I think it was about the time we were in this shop—while I was first associated with Mr. Man.

32 X Q. In your answer to the fifth question you say, "I had a theory that the most perfect incandescent lamp would be one having the highest resistance and the least transverse mass;" what effort did you ever make to develop that theory, and when?

A. The first effort was in an application for a patent, the idea of which was a thin layer of powdered carbon on a refractory base. (Witness here makes a sketch which is made a part of his evidence, marked Sawyer Exhibit 7, April 13th, 1881, W. H. B., and proceeds as follows:)

(Here follows diagram marked p. 2996.)

Fig. 1 is a top view. Fig. 2 a side view. A is refractory base and a narrow groove running along the top opening in an enlarged space at the ends up into which the two conductors B B come. The carbon (powdered) was laid in the groove and packed in the end space; this may not be exactly in the form of the application but is substantially the same. This was a frequent subject of conversation—with some other applications I put in with Mr. Man.

33 X Q. Was this application to which you refer first in your own name or was Mr. Man associated with you?

A. Was in my own name—made some time before I knew Mr. Man. Think the application was not made earlier than October, 1877, and not later than January, 1878; I was continually filing applications, and as this was rejected it cleared my desk of all record of it.

34 X Q. What became of this application?

A. Was rejected and don't recollect the grounds.

35 X Q. Have you made any effort to amend it or keep it alive?

No 286.
E Light Co
v.
McK Light Co } p. 2996

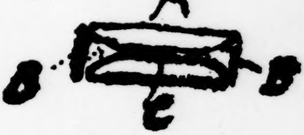


Fig 1

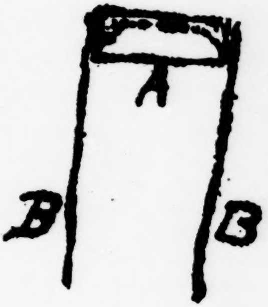


Fig. 2

Sawyer Exhibit 7.
April 13. 1881
W. L. B.
Notary Public

A. Undoubtedly it was amended, but I don't recollect
2998 what was done about it. Probably I considered the examiner's objection as good.

36 X Q. Did you prepare that application yourself?

A. I did.

Counsel for Edison gives notice that the production of this application will be required at the hearing of this interference.

37 X Q. What other effort did you make to develop the theory inquired of in 31 X Q.?

A. The effort to develop that theory and put it in practice was made with Mr. Man at 43 Centre street.

38 X Q. Has that theory ever been stated in any of your patents for electric lights or in those of Sawyer-Man?

A. I can't recollect whether it has been stated or not in any of the patents.

39 X Q. In another portion of your fifth answer you speak of carbonizing paper in what you call a "made-up trap," in which you packed the paper with "powdered gas-retort carbon;" what effect would that carbon have upon the paper?

A. No effect whatever. The carbon which was sold by Mr. Chester was purified carbon, which he sold at about $1 per pound. It was used to surround the paper and protect it from the air; more for this than any other purpose.

40 X Q. What effect did the subsequent treatment of these carbons, in presence of the hydrocarbons, have upon the carbons themselves. I refer to the 6th Q. and Ans.?

A. Two quite different effects. In some cases the whole mass of the original carbon would be hardened, and become homogeneous with the further deposit. In other cases the original carbon would remain unchanged and the deposit carbon could perhaps be broken off from it. This was due probably to difference in the manipulation. If the original carbon was heated up so as to drive
2999 out included gases, but not sufficient to decompose the hydrocarbon surrounding it, its pores will become permeated by the hydrocarbon which a quick impulse of current will decompose in the mass of the carbon, thus hardening it, and so on. But if the carbon is heated so hot as to decompose the surrounding hydrocarbon in the first place, then the original carbon will remain unchanged. By combining the two processes the original and deposit carbon may be made one and substantially the same.

41 X Q. What effect did this treatment have upon the resistance of the carbon conductors?

A. Would reduce the resistance in proportion to the extent of the treatment.

42 X Q. As a matter of fact, about how much was the resistance reduced?

A. Mr. Man's idea and mine upon that question of resistance began to differ; that is to say, my theory that the most perfect electric lamp would be one in which the incandescent conductor had the highest resistance and the least transverse mass was gradually abandoned by myself, while largely retained by Mr. Man. My present theory being that the most perfect electric lamp is one in which the incandescent conductor has not only the least transverse mass, but the least resistance. I soon began to reduce the resistance of my carbons to as low as an ohm; at present I make them only one-quarter ohm; therefore, I would treat the carbons so as to obtain a heavy deposit. Judging from the difficulty in getting the current through some of Mr. Man's carbons treated according to his ideas, they must have had as high as 100 ohms' resistance, but I don't recollect whether we made measurements of any particular ones. Answering the question directly, I should say that Mr. Man reduced the resistance in his carbon from fifty to seventy-five per cent. by the treatment referred to. This is an estimate, and not the result of measurement.

43 X Q. Did this diminution of resistance in the carbon conductors greatly increase the heat within the lamp?

3000 A. Increased the heat, but not in proportion to the diminution of the resistance.

44 X Q. Did this increased heat require the use, in some of your patented lamps, of radiators to convey away the surface heat?

A. In some of them, but don't use them in my present lamps, as they will stand the heat without.

45 X Q. Referring now to your answer to the 14 Q., and that part of it relating to the publication in the Herald of about December 20, 1879, did you make one or more replies to that article and publish them?

A. I believe something was said, but I don't recollect what now.

46 X Q What newspapers did you publish the replies in?

A. I don't know any particular newspaper; I believe I wrote to several newspapers; I think the very day that account of Edison's was published I sent the same article to every newspaper in New York.

47 X Q. Do you remember what newspapers published your article?

A. I think the Sun and the Tribune, or some other paper, but am not certain; I was continually writing to the papers; can't remember any particular article published in any particular paper.

48 X Q. Did you subsequently, and in a [short time, furnish one or more additional articles upon the same subject, which were published in the Sun?

A. Very likely I did. Refer to the previous answer with regard to my constantly writing to the newspapers.

49 X Q. Referring now to your 17th answer, could a lamp as described there, which would burn from one second to ten minutes be used in competition with gas or other commercial lights?

A. It could not; and at that time the invention was not so perfected in all respects, including the enclosing globe and mechanism, as to make the lamp suitable for any practical purpose. By
3001 mechanism I mean the general construction of the lamp, method of sealing conductors, etc. That is all the attach-

ments of the lamp and the general mechanical construction of the lamp.

50 X Q. Referring now to your 18th answer, could a lamp as described there, which would burn from 5 to 100 hours, be used in competition with gas or other commercial lights?

A. I think not.

51 X Q. Have you ever produced an electric incandescent lamp, with a paper-carbon conductor, which could be used in competition with gas or other commercial light?

A. We have produced a lamp of the kind described as capable of competing with gas as any other electric lamp produced with an incandescent paper carbon; I refer to heated carbons.

52 X Q. When and where did you produce such a lamp?

A. At 94 Walker street, substantially the same as in Exhibit No. 4 (Sawyer exhibit), referring to the copy of the drawing making part of the application for the patent. This was between the 20th October, 1878, to the 20th January, 1879. We had this lamp perfected before Mr. Lawrence Myers left.

53 X Q. How long did any of the lamps referred to in the previous answer actually burn?

A. One or two of them burned I think about 100 hours. The majority of them would fracture in about five hours. Nineteen-twentieths of them would fracture in about twenty hours. That is, of course, run up to the temperature which would give about twenty-five candle-light. That is about five times the light the Edison and Maxim lights were usually run at.

Redirect examination by Mr. Broadnax:

54 R. D. Q. Referring now to the lamps referred to in an-
3002 swer to X Q. 53, please state whether or no those lamps are
fitted with the same kind of paper carbons that you made at
43 Centre street?

A. Some of them were and some were treated with gas-retort carbon. Most of them were fitted with paper carbon. We were treating those lamps to get the greatest durability possible. The treatment was the same except we substituted liquid hydrocarbons for gaseous.

55 R. D Q. During your experiments at 43 Centre street, was William H. Church a frequent visitor there?

A. Yes.

56 R. D. Q. Did he witness those experiments with a prospect of interest in the invention?

A. I can't say what experiments Mr. Church witnessed. He was there every day in and out. Don't remember what his prospective interests in invention were.

W. E. SAWYER.

3003 APRIL 13TH, 1881.

GEORGE W. SAWYER, a witness called on behalf of Sawyer and Man, being duly sworn, and interrogated by Mr. BROADNAX, testified as follows:

1 Q. What is your name, age, residence and occupation?

A. My name is George W. Sawyer; am twenty years of age; reside at Earle's hotel; my occupation is working for the Eastern Electric Manufacturing Company.

2 Q. Please state where you were employed during the months of October, November and December, 1878.

A. 94 Walker street, by the Electro-Dynamic Light Company.

3 Q. State whether you are acquainted with Wm. E. Sawyer and Albon Man.

A. I am, with both of them.

4 Q. State what relation you are to either of them, if any.

A. Brother of Wm. E. Sawyer.

5 Q. State whether or not, during that time you were employed at 94 Walker street, you saw there in operation what is known as the Sawyer and Man electric lamp.

A. I did.

6 Q. State what your duties were at the works of the Electro-Dynamic Light Co., at 94 Walker street.

A. Employed to take care of the boiler and engine and operate them.

7 Q. State whether or not, during the time you were employed there, you saw Mr. Wm. E. Sawyer or Albon Man carbonize any paper for the purpose of making carbon burners for their electric lamp.

A. Yes.

8 Q. Which of them?

A. Mr. Man.

9 Q. Who assisted Mr. Man?

A. Edwin L. Myers.

10 Q. Where is Edwin L. Myers?

3004 A. Dead, I believe.

11 Q. How did Mr. Man carbonize the paper?

A. By first cutting the paper to the proper shape; then put it in the retort made of fire-clay, or graphite; one was made of fire-clay, and one of graphite; put it in the boiler furnace and made it red hot; then took it out and let it cool gradually; then took the carbons out and used them in the lamp.

12 Q. Did you see him put them in the lamps?

A. Yes.

13 Q. Which month was it you saw them do this?

A. In the latter part of October, and in the months of November and December.

14 Q. What shape was the retort?

A. One, I believe, was three-cornered, and one was round; was about five or six inches long; they put the papers in the retort and then filled up with powdered carbon.

15 Q. How many lamps did you see them put these carbons in?

A. A number of them; I could not say how many.

16 Q. Did you see those paper carbons illuminated in the lamp?

A. Yes.

17 Q. How long were they illuminated?

A. I can't say how long; I did not pay any special attention to that.

18 Q. State, as near as you can recollect, how long you had been at work at 94 Walker street before you saw Mr. Man carbonizing paper as you have stated.

A. Very shortly after we moved there; how long I cannot say.

19 Q. Was it a week or two weeks?

A. Think it was about a week, it was very shortly after we moved there.

20 Q. Did you see Mr. Man or your brother, Wm. E. Sawyer, making or causing to be made any carbonized paper for burners for their electric lamps at any other place besides 94 Walker street, and if so where?

3005 A. I think at 43 Centre street, in April or March.

21 Q. Was you employed at 43 Centre street?

A. Yes, sir.

22 Q. In what capacity?

A. As errand boy.

23 Q. Did you see them carbonize the paper?

A. No, sir.

24 Q. Did you see the paper after it was carbonized there?

A. Yes.

25 Q. How do you know that the paper was made of carbon?

A. They laid on the table, and I was told they were carbonized paper.

26 Q. Who told you they were carbonized paper?

A. My brother, Wm. E. Sawyer.

27 Q. Did you see any of these carbon burners that your brother told you were made of carbonized paper used in the electric lamps at 43 Centre street?

A. We had several lamps in use there, but I don't know whether the carbons used in the lamps were made of paper or not.

28 Q. Was it at the time that your brother, W. E. Sawyer, and Albon Man were experimenting with their lamps at 43 Centre street that your brother told you that the carbons were made of carbonized paper?

A. Yes, sir.

Cross-examination by Mr. DYER, of counsel for Mr. Edison:

29 X Q. Then you do not know, of your own knowledge, that any carbonized-paper conductors were made at 43 Centre street?

A. No, sir.

30 X Q. Where was the boiler-room at 94 Walker street—what part of the building?

A. In the N. W. corner of the workshop.

31 X Q. Was all the carbonizing done there, done in the furnace of the boiler?

3006 A. Yes; all that was done in the shop.

32 X Q. Were other things carbonized besides paper?

A. Yes.

33 X Q. What other things?

A. Willow twigs.

34 X Q. Anything else?

A. Not that I remember.

35 X Q. What was the proportion of the paper to the twigs?

A. Could not say.

36 X Q. How far away from where you were working were the materials prepared for carbonization?

A. Perhaps 20 feet.

37 X Q. Did you see any paper packed in retorts for carbonization at that shop?

A. Yes.

38 X Q. Who packed it?

A. Mr. Man and Mr. Edwin L. Myers.

Redirect examination by Mr. BROADNAX:

39 R. D. Q. State, if you recollect, what kind of paper was used for carbonization?

A. Paper that looked like blotting paper.

GEORGE W. SAWYER.

Counsel for Sawyer and Man gives notice that the testimony in behalf of Sawyer and Man closes here.

3007 NEW YORK, *Sept.* 22, 1881.

Parties met pursuant to agreement.

Present: Amos Broadnax, counsel for Sawyer and Man; George W. Dyer, counsel for Thomas A. Edison.

Rebutting Testimony Taken on Behalf of Sawyer and Man.

WILLIAM H. CHURCH, a witness produced on behalf of Sawyer and Man, being called and duly sworn, in answer to interrogatories propounded by Mr. Broadnax, deposes as follows:

1 Q. You have heretofore been examined in this case, have you not?

A. I have.

2 Q. I read to you questions and answers 41 and 42, folio 122, printed case, of your previous examination-in-chief.

Counsel reads questions and answers.

Please state if you have any corrections to make to your answers to those two questions, and if so, make such corrections to those answers as you may desire.

Counsel for Edison objects to the above question, and whatever answer may be made to it, for the reason that it is not properly rebutting testimony.

A. My observations were made in Centre street, before they moved to Howard street, as I did not see any work done in Howard street on carbons. I occasionally looked in there—perhaps three or four times—as I was living out of town, and came in town only occasionally.

2½ Q. Then, as I understand you, you first saw the paper 3008 carbons used at 42 or 43 Centre street, as you have testified, and the next time you saw them used was on the corner of Walker and Elm streets; is that correct?

Same objection.

A. Yes, sir.

3 Q. And that you did not see any paper carbons used at Howard street, that you know of?

Same objection.

A. No, sir; not that I know of. But I saw a lamp there burning, which I recognized as one I had seen put up at Centre street; and was told that it was the same lamp by both Mr. Man and Mr. Sawyer.

4 Q. Do you mean an incandescent electric lamp?

Same objection.

A. Yes, sir.

5 Q. Did that lamp have in it a carbon burner?

Same objection.

A. Yes, sir.

6 Q. But you don't know what kind of carbon?

Same objection.

A. I can't swear as to what kind of carbon it was.

7 Q. This lamp that you saw burning in Howard street, and which you say you recognized as the same lamp that you had seen at 42 or 43 Centre street, did you see that lamp burning at 42 or 43 Centre street, I mean did you see the lamp illuminated, and if so, how often and how long did you see it there in Centre street?

Same objection.

A. I saw it very frequently, and watched it quite a number of hours all told. I saw it there burning continuously for two or three hours at a time, and sometimes during the whole afternoon.

3009 8 Q. State, if you know, how long that lamp was in operation in Centre street; I mean how many days or hours was it illuminated?

Same objection.

A. I should think about three weeks in the month of May; I don't recollect that I saw it every day, but I saw it a good many times during that time in operation.

9 Q. State, if you know, whether that lamp was a sealed lamp filled with nitrogen gas.

Same objection.

A. I know it was sealed and filled with nitrogen gas.

10 Q. State, if you know, whether during three weeks in which you say you saw the lamp in operation, the lamp was unsealed and refilled or whether it was continued right along.

Same objection.

A. It was continued right along and never taken apart.

11 Q. State, if you know, whether the carbon was renewed in the lamp, or whether it was the same carbon that you saw illuminated during the whole of the time you saw the lamp in operation.

Same objection.

A. No part of the lamp was renewed. The same carbon remained in from the first to the last.

12 Q. State if you know, whether the lamp to which you have been referring is still in existence.

Same objection.

A. I think it is, but don't positively know.

13 Q. State whether or not you saw this same lamp burning on the corner of Howard and Centre Sts., at the workshop of
3010 Sawyer and Man; and if so, state how often and how long, as near as you can recollect.

Same objection.

A. I saw that lamp burning several times in Howard St., corner of Centre St. I saw it several times, an hour or so at a time, illuminated.

14 Q. State whether you saw this same lamp illuminated at the workshop of Sawyer and Man, on the corner of Walker and Elm Sts.

Same objection.

A. I don't remember seeing that particular lamp there.

15 Q. Referring now to this lamp, about which you have been testifying, you say you saw it in operation at 42 or 43 Centre St. State whether or not you saw any more lamps of the same construction at 42 or 43 Centre St., in operation.

Same objection.

A. I did.

16 Q. How many of those lamps did you see there in operation?

Same objection.

A. There were others of that kind, but I don't remember how many. They were trying to get a better plan of sealing, but that one before testified about was the most satisfactory lamp.

17 Q. Referring now to the lamp, the chamber of which consisted of a Florence flask, as illustrated in your sketch, figure 7, Sawyer Exhibit No. 1, state as near as you can how many lamps you saw made of that *that* kind in Centre St., and illuminated at any one time.

Same objection.

A. Five or six.

3011 18 Q. How often did you see these lamps illuminated?

Same objection.

A. Frequently. I can't say how often. They were experimenting with carbons in those.

19 Q. You mean by that that they were trying to obtain a satisfactory carbon to burn in their lamps?

Same objection.

A. I do.

20 Q. State, if you know, whether they did finally obtain a satisfactory carbon to use in their lamps, at 42 or 43 Centre St.

Same objection.

A. I think they did.

21 Q. State, if you know, whether they finally succeeded at 42 or 43 Centre St., in obtaining a satisfactory paper carbon to use in their lamps.

Same objection.

A. I think they did.

22 Q. Before they moved away from 42 or 43 Centre St., did they finally succeed in getting a satisfactory sealing for their lamps, sufficient to make a good practical lamp?

Same objection.

A. In the one lamp to which I have referred it was satisfactory.

23 Q. In answer to cross-question 3, page 32, folio 127, you say: "In Centre St., No. 42 or 43, as designated this morning, the first lot was in September, in Howard St.; one lamp put up in May was rather crude. I*n* the lamp you referred to in that answer as being "rather crude" the lamp about which you have been testifying this morning?

Same objection.

3012 A. It is.

24 Q. In what respect did you consider that lamp crude?

Same objection.

A. It wasn't a nicely finished lamp. It looked rough.

25 Q. Was that the only lamp you saw in operation corner of of Howard and Centre streets?

Same objection.

A. It seems to me I saw this lamp with two others, put up on the same plan as that one in circuit there in Howard street. I think one had a different form of glass globe—having a bulb at the top like Fig. 1, Sawyer Exhibit 2.

26 Q. Then did you mean by your answer 3 of cross-examination in your previous testimony, that the first lamps you saw put up at 42 or 43 Centre street, as stated in the answer, and that the lamp which you say was put up in May, and was "rather crude," was one of the lamps that was put up at No. 42 or 43 Centre street?

Same objection.

A. Yes, sir; it was.

27 Q. And the next lot of lamps which you saw was in September, in Howard street, of which you think there were three, one of which was the lamp which you saw in No. 42 or 43 Centre street.

Same objection.

A. Yes, sir.

28 Q. Question 8 of your cross-examination, page 32, is as follows: "The first lot put up in Howard street, were they all alike?" Answer: "Yes, as I remember."

Please state whether you have since ascertained that you
3013 were mistaken in saying that they were all alike.

Same objection.

A. They were all alike excepting that one that was brought up from 42 or 43 Centre street.

29 X Q. I do not yet understand exactly what you mean by your answer to question 41 in chief, page 31. The question is as follows:

"Please state when it was that you first saw the paper carbons used in the lamps—not experimentally, but in the lamp as perfected."

Your answer is: "In September, 1878."

What did you mean by that answer? Please state exactly what you meant, or what your understanding of the question was.

Same objection.

A. I saw the first satisfactory lamp put up in 42 or 43 Centre street, and saw it burning there. I afterwards saw the same lamps, with others better made, in Howard street, in September, and subsequently I saw other lamps with the paper carbon in Walker street, corner of Elm street, in December, 1878.

30 Q. Then, as I understand you, the first paper carbons that you saw used, that you knew were paper carbons, were in 42 or 43 Centre street, in lamps like that illustrated by Fig. 7, Sawyer Exhibit No. 1?

Same objection, and the additional objection that the witness has not said anything of the sort indicated in the question.

A. That is correct. The experiments with paper carbons were made at 42 or 43 Centre street, prior to the first of June, 1878, in the lamps represented by Fig. 7, Sawyer Exhibit No. 1?

31 Q. When did you next see the paper carbon used
3014 knowing that it was paper carbon, in the Sawyer and Man lamp?

Same objection.

A. In December, 1878, in Walker street, corner of Elm street, in the lamp as perfected.

32 Q. You say that you saw at 42 or 43 Centre street, five or six of the lamps represented by figure 7, Sawyer Exhibit No. 1. Please state whether you saw all these lamps illuminated at one time.

Same objection.

A. I did.

33 Q. Please state how long you saw them illuminated at one time.

Same objection.

A. Sometimes a few minutes; sometimes much longer. They were experimental for the purpose of getting a good carbon. Carbons were put in of different shapes and forms. They sometimes might have lasted as long as an hour. I didn't always stay to see how long they lasted.

34 Q. Did you ever go away and leave them burning?

Same objection.

A. I have.

35 Q. When those five or six lamps were all in circuit, would they all go out at once at any time while you were there watching them?

Same objection.

A. No, sir; I don't remember ever seeing them all go out at once.

36 Q. How many of them have you seen go out while you were watching them?

Same objection.

3015 A. I have seen them all go out while I watched them, but not at the same time.

37 Q. State, if you know, why they went out.

Same objection.

A. The carbon seemed to consume; which might have been from a defect in the carbon or a defect in the sealing or filling the lamp.

38 Q. Referring still to these same lamps; how many of them were provided with carbonized-paper burners?

Same objection.

A. I could not tell the number. These lamps were taken down and fitted up again and again. Changes in the form—and in other respects—in the carbons were continually made.

39 Q. Do you know of your own knowledge that any of these five or six lamps that you say you saw in circuit at one time were provided with carbonized-paper burners?

Same objection.

A. Yes, sir.

40 Q. How long is the longest that you saw any one of these lamps burn that was provided with carbonized-paper burners?

Same objection.

A. I have watched them from three-quarters of an hour to an hour.

41 Q. I understand you to say that you did not see any lamps illuminated with paper-carbon burners, at the shop on the corner of Howard and Centre streets, that you knew to be paper carbon. Is that correct?

Same objection.

A. Yes; I did not know what the carbons were made
3016 of that were used in Howard street, corner of Centre street.

42 Q. Referring now to the shop corner of Elm and Walker streets, where you say you saw the paper-carbon burner used in the perfected lamp, in December, 1878, please state how long you saw the perfected lamp provided with a carbonized-paper burner illuminated at any one time in that shop, corner of Elm and Walker streets?

Same objection.

A. From two to three hours; as long as I could stay there to watch it; passing in and out, I have seen it burning the entire day, but have never watched it more than two or three hours at a time without leaving the office and then going back again.

43 Q. Was this in December, 1878?

Same objection.

A. Yes, sir.

44 Q. State, if you know, whether or not Sawyer and Man used an illuminating conductor in their lamp made of any other material than carbon.

Same objection.

A. Never to my knowledge.

45 Q. Please examine the lamp I now hand you, and state if you recognize it as the lamp you saw at No. 42 or 43 Centre street, that

was afterwards taken to the shop on the corner of Howard and Centre streets, and that you there saw in operation.

Same objection.

A. I recognize it as that lamp.

Lamp is offered in evidence and is marked Sawyer Exhibit "Lamp No. 1," W. H. B., notary public, Sept. 22, 1881.

3017 Same objection is made to the introduction of the exhibit.

Counsel for Edison gives notice that at the hearing he will move to strike out all of the above testimony, for the reason that it is either new matter or cumulative, and in no sense rebutting; and not waiving any objection to same, cross-examines this witness.

Counsel for Sawyer and Man replies that the testimony is rebutting, and intended so to be, in so far as it meets any presumption on behalf of Edison that Sawyer and Man did not produce a patentable lamp in the spring of 1878. The rest of the testimony is merely explanatory, and intended merely to correct the errors of the witness in matters of date in his previous testimony.

Cross-examination by GEORGE W. DYER, of counsel of Edison:

46 X Q. How do you know this is the same lamp which you saw at Centre street in May, 1878?

A. I know it from a recollection of it: these wooden plates on the bottom is one thing that calls it back to mind, and its general appearance is familiar; I have watched this lamp a great many hours.

47 X Q. Have you ever seen any other lamps like it?

A. Not exactly.

48 X Q. How does this differ from the other lamps that were not exactly like it?

A. In the construction of the base; the sealing and also in the upper structure of it; and then, other lamps which I remember were not as tall—did not have so long a glass tube.

49 X Q. Wherein does the construction of the base differ from that of the other lamps?

A. Instead of the wooden plates, a corresponding metal
3018 ring to the one through which the screws are passed was
placed under a wooden cushion and screwed up; then a spun-metal cap would cover the whole of the sealed portion of the lamp.

50 X Q. How does it differ in regard to sealing from the other lamps?

A. I do not know that it differs in any respect.

51 X Q. How does it differ from the other lamps in the upper structure?

A. The cross-bar at the top differs in this, that a spring was placed in the back in the others, which takes the pressure off from the end of the carbon. The spiral conductors were, in some instances, made of straight pieces and in other shapes; in the other lamps the conductors were not in true coils.

52 X Q. You are confident, then, are you, that this was the only lamp Sawyer and Man ever made just like this?

A. I am.

53 X Q. I understand you, when you saw this lamp burning, it had been filled with gas; is that correct?

A. Yes, sir; it is.

54 X Q. How do you know it was filled with gas?

A. I saw it put in circuit to be filled with gas—that is, this very lamp.

55 X Q. Do you know that it was filled with gas?

A. Yes, sir.

56 X Q. Did you see it filled with gas?

A. I did; I saw the lamp placed in the circuit to be filled; I saw gas made; I saw gas bags used in the circuit; I saw this lamp connected to the pipes between the gas bags through which the gas passed from the full bag at one end to the empty bag at the other end of the circuit, and so on, back and forth, through the lamp.

57 X Q. Do I understand you correctly that this particular lamp was used for the purpose of experimenting with a variety of carbons?

A. No, sir.

58 X Q. Was it used for experimenting at all, and, if so, for what experiments?

3019 A. It was an experimental lamp for the purpose of exhausting and sealing and filling with gas.

59 X Q. What kind of exhausting?

A. My impression is that it was by displacing the atmosphere by another and heavier gas that would not support combustion of the carbon.

60 X Q. How frequently did you see this lamp filled with gas at Centre street (No. 42 or 43)?

A. The lamp was never filled but once.

61 X Q. How many times have you seen this lamp burn in No. 42 or 43 Centre street?

A. Quite a good many days; I couldn't tell the exact number, but I should say between two and three weeks. This was in the month of May, 1878.

62 X Q. How many different carbons did you probably see burned in this lamp?

A. Only one.

63 X Q. Did you see that carbon put into the lamp?

A. No, sir.

64 X Q. Do you know of your own knowledge what kind of carbon it was?

A. No, sir.

65 X Q. Explain how this lamp was used in experiments in sealing at Centre street (No. 42 or 43.) when it was filled only once with gas.

A. It was not thought at the time this lamp was put up that it would show any such life as to the carbon as was experienced in its use. It was the expectation to remove the plates and experiment further in the process of sealing; but the life of the carbon extended through several months, and showed that the sealing was perfect.

66 X Q. How was this lamp sealed?

A. By the glass plate being ground perfectly to fit the end of the tube (I am not sure whether he put any balsam or not between the wooden plates,) all of which with the ring around the flange, were screwed together very perfectly.

67 X Q. Were you at the shop at Centre street all the time
3020 while this lamp was there?

A. I was in and out; in there every day—a great deal of the time.

68 X Q. What proportion of each day do you think you were there?

A. From two to three hours, and frequently more than that.

69 X Q. How do you know that the lamp was not unsealed and sealed up again while you were away from the shop?

A. Because nitrogen gas was not made every day; when they made it they used it immediately; I was generally there when it was made, and knew for what lamps it was intended.

70 X Q. Were many lamps made after this was made?

A. Of course; a great many.

71 X Q. Why were not other lamps made like this that worked so well?

A. Because they endeavored to improve upon the style and appearance of the lamp.

72 X Q. Did they improve upon the style and appearance of the lamp?

A. They did.

73 X Q. Do any of the exhibits in this case show such an improvement; if so, point them out?

A. The next lamp that was made was like Fig. 1, Sawyer Exhibit No. 2, the globe of which was not so long and was enlarged at the top, and the spiral conductor to keep the base of the lamp cool was made in a different shape; the two spirals being made together so as to form apparently only one spiral. Then the sealing of the lamp was covered with a metal cap, spun up so as to cover the whole base of the lamp. Fig. 2 was considered an improvement in having two uniform spirals separate, and the glass tube was not so long. Fig. 3 had, instead of spirals, straight strips put in for the conductors so as to obtain the same length of radiating conductor to keep
3021 the base of the lamp cool. Fig. 4 was another form of making these conductors, and also of holding the carbons which were circular in shape instead of straight, as represented in the other lamps referred to.

74 X Q. What degree of luminosity was given off by this lamp when you saw it burning in Centre street?

A. Sufficient to light a room of the size of the one in which we are sitting, brilliantly.

75 X Q. When you saw this lamp burning in Howard street, had any change been made in it?

A. No, sir; none whatever.

76 X Q. Was its luminosity as great as before?

A. Yes, sir; it was.

77 X Q. You testified in this case in March last, did you not?

A. I did.

78 X Q. Have you, since testifying at that time, read the testimony which was given in behalf of Mr. Edison?

A. I have not. I heard a portion of Mr. Edison's during the two days which I was there; a little while each day; I was engaged in conversation during the greater part of the time I was there. I have no recollection of Mr. Edison's testimony.

79 X Q. What has occurred to refresh your memory since you testified in March last?

A. In looking over my testimony soon after it was printed, I noticed a little discrepancy in the dates to which I had testified as having witnessed these experiments, and I called Mr. Broadnax's attention to it.

80 X Q. When did you next see this Exhibit "Lamp No. 1," after you saw it at Howard street?

A. I saw it at the office of Lorillard & Co., in the private safe of Mr. Man. It was in the month of December, 1878, or January, 1879 (probably January, 1879); and I have since seen it in his private safe several times.

81 X Q. When you saw it there at Howard street, had it been broken?

A. It had.

3022 82 X Q. And mended again?

A. Not then. It wasn't mended till after Mr. Man took it away.

83 X Q. When did you first see it after it was mended?

A. I think in December, 1878, or January, 1879; as I have before testified.

84 X Q. How long was it at Howard street before it was broken?

A. I should say two or three months. It's my impression I saw it burning in Howard street in September. I certainly saw it burning in the shop in Howard street.

85 X Q. When you first saw it after it was mended, did it have the paper inside which is now there?

A. Yes, sir.

86 X Q. Have the paper in there before it was broken?

A. Yes, sir.

87 X Q. Referring to your second question and answer in this examination, what kind of lamps did you see paper carbons used in at 42 or 43 Centre street?

A. In the experimental lamps where Florence flasks were used; as illustrated by Fig. 7, Sawyer Exhibit No. 1.

88 X Q. And what kind of lamps did you see paper carbons used in at the corner of Walker and Elm streets?

A. In the lamps represented in the Sawyer Exhibit 4, Fig. 2.

Cross-examination adjourned until 11 o'clock, Friday morning, September 23d, 1881.

3023 NEW YORK, *September* 23, 1881—11 o'clock a. m.

Met pursuant to adjournment.
Present: Counsel as before.

Cross-examination of WILLIAM H. CHURCH continued by Mr. DYER:

89 X Q. Did you see the paper carbons used in any other form of lamps besides that shown in Fig. 7, Sawyer Exhibit No. 1, at Centre street?

A. Not that I am aware of.

90 X Q. Did you see used in the lamps there any carbon conductors not made from paper?

A. Yes, sir.

91 X Q. How did the number of these lamps compare with those in which paper-carbon conductors were used?

A. I don't know.

92 X Q. The paper carbons which you saw used at the corner of Walker and Elm streets, in lamps like Fig. 2, Sawyer Exhibit 4, were these treated or untreated carbon conductors?

A. They were treated by the Sawyer-Man hydrocarbon process.

93 X Q. How was it as to those that were used in Centre street?

A. I don't remember. My recollection is not distinct about it.

94 X Q. In answer to the 21st question you say that you think that "they finally succeeded at 42 or 43 Centre street in obtaining a satisfactory paper carbon to use in this lamp." What kind of a carbon was this to which you refer in this answer—was it a treated or an untreated carbon?

A. I think it was a treated carbon.

95 X Q. Can you designate the form of these carbons by any sketches which are exhibits in this case?

3024 A. In Sawyer Exhibit No. 1, Fig. 1, a straight pencil is the only one that rests in my memory as the form that they used in Centre street. The other representations, Figs. 2, 3 and 4, were experimental.

WM. H. CHURCH.

Sworn to and subscribed before me this 23d day of September, 1881.

WILLIAM H. BROADNAX,
Notary Public, Kings Co., N. Y.

Certificate filed in New York Co., N. Y.

3025 NEW YORK, *Sept. 23d,* 1881—1 o'clock p. m.

Parties meet pursuant to agreement.
Present: Counsel as before.

ALBON MAN, recalled and resworn, and being interrogated by Mr. BROADNAX, deposes as follows:

1 Q. Please to examine this lamp, marked Sawyer Exhibit "Lamp No. 1," and state whether or not it is one of the Sawyer and Man

electric lamps; state when it was made and how long it was operated.

Counsel for Edison objects to the above question, and whatever answer may be made to it, for the reason it relates to matter not in the nature of rebutting testimony.

A. It is one of the Sawyer and Man lamps. It was made under my direction, in consultation with Mr. Sawyer, and completed, according to the best of my recollection, about the last of March or first days of April, 1878, in substantially its present form. It was run for a few days after completion, successfully, and without apparent consumption of the carbon, at 43 Centre street, in this city, and exhibited to a great number of people. Then by an accident the top of the glass tube or globe was broken off, and I took it down and took the glass globe or tube to Mr. Hahn, in North William St., and he put back the piece and mended the globe or tube; in doing so the top of the globe or tube was smoked or discolored. As it appeared to be very thin, I would not allow Mr. Hahn to remove the discoloration with acids, but allowed it to remain in the condition in which it now is, except cleaning it out with water and ether. Before this time the two conductors that lead into the lamp and support the soapstone diaphragm, were arranged in concentric spirals, instead of in 3026 two separate spirals as now. The lamp was operated before the accident, I should say, about one week. It took about a week to get it restored and ready to set up again in the exact condition in which it now is, except the incandescent portion or light-giving carbon, and except that the lamp is not now sealed nor filled with any gas except the atmosphere, and except, possibly, a piece of potassium which I think has been removed from the lamp. I, with the aid of Mr. William Sawyer, set up the lamp again about one week after the accident to the glass globe or tube occurred, to the best of my recollection, in the second, or possibly the third week of April, 1878. I myself filled it with purified nitrogen gas, placing a piece of metallic potassium inside it in a cloth bag, sealed it up and set it running. In the course of filling, lighting it up several times, and heating it thoroughly, both inside and out, by the current and with the heat of a furnace to drive out occluded gases from the incandescent portion of the lamp, and adherent gases from the glass and interior works of the lamp, I then set it running, and it was run continuously every day except Sundays, until the latter part of May or the first of June, when we left 43 Centre street, and exhibited to a large number of people. It ran all day and sometimes in the evening, and as long as anybody wanted to see it, at high incandescence, lighting up well the whole interior of a black and grimy and gloomy room, some 25 or 30 feet in width and about 35 or 40 feet long, at this place, No. 43 Centre street. I then took the lamp to my office No. 3 Mercer street, and put it in my safe and set up a dynamo machine at Jackson's iron works, on the southwest corner of Howard and Centre streets, ran connecting wires there and made a stand for the lamp in a dark portion of the shop, and from time to time during the summer, until about the last of August

or first of September, I took the lamp there a great many times and ran it and exhibited it to my friends. The lamp was filled with purified nitrogen gas at atmospheric pressure. Upon one occasion
3027 at Jackson's place, I was called away and left the lamp burning, and was unable to go back for it, so that it ran there the greater portion of the day. The luminosity of the lamp at that place was somewhere from about 100 to 150 candle power. About the last days of August or first days of September, and I think in August, the lamp was taken to a room under Arnoux & Hochhausen's shop at the northwest corner of Howard and Centre streets, which we had hired to work in. This may have been in the third week of August, 1878. It was there run and exhibited by myself, Mr. William E. Sawyer and Mr. George Sawyer, and Mr. Frank Holbrook and Mr. Edward Myers, until, I should say, the last week of September, 1878, developing a light of from a 100 to 200 candle power. I think it ran up a good part of the time to 200 candles, but a part of the time the machinery was slowed in the shop, so that it did not run at more than 100 candles, and a part of the time a portion of the current was shunted off to show the operation of our switches, and the lamp was run at varying light, from simple red heat up to over 200 candles. The carbon in the lamp was made from a piece of French carbon, worked down by hand and treated in hydrocarbon gas, according to the process subsequently patented by Sawyer and Man. During the last two or three days that the lamp was run a small perforation or pit appeared in the carbon, showing a defect in it. This went on until a very minute hole was made clear through the carbon (through which light could be seen on holding the lamp up to the window and examining it with a magnifier) when the operation seemed to cease. The lamp continued to give light and to be run after this as before, and was run up to the same light-giving power and exhibited as before for two or three days. It will be seen that the soapstone diaphragm does not touch the sides of the glass tube and is not supported by spiral springs against the interior or the tube, as in our other lamps,
3028 but will vibrate, the soapstone striking against the sides of the tube if the lamp is not carefully handled. It stood upon a bracket placed upon a board partition which was not steady or firm, and through which the outer door of the room passed. The wind blew the door together violently, shaking the partition and the lamp supported by it, and the jar of the diaphragm against the glass broke the carbon at the point where the perforation, to which I have referred, had been. It was the same carbon that was first put in the lamp, and was always used in it up to that time. I took the lamp down myself, with the aid of Mr. Frank Holbrook or Mr. Myers, I don't recollect which, and found the pressure of the gas in the lamp was very slightly, at that time, in excess of the atmospheric pressure. Mr. Holbrook or Mr. Myers, whichever it was, and myself had prepared some test, I cannot now recollect what it was, to ascertain if possible, whether there was any gas compound of hydrogen or nitrogen in the lamp. We found none by the chemical test that had been prepared. We then, after making this trial,

placed a rubber tube over each of the tube conductors in the lamp, and blowing into one slightly held the other at our nostrils, endeavoring to see if there was any smell to the gas which came from the lamp. I had suspected that there might be a smell of bitter almonds or peach blossoms, but we could neither of us detect any. In speaking of this I should say it occurred before any opening or taking down of the lamp other than I have described. I completed the taking down of the lamp, took out the piece of potassium that was in it, put in a new carbon, stood it up loosely as it now is, took it and put it in my safe at No. 3 Mercer street, where it has remained ever since (except being taken over to the corner of Walker and Elm streets to show it to some one occasionally) until I gave it to Mr. Broadnax a day or two since. In numerous tests made for the purpose, we failed to detect any gas in the globe other than the nitrogen with which the globes were originally filled at
3029 whatever stage or age of the lamp the test was made. And some of these tests were made where the carbon had been destroyed and in others where the carbons remained perfected. We had suspected that there might be a chemical union at high incandescence between carbon and nitrogen, and Mr. Meyers, who was a good practical chemist, a graduate under Prof. Morton, of the Stevens Polytechnic institute, made these tests at our request, but was never able to find any evidence of such combination.

2 Q. State if you please, whether you opened any other sealed incandescent lamps in which carbon was the illuminating conductor, and if so, please state whether they are operated at high incandescence, what gases they were filled with, how many there were, how long they operated, and whether any of them exploded during their preparation or operation, and state whether you used or attempted to use anything but carbon as the illuminating conductor in your lamps.

Same objection.

A. I made and used a large number of incandescent lamps from the commencement of our operations up to February or March, 1879. All of them with carbon burners or incandescent conductors, and with nothing but carbon—never attempted to use anything else. They were all run for considerable periods, more or less, some for minutes, some for hours, some for days, some for weeks, some for months. The only gases we used, or attempted to use, were carbonic acid gas, ordinary illuminating gas, purified illuminating gas, hydrocarbon crude nitrogen gas, and pure nitrogen gas—or as nearly pure as we could get it. In most of these lamps the pressure was ordinary atmospheric pressure, in some highly rarified gases were used. We never burst the globe or glass of any lamp but one, that was filled with hydrocarbon or illuminating gas not sealed up tight, left over night and the air united with
3030 the gas, and the instant the current was turned, before any time to heat the gas, or cause it to expand, the globe, which was a Florence flask, was blown into innumerable pieces by the explosion that occurred. A large number of these lamps were made

of Florence flasks and filled with ordinary illuminating gas. They were run for hours at a time, day after day, thoroughly heated up, but never exploded or burst. We were in the habit, for fear they might not be properly sealed so as to exclude the air, which in union with the gas would cause explosion, of running the gas through every morning for a considerable time and freshly sealed them up. They were successful lamps, except for the fact of the deposit of carbon upon the illuminating part and *open* the interior of the glass. We would have to take them down every few days and clean them out and put in new carbons sometimes, because the carbon would grow too big to be rendered incandescent by the current used.

Counsel for Edison gives notice that he will move at the hearing to exclude this testimony of Mr. Man, upon the ground that it is not proper rebutting testimony, and upon the further ground it has no relation upon the subject in controversy, and declines to cross-examine.

ALBON MAN.

Sworn to and subscribed before me, this 23d day of September, 1881.

WM. H. BROADNAX,
Notary Public, Kings Co., N. Y.

Certificate filed in N. Y. Co., N. Y.

3031 Further taking of testimony pos-poned by consent to a day to be determined upon at a future time by the counsel.

CITY AND COUNTY AND STATE OF NEW YORK, *ss:*

I, William H. Broadnax, a notary public within and for the county of Kings (and having my certificate filed in New York county), and State of New York, do hereby certify that the foregoing deposition of Albon Man, William H. Church, William Sawyer, Amos Broadnax, Lawrence Myers, William E. Sawyer and George W. Sawyer, were taken on behalf of William E. Sawyer and Albon Man, in pursuance of notice hereunto annexed, before me, at 57 Broadway, in the city and county and State of New York, on the 14th, 15th, 16th, 17th days of March, and the 12th and 13th days of April, 1881, and on the 22d and 23d days of September, 1881; that each of said witnesses was by me duly sworn before the commencement of this testimony; that the testimony of each of said witnesses was written out by J. Edgar Bull in my presence; that Messrs. Dyer and Wilber, representing the opposing party Thomas A. Edison, were present during the taking of said testimony; that said testimony was taken at 57 Broadway in the city of New York, and was commenced at two o'clock p. m., on the 14th of March and was continued pursuant to adjournment on the 15th, 16th and 17th days of said month and the 12th day of April, 1881, and the 23d day of September, and was concluded on the 23d day of the month last mentioned; that I am not connected by blood or marriage with either of said parties, nor interested directly or indirectly in the matter in controversy.

[SEAL.] In testimony whereof I have hereto set my hand and affixed my seal of office, at 57 Broadway, in the said county, this 10th day of December, 1881.

WM. H. BROADNAX.

Ex'd: J. A. W.—M. McK.

3032 In the United States Patent Office.

WILLIAM E. SAWYER and ALBON MAN
vs.
THOMAS A. EDISON.
} Electric Lighting.

Testimony on Behalf of Edison.

To Amos Broadnax, attorney for Sawyer and Man:

Please take notice, that on Friday, June 10, 1881, at eleven o'clock, a. m., at No. 65 Fifth avenue, New York city, I will proceed to take the testimony of T. A. Edison, Charles Batchelor, E. H. Johnson, John Kruesi, and others, in behalf of said Edison, and continue the examination from day to day until completed.

You are invited to be present and cross-examine.

DYER & WILBER,
For Edison.

Washington, D. C. Good service this 8th day of June, 1881.

AMOS BROADNAX,
Att'y for Sawyer and Man.

3033 In the United States Patent Office.

SAWYER AND MAN
vs.
THOMAS A. EDISON.
} Electric Lights.

Pursuant to notice hereto annexed, Mr. Z. F. Wilber appeared for Mr. Thomas A. Edison, at 11 o'clock a. m., this 10th day of June, 1881, at No. 65 Fifth avenue, New York city, and at the request by telegram of the attorney for Sawyer and Man, I have postponed the taking of testimony until 11 o'clock a. m., June 11th, at same place.

WM. H. MEDOWCROFT,
Notary Public and Commissioner, New York County.

3034 NEW YORK, *June* 11*th*, 1881.

Pursuant to adjournment the counsel for the respective parties appeared before me at No. 65 Fifth avenue, New York city, at 11 o'clock a. m., George W. Dyer appearing as counsel for Thomas A. Edison, and Amos Broadnax as counsel for Sawyer and Man.

By consent, the questions and answers were reduced to writing by H. W. Seely, he having first been duly sworn to faithfully and truly record the same.

THOMAS A. EDISON, a witness produced in his own behalf, being duly sworn, testified as follows in answer to questions proposed to him by GEORGE W. DYER, counsel for Edison:

1 Q. Please state your age, and residence, and occupation.

A. Age, 34; occupation, inventor; residence, Menlo Park, N. J.; for the time being living in New York city.

2 Q. Please relate in detail your earliest experiments in the carbonization of paper.

Question objected to, unless the experiments were made, or to be used, or with a view of using the paper in electric lighting, and unless the intention was to make the paper in burners for electric lamps.

A. I carbonized paper in the summer of 1876. Such paper was to be used for battery carbons, for non-conductors of heat, and articles were to be made in different shapes and carbonized. A great many articles were so made and carbonized from paper. Sheets of carbonized paper were used for electrical resistance about that time. Strips of card-board or bristol-board, about a quarter of an inch wide and five inches long, were placed in gas tubes and carbonized by placing the same in a furnace and heating the tube to a white heat. The strips were packed in the tube, one upon the
3035 other, and the interstices filled with charcoal powder. Sheets of tissue paper were laid in iron boxes, fifty to a hundred deep, on the top of which was laid a weight of metal so that the carbons would remain straight after being carbonized. Also sheets of thick bristol-board several inches square were carbonized under strain to keep them straight. Some experiments were also made to carbonize small crucibles made out of bristol-board.

Counsel for Sawyer and Man objects to the answer as going to show that the invention was made before the date named in the preliminary statement, in so far as it bears on the making of the carbon electrode of paper for the electric lamp.

3. Q. How extensive were these experiments, and what persons, if any, had knowledge of them?

Same objection as to former question.

A. The experiments were quite extensive. My intention was to go into the business of making carbon wire for various purposes, electrical and chemical, for electric lighting and batteries. A company called the American Novelty Company was to handle the goods in connection with a gentleman named James, who is now dead. Mr. Charles Batchelor, and, I believe, Mr. E. H. Johnson, saw many of the experiments. Mr. Adams, one of my assistants, now dead, helped me in the experiments. I would mention that we also carbonized wood made up in various shapes, as well as paper.

4 Q. What was the quality of the paper carbon produced at that time in the way you have described?

Question objected to on the same ground as before.

A. They were very fair carbons after we had got the idea of carbonizing them under strain and pressure.

3036 5 Q. Did you, at any time, determine the quality of these paper-carbon strips as to electrical resistance?

Question objected to on the same ground as before.

A. Yes; we placed them in electrical circuits and worked sounders through them. We also placed one of the crucibles in circuit, and boiled water by the heat engendered by the passage of the current.

6 Q. Did you test the electrical resistance of this carbonized paper as compared with various metals?

Objected to as impertinent.

A. Yes, sir; we did, as one of the uses of the paper was to make rheostats, and we concluded that the carbon would be suitable for rheostats. The resistances of the various strips were not wide apart from each other. The resistance as compared to metal was very much higher.

7 Q. Please state in detail your next experiments with carbonized paper, and when such experiments were made.

A. My next experiment with carbonized paper was the use of the same in a telephone, about May or June, 1877. We made telephones in which a great number of sheets of carbonized paper and bristol-board paper were placed between the electrodes in a telephonic circuit, and were agitated by the movements of a diaphragm for the purpose of transmitting articulate speech. In fact, in 1877, we tried every conceivable form of carbon in telephones. About August or September, 1877, strips of carbonized paper were placed *in vacuo* and brought up to incandescence. Many experiments were tried upon the incandescence of boron, silicon and carbon, in air and vacuo, about that time. My impression is that two gentlemen, Doctor Cordelius Herz, now in Paris, and Stephen D. Field, were witnesses to some of these experiments, whether boron, silicon or carbon experiments I cannot say. Also Mr. Charles Batchelor, Adams, who is dead, and others whom I cannot remember, saw these experiments. I think Herz and Field saw these experiments in September of 1877. 3037

8 Q. Please explain as fully as you can how these last-named experiments, in 1877, were conducted.

A. Two rods of brass, sliding in bearings forming the two poles of the battery, had upon their ends small clamps in which different substances could be clamped. In these clamps strips of carbonized paper were placed, about an eighth of an inch wide and two inches long. The paper used for carbonizing was bristol-board. The carbon was brought up to incandescence, but quickly oxidized and was destroyed as it was in the open air. Attempts were made to coat the carbon with powdered glass, so it would melt and run over the carbon and thus preserve it. This did not work. Then experiments were tried on pieces of silicon, which the books stated did not oxid-ze when in incandescence in the open air. Also upon boron; but these did not succeed well, as they were in very small pieces, and we could not make good contact at the electrodes. Afterwards we tried the experiment *in vacuo* with a common air pump, but the vacuum that we were able to get was so poor that the carbon oxidized almost as rapidly as it did in the air.

9 Q. Have you any sketch of the construction used for holding the carbonized-paper conductor mentioned in your previous answer? If so, produce it. If you have not such sketch, please make one now, to be attached as an exhibit in this case.

A. I think I have the original apparatus which I believe I can produce, and will do so if possible.

10 Q. In this apparatus referred to, was the carbonized paper strip an incandescent conductor suitable for use in an electric lamp?

Question objected to, unless the strip was afterwards used in an electric lamp, or intended for one at the time.

3038 A. It was used as an incandescent conductor in an electric lamp, but not under proper conditions.

11 Q. When was this experiment made?

A. I think about September, 1877.

12 Q. Why did you not refer to these experiments in your preliminary statement filed in this interference?

Objected to as incompetent, irrelevant and immaterial.

A. The experiments had, I think, slipped my memory when I made out the preliminary statement.

13 Q. Please state in detail your next experiments in this connection.

A. The next experiments took place, I think, in October or November, 1878. My assistant, Mr. Batchelor, made a great number of paper carbons, fifty or upwards, which consisted of tissue paper, and other kinds of paper, coated over their surface with a mixture of lamp-black and tar, and then rolled up in the form represented by a knitting needle, and afterwards carbonized by heat. These were included in electrical circuits and brought up to incandescence *in vacuo*. They were also used in a lamp devised about the same time, which lamp is shown in my patent 224,329, where the light was given by the incandescence of the carbon at the point of contact between the electrodes. The carbon did not last very well *in vacuo*, and we found it very difficult to clamp it so as to prevent the large current used from producing an arc at the point of contact, but in a form of lamp similar to that shown in patent 224,329, they gave better results.

14 Q. What degree of use was made of the electric lamp last described?

A. We burnt them for several hours at a time, but the best results were obtained with wood carbons.

15 Q. Are any of those lamps now in existence?

A. I do not think so. I think there were one or two made and then used for other purposes.

3040 16 Q. Does the drawing of the patent you have just referred to show fairly the construction of the lamp which was made and used at the time named?

A. It does; but we made other forms not shown in the patent. I have represented these in a sketch which I now produce, marked "Edison Exhibit 1."

(Here follows diagram marked p. 3039.)

In this exhibit Fig. 1 represents a spring *a*, secured to a pillar B. Upon the extremity of the spring is a clamp *c*, for securing the carbon. The lower extremity of the carbon rested upon iridium-pointed prongs *e*, *d*, *f*, at the point *x*, the tension of the spring acting to press the carbon slightly against the iridium points. Sometimes the current was passed through the wire *g*, through *a*, thence through the carbon to the points, and out by the wire *l*, which connected to all three points. At other times the current was passed through the wire *h*, thence through the point *d*, across a portion of the carbon, thence to the point *e*, and wire *k*. This latter method is shown better in Fig. 4. In this figure the spring *a* is dispensed with, and a weight, *c*, is used to press the carbon against the two iridium-pointed electrodes *e*, *d*. The current passing from *d* to *e*, through a portion of the carbon, caused it to become incandescent, and as fast as the carbon wore away by oxidation it was fed down by the action of the weight or even by the weight of the carbon itself. In Fig. 2 the current passed through the point *h*, across the carbon strip, thence down through the point *k*, rendering that portion of the carbon between the two electrodes incandescent. The contact between the two points was brought about by the weight of the carbon paper. The whole apparatus was placed at an angle. In Fig. 2½ is shown about the angle at which the paper was placed, *x* being a limiting stop for the downward passage of the carbon. It was so arranged that if the points *h* and *k* were taken away the paper would fall between the support *g* and limiting stop *x*. Fig. 3 shows a modification of the apparatus in Fig. 1, a mercury cup being placed on the top of the carbon, in which a platina
3041 wire was in contact with the mercury, *a* being the mercury cup, *g* being the platina wire. In the patent No. 224,329 a ball of iridium was used upon the upright metallic portion of the electrode, upon which the contact between carbon and the iridium took place, as seen in Fig. 2 of the drawing of the above-mentioned patent.

17 Q. In the instances named of patent 224,329, and shown in your Exhibit No. 1, were the conductors of carbonized paper?

A. Yes, sir; a great many of them were carbonized paper—a few were made out of wood.

18 Q. In all the above-named instances was provision made to keep the electric continuity intact, and prevent the formation of an electric spark?

A. Provision was always made for the passage of a continuous fig 1

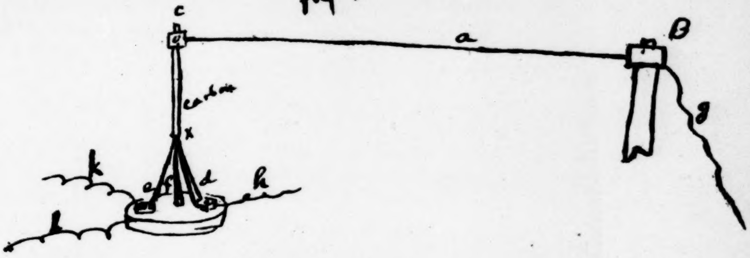

c
a
B
p
carbon
x
k
e
f
d
h
L
g

fig 2

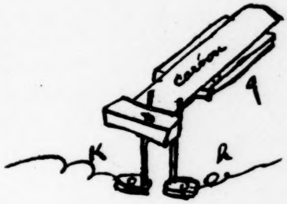


fig 2½

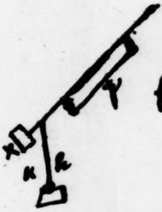


fig 3.

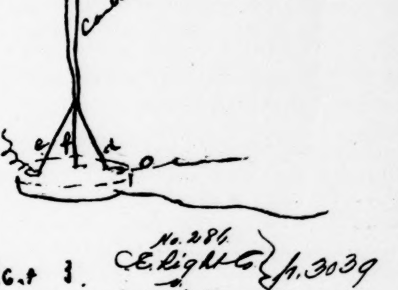
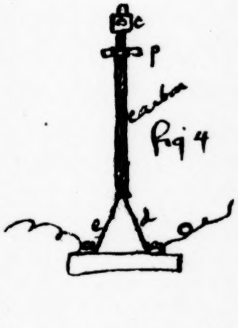

g
a
carbon
e
f
d

fig 4


c
p
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Edison Exh. C.+ 3.

No. 286
E. Light Co
v.
McK. Light Co } p. 3039

current, the light given was partially due to an arc and partially to electrical incandescence.

19 Q. Can you give any instances of electric lamps of other inventors operating in substantially the same way?

Question objected to as incompetent, impertinent and irrelevant.

A. I believe the Wendermann lamp operated in the same manner, also the Joel lamp, now operating in London; and I also believe Mr. Sawyer's late lamps act somewhat on that principle.

20 Q. Are these experiments just described as having been made in October or November, 1878, referred to in your preliminary statement?

Question objected to as incompetent.

A. Yes, sir; these and other experiments made about the same time.

21 Q. Please relate fully the other experiments referred to in your previous answer.

A. We, in November or December, 1878, had our vacuum pump placed in order to conduct some experiments on incandescent
3042 carbon conductors *in vacuo*, and we tried a great number of experiments with paper carbons, wood carbons, and carbons made with carbonized broom-corn. What we desired at that date, and had concluded as the only possible solution of the subdivision of the electric light, was that the lamps must have a high resistance and small radiating surface, so as to be capable of being worked in multiple arc commercially, and our calculations showed us that the lamp must have at least 100 ohms resistance to compete successfully with gas; otherwise, if the lamps were of low resistance, the cost of the main conductors would be so great as to render the system uncommercial. What is meant here by a subdivision of the electric light is that many thousand lamps could all be placed upon a single circuit and be entirely independent of each other. We, from our previous experiments, knew that we could get the requisite resistance and small radiating surface necessary for a commercial use of the light, by means of carbonized paper or wood; and, therefore, while working to accomplish this end by means of platinum, we endeavored, by a more perfect vacuum, to obtain incandescent conductors of carbon which would give us the result. But our experiments in November, as before mentioned, with a good pump, wherein we used paper and wood carbons, were not so satisfactory as the experiments we were conducting with platinum conductors. When we made the carbon in such a form as to have a small mass and high resistance to suit our purposes, it would last but several minutes. We then laid these experiments aside, and went on with platinum, to endeavor to obtain a lamp of high resistance and small radiating surface. The results of our experiments are shown in patents No. 227,228, 227,227, 227,229. The great point we desired was a lamp of high resistance and small radiating surface, and it did not matter very much whether it was of carbon or of platinum. The necessity of these features, and the necessity of the single-lamp

multiple-arc system is more particularly set forth in a British
3043 patent No. 2402, dated the 17th of June, 1879, in lines 12 to 37 inclusive, 3d page. Also from line 98, page 1, to line 27, page 2, of U.S. patent 227,229. Also in U.S. patent 223,898. Nearly the whole of this patent gives information on the subject. Returning to the experiments mentioned at the beginning of this answer on incandescent paper and other carbons, we found our endeavors blocked in the matter of obtaining incandescent conductors of high resistance and small radiating surface, by the fact that we could not make them last for any length of time in the best vacuum obtainable with our air pump, which was considered a good one. But when in the course of our attempts to attain the same object by means of incandescent platinum, we had procured a Sprengel mercury pump and ascertained that we could get exceedingly high vacuum, it occurred to me that, perhaps, a filament of carbon could be made to stand in the sealed glass vessels which we were using, exhausted to a high vacuum, and in October, 1879, we made lamps of paper carbon, and carbons of common sewing thread placed in a receiver made entirely of glass, with the wires sealed therein by fusion, and the whole exhausted by a Sprengle mercury pump to nearly the one-millionth of an atmosphere and these filaments of carbon, although excessively fragile, owing to their small mass, had a smaller radiating surface and higher resistance than we had hoped; we had reached the conditions where, notwithstanding the carbons were small in mass and filamentary, they were stable. Sufficiently so to allow of the economical subdivision of the electric light and the possibilities of competing commercially with lighting by gas. It was the new conditions which caused this lamp to be a success, which conditions were high vacuum in a receptacle in which no deterioration or lowering of the vacuum occurred to destroy the carbon. These experiments resulted in the lamp and various modifications and forms more particularly set forth in my patent 223,898, and in the application now in interference.

3044 22 Q. Please state what you were doing in the way of experiments upon this subject between November or December, 1878, and October, 1879.

A. I was endeavoring to obtain a lamp of high resistance, for instance, a hundred ohms, with small radiating surface, the former to permit of economical subdivision, and the latter to permit of economy in the use of electric power, and I used platinum and platinum-iridium wire during that time to attain this result, all of which are more particularly set forth in the patents which I have heretofore recited; in conducting those experiments we made a great variety of platinum lamps in which a major portion of the wire was so coiled as to not radiate light, to the end that the lamp might have a high resistance; one of these forms is shown in my patent 227,229.

23 Q. At what date did you begin to make glass bulbs or shells especially adapted and used for electric incandescent lamps?

A. I think separate lamps, independent of the air pump, were made either in December, 1878, or January, 1879, except the device used in 1877, which was capable of being detached from the pump and placed in any position, but my impression is that the first vacuum bulb for an incandescent conductor that would hold its vacuum, was made in June or July, 1879; this was made entirely of glass, with the conducting wires sealed therein and the vacuum obtained with a Sprengel pump; a platinum conductor was used with these lamps; it might have been as late as August, 1879; I will look over some of my memoranda to-night and refresh my memory on that point.

24 Q. When did you produce electric lamps with incandescent paper-carbon conductors in vacuum bulbs, hermetically closed, so as to be a commercially complete lamp, capable of entering into competition with gas lights?

A. I made such a lamp about October 22d, 1879, which 3045 had the characteristics of high resistance, small radiating surface, and sufficient stability and economy to allow of competition with gas.

25 Q. What was the extent of your manufacture and use of such lamps thereafter?

A. We commenced immediately to make a number of vacuum pumps and started to manufacture these lamps of paper carbon, with the pump we had on hand; during November we made a great number of lamps of this character, perhaps as many as one hundred; these were put up in the laboratory at Menlo Park, and various experiments tried with them, among which was a test of their candle power, economy, resistance, lasting time at various degrees of incandescence; in the latter end of November, 1879, we commenced operations with a view to get our dynamo machines, regulators and wires in order to make a public exhibition of these lights. What I mean by a public exhibition is a more general exhibition, as everything that I did in my laboratory for the last three or four years was seen by thousands of persons from all parts of the world.

A great many persons visited the laboratory to see the lights in operation in December, 1879, caused by an intimation in one of the daily papers that my electric lights were burning. But on December 21st, 1879, the New York Herald published an account of my experiments, a copy of which article is now furnished, marked Edison's Exhibit No. 2.

(Here follows sheet of New York Herald, marked p. 3046.)

On December 25, 1879, I had lighted up my laboratory, my office and two or three houses, situated about a fifth of a mile from the laboratory, and also about twenty street lights. On New Year's eve, 1879, about 3,000 people visited Menlo Park, and thereafter to the present time all my experiments have been public. I have made probably 3,000 lamps containing the paper-carbon conductor, now in interference.

Some time in the spring of 1880, I lighted up the steamship "Columbia" of the Oregon Steam Navigation Company, with about seventy-five to a hundred lamps containing paper carbons 3047 which continued to light the ship satisfactorily for several months. Exhibitions of the same were made on the steamship "Columbia" at Rio Janeiro, Brazil, Valparaiso, Chili, San Francisco, California, and Portland, Oregon. I understand some of the lamps were lighted during the voyage around Cape Horn, and were kept lighted from San Francisco to Portland on the regular trips for several months, and I have recently shipped several hundred lamps to replace the ones broken. Since that time I have tried an enormous number of experiments to cheapen the cost of my lamps, to increase their length of life, and economy and resistance. The nuclei for manufacturing the lamps, established at Menlo Park in November and December, 1879, have been expanded into two large factories, one situated at Menlo Park and the other at East Newark, N. J. The factory at Menlo Park employs about one hundred hands, turns out about one thousand lamps a day, and has manufactured about sixty thousand lamps. The factory at East Newark is being arranged to manufacture fifty thousand lamps per day.

26 Q. Returning now to the paper-carbon incandescent lamps made by you in the winter of 1879–'80, what actual use were they subjected to, and what was the extent of their durability as lights; also what was the quantity of light produced by each lamp according to gas standards?

Objected to as incompetent, irrelevant and immaterial.

A. Each lamp gave about 12 to 16 candles of light. They were put up on chandeliers and run until they were destroyed. Some of them were run all day and night and others by night. A record was kept of the hours each one ran, which record I have here. The lamps are numbered from 142 to 417. Examining this record to refresh my recollection, I am able to state that, for 3048 instance, lamp 142 lasted 404 hours; lamp 159 lasted 480 hours; lamp 189 lasted 217 hours; lamp 255 lasted 294 hours; lamp 223, 262 hours; lamp 167, 15 hours; lamp 204, 16 hours; 203, 17½ hours; lamp 155, 280 hours; 201, 280 hours; 164, 322 hours; 172, 259 hours. Looking over the whole record, I should judge the average life was about 300 hours. I remember two lamps, one of which lasted 1,350 hours, and another one 940 hours, cut from the same mold and of the same size and same paper as the lamps I have mentioned by numbers. The numbers I have given occur on the pages of the book consecutively.

By agreement of counsel, here made, the book of record referred to in the above answer is tendered to counsel for Sawyer and Man for use in cross-examination, and copies of so much of the record as has been testified about by the witness, being pages 1 to 15 inclusive, are attached as exhibits and marked Edison's Exhibit No. 3.

The taking of further testimony was adjourned until Monday, June 13, 1881, at 10 o'clock a. m., by consent, at the same place.

WM. H. MEADOWCROFT,
Notary Public, New York County.

3049 Pursuant to adjournment, this examination was resumed June 13, 1881, at 10 a. m., at No. 65 Fifth avenue, same counsel being present.

The witness, THOMAS A. EDISON, further answers to questions proposed by GEORGE W. DYER, as follows:

27 Q. Since testifying on Saturday, have you made examination among your papers and exhibits at Menlo Park with reference to your early experiments in electric lights in which carbonized paper was used as a conductor? If so, produce what you have found and explain the same.

A. I have made such an examination. I produce an electric lamp in which experiments were made with a paper carbon brought up to incandescence *in vacuo*. This lamp was used about September or October, 1877. The apparatus originally was one for illustrating Geissler tube action *in vacua*. The base of the apparatus fitted over the hole in the platen of the air pump. It was then exhausted and the cock turned to preserve the vacuum of the globe of this lamp. We did not succeed in getting a higher vacuum than 2½ millimeters on the mercury gauge, and we could not make the carbons burn more than a few minutes at a time. Some of the carbons were brought up to brilliant incandescence and probably gave thirty or forty candles of light. The carbons were brought up to various degrees of incandescence. The carbons were made of sheet paper of various widths and thickness. I think they were made of bristol-board. They were from three-sixteenths to a sixteenth wide, and probably from eight to fifteen thousandt-s thick. I believe they were carbonized in tubes made of gas pipe. I cannot remember whether they were prepared at the time or were on hand; we had an immense collection of carbonized paper and wood on hand, which we used in our telephonic experiments in 1877.

3051 The lamp referred to in the above answer is put in evidence, and is marked "Edison's Exhibit First Incandescent Lamp."

Counsel for Sawyer and Man object to the exhibit upon the ground that it goes to show and is intended to show, that the invention was made previous to the date alleged in the preliminary statement of Mr. Edison, in this interference, and he objects to all that part of the answer that is intended to show, or goes to prove, that the invention was made previous to the time alleged in such preliminary statement, and gives notice that upon the hearing of this interference, he will move to strike out the exhibit, and all that part of the answer objected to.

28 Q. Can you explain now why you did not refer to this exhibit in your preliminary statement?

Objected to as incompetent, immaterial and irrelevant. Notice of motion to strike out at the hearing.

A. I had forgotten about the experiments. I had forgotten that I had the exhibit, and it only came to my recollection Saturday in conversation with my assistant, Mr. Batchelor. The results were probably not sufficiently satisfactory to impress it upon my mind. I try so many thousand experiments in all branches of physics that I sometimes forget some of them. The preliminary statement was made at a time when I was under great strain, and crowded with people at my laboratory.

Answer objected to upon the same ground stated in the objection to the question. Notice of motion to strike out at the hearing.

3052 29 Q. If you have any other exhibits found by you at Menlo Park on your late search, please produce such with full explanations.

Question objected to upon the ground that it is incompetent, unless it is intended to call out evidence to show that the invention was made subsequent to the date stated in the preliminary statement.

A. I present an exhibit which serves to refresh my memory regarding the experiments tried on electric light in 1877. The exhibit is dated November 1st, 1877, witnessed by Charles Batchelor, myself and John Kruesi, and I know the signatures to be their handwriting. In this exhibit is shown lamps giving light by the incandescence of boron, silicon and other substances included in the electric circuit, such lamps being arranged in series and in multiple arc. The experiments with carbonized paper in vacuum were made previous to the date of the exhibit of November 1st, 1887.

Answer objected to as intended to show that the invention in controversy was made previous to the date given in the preliminary statement of Mr. Edison.

Notice of motion to strike it out at the hearing.

Paper referred to put in evidence and marked Edison's Exhibit No. 4.

(Here follows diagram marked p. 3050.)

Exhibit objected to on the grounds stated in last objection, and notice of motion to strike out repeated.

I now produce another paper, dated December 3d, 1877, which serves, like Exhibit No. 4, to refresh my memory regarding experiments with the paper carbon. This paper is witnessed by myself, Charles Batchelor and John Kreusi, and I know the signatures to be their handwriting. It refreshes my memory as to the fact
3054 that we were trying to subdivide the electric light into a
small number of burners, where the circuit was closed by solid conductors, and the reasons why experiments were conducted with boron and silicon was because they were not subject to oxidation like carbon, which we had previously tried, and which did not last as long at a white incandescence as pieces of graphitoidal silicon, forming part of the electric circuit, and rendered incandescent by the passage of the current. The results of the carbon experiments, and also of the boron and silicon experiments, were not

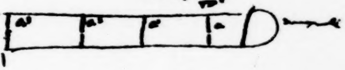
No. 286.
E. Light Co.
v.
McK Light Co. } p. 3050

Electric Light

Nov 1877
70 folio
Chas Batchelor

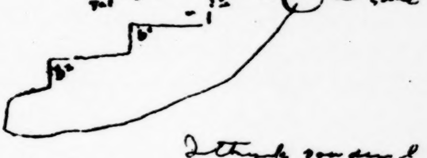
I have tried Boron Ruthenium Chromium and this J Kruesi almost infusible metals for separators in my Electric Light device. Boron is very high resistance and would be arranged thus

Fig 1



Silicon on the other hand is very low resistance and would have to be arranged thus

Fig 2



I think powdered Silicon mixed with Lime or other very infusible non Conductor or semi Conductor would be good

Copied in Vol No 1 Experimental Researches page 115 Feby 26. 1878
Wm Carman

Edison's Exhibit No. 4

3 Electric Light Copy of this on page 116. Vol 1. Exp. Researches this 21 day of Sept. 1878 Wm Carman 3

Dec 3 1877
T A Edison

Further Experiments with Palladium & Silicon prove their adaptability to subdivision of the Light. It is possible to get good results by pulverizing the silicon & putting it in a glass tube passing the current through the powder.

Chas Batchelor
M N Force
J Kruesi

(Edisons Exhibit No 5)

No. 286.
C.E. Light Co.
v.
McK. Light Co.
p. 3053

considered sufficiently satisfactory, when looked at in the commercial sense, to continue them at that time, and they were laid aside.

The paper referred — in the above answer put in testimony and marked "Edison's Exhibit No. 5."

(Here follows lithograph marked p. 3053.)

Paper exhibit objected to as impertinent and irrelevant, and as intended to show that the invention was made previous to the date mentioned in the preliminary statement.

Notice of motion to strike it out at the hearing.

30 Q. Please state whether or not the paper-, Exhibits No. 4 and No. 5, were written at the dates given upon each of them.

A. Yes, sir; they were.

31 Q. State whether or not your memory is distinct as to the fact that the experiments with boron and silicon, mentioned in these exhibits, were made after your experiments with carbonized-paper conductors, and after the employment of such conductors in the lamp marked "Edison's Exhibit First Incandescen*e* Lamp."

Same objection as before, and same motion.

A. I am certain it was before, because we used boron to get rid of oxidation, to which the carbon was very sensitive.

3055 32 Q. If you have any other exhibits relative to the matter in question, found in your late search at Menlo, please produce the same with explanations?

A. I present a lamp, which is one of my well-known carbon horseshoe lamps, made, I think, some time in December, 1879, and is of the same kind and character as those made in October, 1879. This lamp is illustrated in the New York Herald of December 21st, 1879, heretofore put in evidence.

33 Q. State, if you please, in that connection, whether or not this lamp was actually put in circuit, when and where burned, stating the length of time and the amount of light given by it.

A. I find that its number is 235, and on referring to my note book, I find that the lamp either burnt seventy hours and eighteen minutes or 250 hours and forty minutes, as the record is obscure. It gave a light of probably from twelve to sixteen candles. It is one among a hundred that were burning at the same time. One lamp which I had previously mentioned, made in the same way and in the same manner of carbonized paper, lasted over 1,300 hours, and I believe that the lamps of this character, made in the regular way, had an average life of about 300 hours, which was sufficient to render them a commercial success in competing with lighting by gas. Had they but lasted an hour, or if the average life of a great number of these lamps were only a few hours, they would not have been a commercial success, and the results would have been of no benefit to the public.

But these lamps, in addition to the fact that they lasted for a long time, had other characteristics, without which, even with a long life, they would not have been available for competing with gas. These important characteristics were that they were of high resistance of small radiating surface, and hence economical, for the reason that smaller conducting wires could be used for conveying the current, as owing to the high resistance of the lamps, 3056 weak currents were only necessary, and sufficient energy to produce the result was forced through the wire and lamps by increasing the electric pressure or electro-motive force. If lamps of low resistance were placed in multiple arc in a single circuit the aggregate resistance of all the lamps would be very low, and conductors of correspondingly large dimensions would have to be used, otherwise a great loss of current in the form of heat would take place on the conductor. Hence, if the resistance of each lamp was made, say 100 times greater, then the conductors could have a hundred times less area, and the losses would be the same in both cases. With small radiating surface less energy is required to produce a candle power than on a larger surface. Again, economy is attained from the fact that these filaments of carbon, being small in mass, do not conduct heat any better than they do electricity, and therefore very little heat is conducted from the glowing incandescent conductor to the clamps and supports for the same. Hence no special appliances are essential to get rid of the heat of conduction, as are employed in the type of lamps experimented upon by Mr. Sawyer. Again, high *vacua* render the carbon horseshoe practically stable and at the same time result in great economy in the use of electricity, as practically all the energy is lost by radiation, and none by conduction. My experiments have shown that if the carbon horseshoe is placed in an atmosphere of nitrogen at the atmospheric pressure, which is the method adopted by Mr. Sawyer in his lamp experiments, it requires nearly twice as much electricity to bring the horseshoe up to the same candle power as it does when the horseshoe is in high vacuum. As in the former case, heat is lost by conduction through the gas, which serves to carry it to the inclosing globe, from which it radiates invisibly. Hence this lamp is, I believe, the first one ever produced that was commercially available for competition with lighting by gas, and of great public utility.

This lamp, No. 235, was made at my own laboratory at 3057 Menlo Park some time in December, 1879, was put up in a street lamp at the top of the stairs in front of the depot at Menlo Park, a fifth of a mile from the laboratory, and there burned until destroyed. I think it was made a few days before it was put up. According to its record I find it had burned forty hours previous to January 3d, 1880. It was seen along with about a hundred others like it, by at least twenty-five thousand people, in December and January. At least that is my impression.

All that part of the answer after the ninth line (fourth printed line) is objected to as irresponsive, and a mere lecture on the best proportion for making a lamp and burner, in Mr. Edison's opinion.

The lamp referred to in the previous answer is put in evidence and marked "Edison's Commercial Incandescent Electric Lamp."

34 Q. Please point out the peculiarities of construction which make this lamp of practical value as compared with other incandescent lamps, and particularly those produced in accordance with the inventions of Sawyer and Man.

A. I have already stated that in my previous answer, to which I refer as an answer to this question.

35 Q. Please state whether or not this exhibit is one of the class of lamps of which you have testified previously that about 3,000 were made, and if there were any differences in construction in any of the 3,000 lamps, please state what such differences were.

A. They were the same, except, perhaps, in the shape of the clamps for holding the carbon and in the form and method of clamping the paper horseshoe carbon to the wires that pass through and were sealed into the glass.

3058 36 Q. Calling your attention to this exhibit, please describe fully the bulb or globe, stating when and where it was made and by whom, and the advantages connected with its form and size.

A. The lamp was made some time in December, 1879. I think by a person named Boehm, who was employed as a glass-blower at my laboratory at Menlo Park. The great advantage of this form and kind of inclosing chamber is that, unlike all previous attempts made for lighting by the incandescence of carbon, the incandescent conductor is placed in a chamber made entirely of glass the wires forming the leading-in conductors passed from the exterior to the interior of the chamber, and sealed by fusion of the glass where they pass through it. Hence these glass chambers when exhausted to high vacuum preserved the exhaustion constant, and thus provide the all-essential condition for high economy and length of life of the thin filament of carbon which it is essential to use to attain high resistance, to permit of the economical subdivision of the electric light. All attempts, I believe, heretofore have failed to preserve the vacuum, where a vacuum is used, and thus preserve the carbon, for the reason that the chamber was not composed entirely of glass, but of glass and metals and materials, between the glass and which there was a difference in coefficient of expansion, which at times admitted the air; hence most inventors have used a supposably inert gas in the chamber, at atmospheric pressure, and the leading-in wires have not been passed through the glass and fused therein, which is an essential feature. The form and size of this lamp are very convenient, as it is small, light, portable, durable, and admits of radiating the light in all directions, so that practically none is lost. Its size is such that it contains very little air, hence is quickly and economically exhausted of the same in the process of manufacture, and the whole lamp is so light as to be used on chandeliers now used for gas, in great numbers.

3059 37 Q. Referring to the same lamp, please describe the leading-in wires and the incandescent conductor, and state the advantages connected with the form and size of the same.

Objected to as immaterial, impertinent and not bearing upon any issue in controversy.

A. The leading-in wires to within a quarter of an inch of the glass are formed of copper. To these copper wires are secured, by soldering, platinum wires, which pass through and are fused in the glass. Upon the extremity of these wires within the chamber are clamps, which serve to clamp the broadened ends of the filament of carbonized paper. This broadened end is essential to permit of a proper clamping and electrical contact, as the increased conductivity of the broadened end to the electric current prevents it from becoming incandescent. Hence, little arcs and bad contacts at the point of clamping, which would tend to destroy the lamp do not take place. If the filament of carbon was the same size all over, so that the portion clamped was no larger than the portion which was incandescent, the lamps of this character would be rapidly destroyed by the formation of small arcs at the point of clamping, which throwing out the vapor of carbon and platinum within the vacuum would permit of the formation of a large arc between the two leading-in wires, and the lamp would be instantly destroyed. The paper horseshoe being of small radia-ing surface and small in mass, is very flexible, and after the passage of the electric current very tough. Hence the lamps may be handled, practically, with impunity as far as breaking the carbon horseshoe is concerned. In fact, after the current has passed through the horseshoe the two broadened ends may be taken in the fingers and pulled out nearly straight without breaking. The advantages of the horseshoe shape are, that it permits of the expansion and contraction of the carbon freely without injuring it, and also permits of nearly all the light being utilized—in fact nearly the maximum amount. The necessity of using
3060 platinum to seal in glass is, that of all metals its coefficient
of expansion is nearest glass, and hence the glass and platinum will expand and contract together under differences of temperature and thus prevent leakage of air or cracking of the glass chamber.

Same objection to answer as to question.

38 Q. Please state how the carbon conductor in this lamp and those like it was made, and where?

A. The carbon conductor was made at my laboratory at Menlo Park, either in October, November, or December, 1879, in the manner and of the material described in my application, now in interference.

39 Q. Please state how you exhausted the air from this lamp and others made like it?

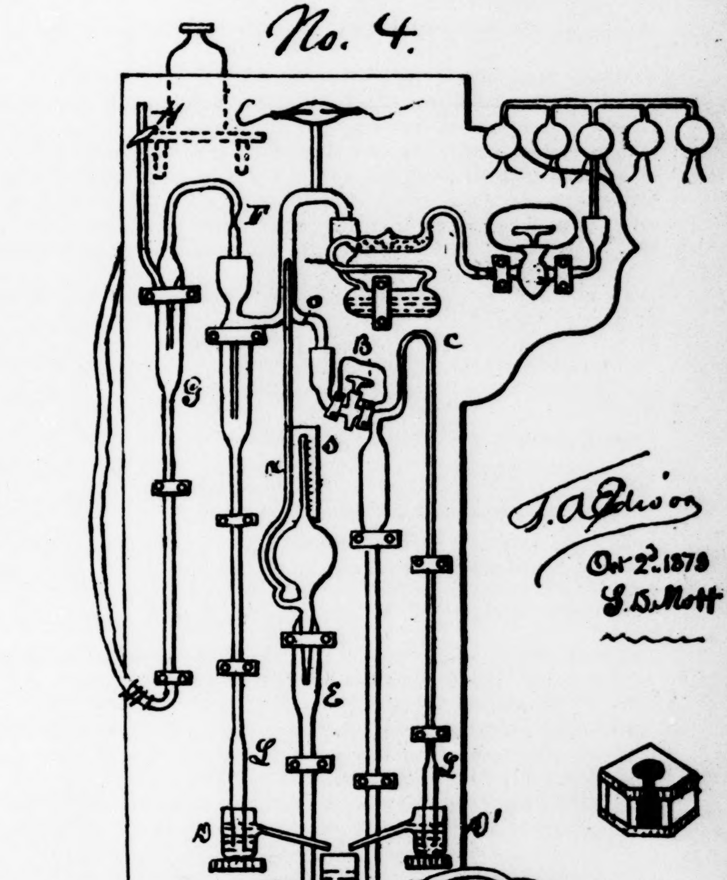
A. We exhausted the air by means of a double glass pump—one part of the pump being known as a Geissler pump, and the other as a Sprengle pump, in which mercury was used in the well-known manner. The apparatus is shown on page 99 of my Note Book No. 85 (a copy of which sketch is produced and put in evidence and marked Edison's Exhibit No. 6).

(Here follows diagram marked p. 3061.)

No. 286.
E. E. Light Co.
v.
McK. Light Co.
p. 3061

Edison's Exhibit No. 6

No. 4.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T. A. Edison
Oct 2d. 1879
S. D. Mott

Exhibit objected to as being secondary evidence, being an alleged copy and not the original referred to by the witness, and the copy not being produced.

Counsel for Edison states that the sketch referred to is one of the pages of a very valuable book of original records, which book is now tendered to the counsel for Sawyer and Man, for inspection, and that a tracing copy will be furnished as soon as it can be made and before the examination of this witness is closed.

40 Q. To what extent was exhaustion produced by the apparatus described?

A. I think the exhaustions were carried beyond the mil-
3062 lionth of an atmosphere. We had on this apparatus a Mc-
Leod g*ua*ge to measure the degree of exhaustion. In the notes which accompany this sketch it is stated that a vacuum was obtained where the jump spark from an induction coil jumped five (5) inches in air rather than pass across between electrodes a quarter (¼) of an inch apart in vacuum. This denotes exceedingly high vacua, exceeding the millionth of an atmosphere.

41 Q. When was the sketch referred to made?

A. It is dated October 2d, 1879, and witnessed by S. D Mott, and myself. The drawing was made by Mr. Mott, and it was, I think, made on the day of date. The notes are in the handwriting of Mr. Upton, I think the notes were made about the same time.

42 Q. Please read from these notes whatever refers to the construction and mode of operation of the vacuum apparatus shown in the sketch?

A. I will furnish a copy of the notes referred to taken from the book, which copy will be marked Edison's Exhibit No. 7.

Mr. Broadnax objects to the notes, because it appears that they were not made by the witness himself or in his presence.

43 Q. Whose property is this book, and under whose direction and by whom were the entries made in it?

A. The book belongs to myself. It is one of about two hundred or more books in which my experiments in electric lighting are recorded. The entries relating to this exhibit were made by Francis Upton, my assistant, under a general direction from me. The sketch itself was made by Mr. Mott, another one of my assistants.

44 Q. Please describe, briefly, the manner in which the apparatus
shown in the sketch referred to operates in exhausting air
3063 from lamps, and if necessary to make the sketch more clear,
put additional letters of reference on the parts.

A. The bottle at the top of the pump is the mercury reservoir, leading from which is a rubber tube through which the mercury passed up to the first glass tube on the left-hand side of the pump board. The mercury then passed into the air trap G, then around the bent tube to the contraction F, through a small tube within a bulb, thence dropping down the second tube on the right to D. These drops of mercury, in dropping acted as pistons, between which the air was confined, after the manner employed by Sprengel. E

X is the McLeod *guage* for measuring the degree of exhaustion. A bottle on the left lower corner, containing mercury, was connected to the McLeod *guage* by a rubber tube. When this bottle was lifted, the mercury passed up in the round bulb of the *guage* and forced what residual air there was up into a tube with a capillary base, and with a paper scale behind it. The two tubes on the right of the pump stand form the well-known Geissler pump. The mercury bottle at the lower end on the right was connected to the second glass tube on the right of the pump board by a flexible rubber tube. A stop-cock B being turned so that no mercury could enter the main vacuum apparatus, the bottle was lifted and the mercury ran into the chamber in the upper part of the tube, filled it, and forced what air there was in it over into and down the first tube on the right to the trap D, and thence to the atmosphere. The mercury bottle was then lowered and the mercury ran out of the chamber leaving a vacuous space. The cock B was then turned, so that the chamber formed part of the general vacuous space of the pump. The bulbs on the right-hand corner at the top were the lamps which were all sealed by fusion with each other, and then to a tube provided with a ground-glass stopper, fitting into the vacuum apparatus. A stop-cock on the right near the top served to
3064 disconnect the pump from the bulbs or lamps when they were
properly exhausted, so they could be sealed off and others put on without losing the vacuum in the pump entirely. The two bulbs on the top and above letters B and C contained phosphoric anhydride, to remove water vapor from the air, and gold leaf to absorb mercury vapors. Above these is the Geissler spark gauge, with the two electrodes. The major portion of the air was taken out by the Geissler pump, and the rest of the exhaustion was carried on by the Sprengel pump.

45 Q. In addition to means for making lamps completely like that shown in Exhibit Edison's Commercial Electric Lamp, and means for exhausting the air completely from such lamps, what else had you done in the latter part of 1879 towards a perfect operative system of electric lighting by incandescence?

A. I had been devising a complete system for the general distribution of electricity, so as to compete with gas. I had dynamo machines, a station regulator for keeping the pressure constant througout the system, meters for measuring the amount of current consumed by each customer, street mains for distributing the electricity, sockets for holding the lamps and chandelier appliances, electro-motors for utilizing electricity for power on the light wires, vacuum pumps and devices for the manufacture of electric lamps, carbonizing furnaces, and molds and appliances therefor, and in fact a complete system of electric lighting by incandescence, upon the plan of general distribution over large areas. About the middle of December the whole system was started and publicly exhibited to many thousand people. Several houses were lighted, besides my laboratory, and twenty street lamps were also lighted. What has been done since that date has been towards means and methods of manufacture, cheapening the processes of manufacture, and estab-

lishing factories. In the latter end of December, or in the early part of January, I accepted the proposition of Mr. Villard to
3065 light up the steamship Columbia. I immediately went to
work preparing to do so. The apparatus was finished and placed on board a few days after she came out of the ship yard, which was, I think, in May or June, 1880.

46 Q. What was the resistance of the lamps made by you in the latter part of 1879?

A. Some of them were as high as 1,000 ohms, but the average resistance of the paper carbon was about 100 ohms when hot.

47 Q. In your late search at Menlo, did you find paper or model exhibits of experiments for 1878, which you are now ready to offer?

A. I did not find any apparatus that I was sure was used in 1878 with the paper carbons; but I have a man searching for them. My practice is that when I make apparatus to try an experiment I keep making changes on this apparatus to try other experiments, many of which have nothing in common with the purpose for which the instrument was first devised. I conduct such a great number of experiments that I could not afford to keep the original apparatus if it was required to try another experiment, even with a matter entirely dissimilar as to its object.

Counsel for Edison gives notice that if at any time during the examination or cross-examination of his witness, any exhibits of experiments of 1878 are found, he will put the same in evidence.

48 Q. In all the instances of carbonization of paper given by you in this testimony, was there any other treatment of the paper besides simple carbonization?

A. In the lights made of paper horseshoes, of which there were about a hundred burning at a time, and which I have spoken of as being exhibited to the public, the paper carbons were not treated. Some lamps were made in December, 1879, to see what effect treatment would have, but only a few were made. In the experiments in 1877 with a paper carbon no treatment of the carbon with
3066 any other substance was made, except the incidental effect
of the grease used in the lamp being decomposed and depositing carbon on the incandescent conductor in the Exhibit First Incandescent Lamp. This was not the intentional treatment. The carbons made in 1878 were generally composed of paper having its surface treated with lamp-black and tar. I believe a few of the carbons made in 1878 were soaked after carbonization in tar, and recarbonized.

49 Q. I call your attention to the printed record of the testimony of A. Man, near the bottom of page 7, where he says "we use principally ordinary blotting paper." Have you had any experience in the carbonization of ordinary blotting paper, and if so, with what results?

A. Yes, sir. I have carbonized blotting paper. It makes a loose, non-coherent, friable carbon. Some kinds of blotting paper separate in carbonizing into two or three layers. When a current is passed through it, little arcs occur throughout the carbon, due to the loose contact of one fibre with another. I have made incandescent carbon conductors out of it, but they were not satisfactory.

50 Q. I further call your attention to another paragraph upon the same page of Mr. Man's testimony, at the bottom of the page, where he speaks of "rubbing down and working out by hand the carbon," and ask if you have ever had any experience in this kind of manipulation of paper carbon?

A. I do not conceive how it is possible to rub down a paper carbon made out of blotting paper, without it is very large, such as an eighth ($\frac{1}{8}$) of an inch square, and then I judge it would be exceedingly difficult. I never did this, nor did I ever see any one do it. If the carbon was anything like the flexible filament as shown in my commercial electric lamp, I should say it is impossible. Further, I do not see the necessity of it, as any thickness of paper could have been used, and any desired shape could have been obtained from the paper in the first instance. It is not an easy matter to rub down blotting paper before it is carbonized. 3067 & 3068

The taking of further testimony herein was adjourned by consent to Tuesday, June 14, 1881, at same place.

WM. H. MEADOWCROFT,
Notary Public, N. Y. Co.

Pursuant to adjournment this examination was resumed June 14, 1881, at 10 a. m., at No. 65 Fifth avenue, the same counsel being present.

The witness, THOMAS A. EDISON, further answers to questions proposed by GEORGE W. DYER, as follows:

51 Q. I call your attention further in testimony of Albon Man, answers to the 4th and 18th questions, and ask if paper carbonized electrically as described can afterwards be made incandescent?

A. I have tried many experiments on the carbonization of paper, both by the passage of the current through a filament with plumbago on its surface, and also by the passage of current through a platinum conductor on which the paper rested, and always found that the decomposition of the cellulose and water of the paper produced sufficient oxygen to consume all the carbon of the paper, and the result was that nothing was left but the natural ash. These experiments were conducted *in vacuo*. I do not see how it is possible to produce a carbon which could be used in a lamp by simple carbonization of the paper by the heat produced by the passage of the electric current in an atmosphere of nitrogen, hydrogen or air.

3069 52 Q. Referring to the 57th and 57½ questions and answers of Albon Man what would become of a Florence flask filled with gas as described and subjected to currents of electricity?

A. I have placed illuminating gas in flasks similar to a Florence flask and in which there was an incandescing conductor of carbon, and on heating the same to high incandescence, the globes exploded, due to the enormous expansion of the gas and decomposition of the same.

53 Q. Referring to answer Q. 61 in the testimony of Albon Man, what comment, if any, have you to make on the statement that the oxygen of the salts would consume the paper?

A. I do not see how any oxygen salt would cause an*d* paper to become a conductor. I do not believe there is a dry oxygen salt that is a conductor of electricity sufficient to allow a current to pass through a strip of paper impregnated with it. If it was moistened to permit of conductivity, the moisture would be evaporated before carbonization, because the water could not exist at a high temperature sufficient to carbonize. And if the water was dissipated, the oxygen salt would not be a conductor.

54 Q. Referring to the answer Q. 67 of Albon Man, what comment, if any, have you to make upon that?

A. I do not see that the treating of the paper carbon by a hydrocarbon gas, to deposit hard carbon, improves the paper carbon. If the paper carbon was originally bad, it will always remain so. If it is coated by deposition of hard carbon, the light is radiated then from a hard carbon and not from a paper carbon. If the paper carbon is to have a deposit of this hard carbon placed over it, and within it, it doesn't matter whether the paper carbon is good, bad, or indifferent, or is any other form of carbon, or even a metal. The incandescing conductor of the lamp becomes really and truly a hard-carbon conductor, as the major portion of the current passes through the hard carbon and all the light is radiated from it.

3070 If a paper carbon is dipped in different hydrocarbons several times, and recarbonized each time, a deposit of hard carbon takes place on the surface as well as within the paper. The use of a hydrocarbon for depositing hard carbon by electrical incandescence, is only a method for rendering a useless carbon available in an electric lamp.

It is, in fact, an*d* evidence of the imperfection of the carbon paper.

Answer objected to as being mere argument and not any statement of facts responsive to the question, the answer being mere criticism.

55 Q. In the foregoing answer have you expressed an opinion simply as an expert, or spoken from knowledge derived from experiments made by yourself?

A. Derived from experiments made by myself.

56 Q. Referring to the answer of Albon Man to the 80th question, what effect would the glue mentioned in the answer have in the employment of the paper carbon for incandescence in a lamp?

A. The effect would be that when the same was placed in the lamp it would be carbonized, and a great amount of smoke would come out and obscure the globe. This is from my actual knowledge.

57 Q. Calling your attention to the answers of Albon Man to questions 83, 84 and 85, I ask what would be the result of carboniz-

ing the paper described, in the way described, and working it down after carbonization as described.

A. The result of using several thicknesses of blotting paper pressed together would be that when they were carbonized they would all separate, each would be contorted in a different manner, and I do not believe they could be used or worked down, as stated by Mr. Man. I know this from my own experience. Could they have been kept together, which was impossible, according to the method of carbonizing described by Mr. Man, they might 3071 possibly have been worked down by emery paper, providing they were large enough, but from the sizes given by Mr. Man in another part of his testimony, I do not see how it is possible. It would seem that the proper method would have been to cut the paper in the form desired, and then carbonize it, instead of cutting it in a form not desired, and then working it down after it was carbonized.

That is a method of manufacturing by machinery or appliances

58 Q. I call your attention to the sketch Sawyer's Exhibit No. 3, Albon Man, and ask if it would be possible for the spring clamp there shown to clamp the ends of the carbonized paper described.

A. I do not see how a practical lamp could be made with such clamps. Mr. Man has testified that the width of the carbon was from $\frac{1}{12}$ to $\frac{1}{20}$ of an inch, and as these carbons rest upon the plate of platinum, *c*, in the sketch, the length of the spring portion of the clamps would only be from one-twelfth to one-twentieth of an inch. This is manifestly absurd.

59 Q. I call your attention to the answer of Wm. E. Sawyer to the sixth question, and ask if such a carbon was used as an incandescent conductor in an electric light, what would be the source of light in the incandescent conductor.

A. The source of light would be a hard gas carbon and not the paper carbon.

69 Q. I call your attention to the answer of Wm. E. Sawyer to the eighteenth question, and to what is there stated about candle power, duration of burners, and fracture, and ask you to state from your own knowledge the results that would follow from the various conditions named in the answer.

A. The life of the lamp would depend upon the unit incandescence. Referring to Mr. Sawyer's answer to cross-question fifty-three, I have made a calculation as to the radiating surfaces of the carbon whose size has been given by Mr. Man, and as to that of the carbon in my exhibit marked "Edison's Commercial Incan- 3072 descent Lamp," and find that the candle power per unit surface is greater in my lamp at sixteen candles than in the lamp described by Mr. Man, giving thirty candles. In giving candle powers, the total radiating surface is the main factor which should be always given.

Had I the same radiating surface in my lamp it would have given about thirty candles, and lasted just as long, theoretically. Practically it would last longer, as the smaller and lighter the carbon the more difficult it is to manufacture it so perfect. To show how absurd it is to give candle power without the radiating surface, one might make a lamp that would give twenty-five candles when only brought up to a yellow heat. From my experience I should judge that the carbon made of the material and in the manner specified and used under the conditions specified, would last on an average about as long as was stated by Mr. Sawyer in his communication to the New York papers, about December 22d or 23d, 1879, that is, they would not last more than a few minutes. In fact, Mr. Sawyer stated in a communication to the N. Y. Sun, December 22d, 1889, which is now before me, and dated from 78 Walker street, Dec. 21st, that a carbonized paper lamp would not last three hours and also stated that in practice it would not last twenty minutes, in a perfect vacuum. Now, as Mr. Sawyer did not get anywhere near a perfect vacuum, and yet from his experiments predicated the statement that even in a perfect vacuum they would not last twenty minutes; the results obtained by Messrs. Sawyer and Man can be readily surmised. They were undoubtedly very dismal failures.

The article from the N. Y. Sun of December 22d, 1879, referred to in the foregoing answer is put in testimony and marked Edison's Exhibit No. 8.

The exhibit is objected to upon the ground that there is no evidence that it was published in the N. Y. Sun, or that Mr.
3073 Sawyer wrote it. All reference made to the article in the witness' answer is objected to on the same ground. And upon the further ground that the article is not in evidence in any sense.

61 Q. Refer, if you please, to the description given by the witnesses for Sawyer and Man and the sketches and drawings referred to by them in the printed record of Sawyer and Man's testimony, and taking into view the incandescent conductors employed, and the heat radiators employed, and the other parts of the lamp, would such a lamp, in your opinion, be a practical lamp or not, giving reasons for whatever opinion you may express?

A. No, sir, it would not be a practical lamp. The testimony of even Messrs. Sawyer and Man, and the statements of Mr. Sawyer and his witnesses prove that it is not a practical lamp. No lamp has ever yet been devised up to the present date that was practical which had an enclosing chamber partially made of a cup of metal and secured to the glass by cements. In fact, Mr. Sawyer states the same in his patents, and shows many devices to obviate this defect. A sufficiently high vacuum cannot be obtained in chambers of this character to prevent oxidation and electric convection of the carbon. When the globe is filled with nitrogen the atmospheric gases will still pass in, in the manner described by Graham in his experiments upon the transpiration and diffusion of gases. A great many inventors, including Messrs. Sawyer and Man, place their carbons in an atmosphere of nitrogen, on the theory that nitrogen is inert towards carbon. It is well known that carbon at high incandescence combines with nitrogen to form cyanogen, and the cyanides due to ash of the carbon. My assistant, Dr. Moses, has obtained a

chemical reaction for cyanogen compounds, formed by electrical incandescence of carbon in an atmosphere of nitrogen. To obviate the defects of an imperfectly sealed chamber, Messrs. Sawyer
3074 and Man introduce nitrogen gas, upon the theory that if the atmosphere in the globe is at the same atmospheric pressure as the exterior atmosphere, there will be no tendency of the oxygen of the exterior atmosphere to pass within the globe, and that nitrogen is inert towards carbon. Both of these theories are wrong.

Another reason why the lamp would not be a practical lamp is that the carbon in the lamp which Mr. Sawyer testifies was the perfected lamp is not provided with thickened ends, whereby the incandescence of the carbon is reduced; hence it can only have its incandescence due to the passage of the current reduced by conduction of the heat away from the carbon at the point of contact. The carrying capacity and heat conductivity of these clamps are so small, compared to the size of the carbon, and the incandescence which it is necessary to bring the carbon up to to give, say twenty candles, that the carbon at the points of contact would be partially incandescent, as the heat could not be conducted away fast enough, and a bad contact between the carbon and the clamps would necessarily follow, accompanied by small arcs, which would gradually increase and ultimately destroy the contact. The amount of energy lost by conduction would be far greater than that lost in the form of useful light. My assertions in this respect about the conduction of heat are verified by the construction of the lamp itself, where special means are employed in the way of radiators whereby the heat of conduction may be radiated so that the lamp will not get too hot. This energy is of course useless for light-giving purposes, and consumes nearly as much electricity as is required to produce a light of twenty candles in the carbon. The great heat also produces great differences of temperature in the enclosing case, and therefore difference in the expansion of portions of the case, which causes leakage from the atmosphere into the case. Another thing is, that if when the lamp is cold the gases within it are at the same
3075 pressure as that of the atmosphere, this result will be changed when the lamp is lighted. The gas within the globe becomes expanded, and there is a different pressure, the tendency of which, if there is leakage, is to force the gas out of the lamp until the pressures are constant. If this takes place, and the lamp is allowed to cool, then the atmospheric pressure will be the highest, and there will be a tendency for the atmosphere to pass into the globe. For these and other reasons which could be mentioned the lamp which Mr. Sawyer calls his perfected lamp is, in my view, entirely impractical, commercially, scientifically, or otherwise.

I have previously stated the reasons why it would not be practical, commercially, in a previous part of my testimony. Its resistance would be too low to admit of practical subdivision, on account of the great investment required for copper conductors. It would not be sufficiently economical, on account of the energy lost by conduction and by convection through the residual gas.

Counsel for Edison gives notice that reserving the right to put in certain patents, the data of which he will procure, and exhibits of experiments in 1878, for which search is now being made during the course of this examination, he here rests his examination of Mr. Edison, and offers him for cross-examination.

Counsel for Sawyer and Man gives notice that his cross-examination of the witness will be *de bene esse* as to all that part of the witness' testimony that is intended to show or goes to show that he made the invention previous to the date alleged in his preliminary statement, and that he does not intend that his cross-examination shall be construed as a waiver of any objection he may have entered of record, and that he will object and move to strike
3076 out, either before or at the hearing of the interference, any
re-examination of the witness, or any testimony or exhibit put in that does not refer to new matter brought out in the cross-examination.

Cross-examination by AMOS BROADNAX, Esq., counsel for Sawyer and Man:

62 X Q. In answer to question 1 of your examination-in-chief, you say you are an inventor by occupation. Please state what inventions you were working on in the summer of 1876.

A. I was working on telephones, acoustic electrical transmission, electric pens, multiple copying apparatus, duplicating ink, galvanic batteries, sextuplex telegraphs, duplex telegraph, manufacture of carbon articles, and other things which I cannot now remember.

63 X Q. How much of your time during the summer of 1876 were you engaged in working on telephones? I mean what time in the summer did you begin to work on telephones, and what time did you leave off.

A. I commenced to work on telephones in 1875. I have never left off since that date.

64 X Q. How much of your time was given to telephones during the summer of 1876?

A. It would be a difficult matter to divide my time up between all the things I was working on. I should say one-tenth of my time was given to speaking telephones.

65 X Q. Were you working in the summer of 1876 at one and the same time, or during the same period of time, upon all the inventions you mentioned in answer to 62 X Q?

A. Yes, sir, I think I was.

66 X Q. Was there any exigency in the development of either of the inventions referred to by you that moved you to carbonize paper?

3077 A. I have stated that one of the things I was working on was the carbonization of paper to form different articles. One of my assistants, Mr. Johnson, had formed or was about to form a company called the American Novelty Company, whose purpose was to work off some of the small inventions which I was making. The manufacture of a great many articles from carbon was one of these inventions. Among other things was an electrical sheep-shearing machine, an electrical drill, an electrical engraving machine, ribbon mucilage, and other inventions which I cannot now remember. They were small things. I think he had a list of about twenty.

67 X Q. What articles did you propose to manufacture of carbonized paper?

A. Battery carbons, strips of carbon for electrical resistances, dishes for use in making chemical reactions, and tissue paper as a non-conducting packing.

68 X Q. How many of these articles did you make?

A. We made four or five crucibles, a great many flat sheets, and a half a pound to a pound of carbonized tissue paper.

69 X Q. How long did you continue to work at your experiments in the manufacture of articles of carbonized paper, in the summer of 1876?

A. I should say we tried experiments on and off for perhaps two months.

70 X Q. Please to state when you began your experiments and when you discontinued them, as near as you can recollect?

A. As near as I can recollect it was in the summer of 1876.

71 X Q. Can't you state at what time in the summer of 1876, you commenced your experiments, and at what time you discontinued them?

A. I should judge that it was about June or July, 1876.

72 X Q. State, if you please, when it was that you next took up the subject of carbonizing paper?

A. I think about January, 1877.

3078 73 X Q. What circumstances moved you to return to the carbonization of paper in January, 1877?

A. Using it in a telephone.

74 X Q. How long did you continue to use carbonized paper in your telephone?

A. I think I used it as late as January or February, 1878; perhaps later. All my exhibits are in the telephone interferences, and I have nothing here to refresh my memory.

75 X Q. For what other purposes did you use carbonized paper in January, 1877?

A. I used it for resistances.

76 X Q. After January, 1877, did you discontinue the carbonization of paper?

A. No, sir. I think we carbonized paper when we wanted it, although we generally had plenty of it around the laboratory. If none of it suited our purpose, we generally carbonized what we required.

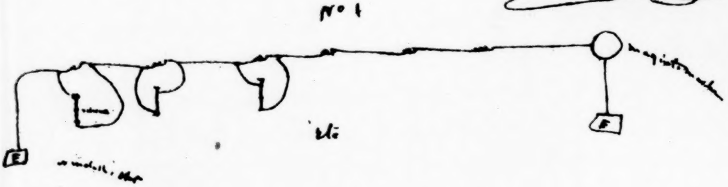
77 X Q. Why did you use carbon made of paper in your telephone and in your battery, in preference to carbon made of anything else?

A. Because it was in convenient form. We could get it in all the forms we wanted it. We also carbonized wood of various kinds, as well as paper.

No. 286
C. E. Light Co
v.
McK. Light Co. } p. 3079.

Electric Light

Oct 5 1877
T A Edison
Chas Batchelor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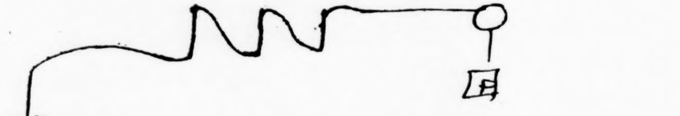
magneto machine
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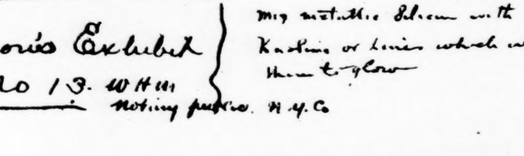


Edison's Exhibit
No 13. WHM
Nothing pertinent. H.Y.Co

Mix metallic Silicon with Kaolin or lime which will Cause them to glow

78 X Q. Had the carbon made of paper no other superiority for the purpose for which you wanted it beyond that of mere convenience in manufacture?

A. In our telephones we had to have it in a great many experiments very thin. Hence paper was the most convenient material to use. For nearly all the purposes for which we used carbon, it was the most convenient material. In our telephone experiments we used every kind and character of carbon, and every form and shape. In 1877 most all our thoughts were on carbon and plumbago. It was carbon from Monday morning to Saturday night, month in and month out, and always in connection with its interpolation in an electric circuit.

(Here follows diagram marked p. 3079.)

3080 & 3081 79 X Q. When did you turn your attention to the subject of electric lighting?

A. In September or October, 1877.

80 X Q. Please to describe the first electric lamp you made or caused to be made.

A. I think my first experiments were with heating platinum wires to incandescence. Afterwards, heating carbon paper up to incandescence in the atmosphere. Also coating the carbon with powdered glass, which, in melting, was to protect it from the atmosphere.

Also with powdered silicon. Also in the lamp marked "Edison's First Incandescent Lamp." Afterwards by the passage of current through pieces of boron and silicon, rendering them incandescent. Also silicon and boron placed between carbon points. All these experiments, I believe, were conducted between September, 1877, and January, 1878.

81 X Q. You do not answer my question, which is repeated.

A. The first carbon electric lamp, if it may be called an electric lamp, was a piece of carbonized paper, about an inch long, one-sixteenth of an inch broad, and six or seven thousandths of an inch thick, the ends of which were secured to clamps, which clamps formed the poles of a battery. The carbon was brought up to incandescence, and of course oxydized immediately. That was one of the '77 experiments. The first lamp *in vacuo*, if it may be called a lamp, was Edison's Exhibit First Incandescent Lamp. This consists, as will be seen, of two clamps, forming the poles, between which a strip of carbonized paper was placed and secured by clamping. The base of the lamp being placed over the mouth of the hold on the platen of the air pump, had the air exhausted from the globe as far as possible by our air pump, and the carbon brought up to incandescence after the air due to the first heating had been pumped out.

82 X Q. Did your first experiment in electric lighting consist of a section of carbon made of paper placed in an electric circuit
3082 in the open atmosphere, to which you applied a current and burnt up the carbon?

A. I have already stated that I first tried platinum, but we will leave this out of consideration; and my answer will be yes. It was a mere experiment with the carbon in open air. I knew beforehand what it would do. It was to ascertain, I think, the amount of current required to bring it to incandescence.

83 X Q. When was that experiment made? State the date, as near as possible.

A. It might have been in September or in October, 1877.

84 X Q. Was it surely in one or the other of those months?

A. I am not absolutely sure, but my impression is it was in either one of those months.

85 X Q. You are certain that it was in the year 1877?

A. Yes, sir; I know it from my Exhibits Nos. 4 and 5.

86 X Q. Was that the first attempt that you made to use carbon made of paper in electric lighting?

A. The first premeditated attempt to use paper for lighting by incandescence. I have stated that one of our objects in 1876 was to make carbons for electric lighting, but not by incandescence.

87 X Q. When did you make your next attempt to use carbon made of paper in incandescent electric lighting?

A. In September, October or November, 1878. I should say October is the month we started to make paper carbons.

88 X Q. You say that your first premeditated attempt at using carbon made of paper for incandescent electric lighting was in September or October, 1877, when you placed a piece of carbonized paper in circuit in the open air, for the purpose of ascertaining the amount of current to make it incandescent. And that your next attempt was in the fall of 1878. Now please to state whether 3083 this second attempt embraced the Exhibit "Edison's First Incandescent Lamp"?

Question objected to by counsel for Edison as containing a misstatement of the witness' testimony.

A. My second attempt was not in the fall of 1878. I have already stated in my testimony that my first attempt at making an incandescent carbon lamp, if it can be called a lamp, was made in September or October, 1877, and consisted in bringing a strip of carbonized paper up to incandescence in the air. And my next attempt to make an incandescent lamp with carbon paper, if it may be called a lamp, was that shown in Edison's Exhibit First Incandescent Electric Lamp, which was also made in 1877, within a day or two of the first experiment. The attempts made at coating the paper with glass and silicon are not taken into consideration in this answer.

The taking of further testimony was adjourned by consent to Wednesday, June 15, 1881, at 10 o'clock at the same place.

WM. H. MEADOWCROFT,
Notary Public, New York County.

Pursuant to adjournment, this examination was resumed June 15, 1881, at 10 o'clock a. m., at No. 65, Fifth avenue, same counsel present.

The witness, THOMAS A. EDISON, further answers to questions proposed by AMOS BROADNAX, Esq., counsel for Sawyer and Man, as follows:

89 X Q. Then, as I understand you, your first and second attempts at electric lighting with carbon made of paper were made either in the month of September or October, 1877, the second attempt being made within a few days of the first?

3084 A. Yes, sir; lighting by incandescence of carbon paper.

90 X Q. The first attempt was the use of the carbonized paper in the open air, and the second embraced the lamp marked "Edison's Exhibit First Incandescent Lamp."

A. Yes, sir.

91 X Q. Do you fix the time at which these attempts were made by the Exhibits Edison No. 4 and Edison No. 5?

A. Yes, sir; these exhibits refresh my memory as to experiments conducted at that time, and previous thereto.

92 X Q. What is there upon Exhibit No. 4 that calls your attention to any experiments made in electric lighting by incandescence with carbonized paper?

A. The exhibit merely refreshes my memory so as to enable me to state the date of the time when I did try experiments with carbonized paper. The exhibit is headed "electric light," and explains itself.

93 X Q. Do you find anything on the exhibit that makes any reference to electric lighting by incandescence with carbonized paper?

A. No, sir, I do not. I have already stated that the exhibit serves only to refresh my memory as to the date. The reason why boron and silicon were used is that they are not so sensitive to oxidation as the paper previously tried.

The last part of the answer is objected to by counsel for Sawyer and Man as irresponsive.

94 X Q. In whose handwriting is Exhibit No. 4?

A. Most of it is in my own handwriting.

95 X Q. There is a strip of Exhibit No. 4 torn out between the names of Mr. Charles Batchelor and J. Kruesi. Who tore that out?

A. I do not know. These papers were originally in books,
3085 and the books were all destroyed, and the sheets forming the
same, numbered and bundled together. The most of them
were used as exhibits in my telephone interference.

96 X Q. Was there any one else's signature written upon this paper between the names of Charles Batchelor and J. Kruesi?

A. I do not know. I do not think so. It looks as if it had been stuck on a paper file and torn off.

97 X Q. Who made the diagrams upon this paper Exhibit No. 4?

A. I did.

98 X Q. When were the diagrams and writings made upon this paper—so much of them as was made by you?

A. At the date stated thereon.

99 X Q. There are two dates on the paper. Which date do you mean—the date on the right-hand corner at the top, under which your name is signed?

A. I refer to the date November 1st, 1877.

100 X Q. There is a memoranda at the bottom of the paper as follows: "Copied in volume No. 1, Experimental Researches, page 115, September 28, 1878." Signed William Carman. Who is William Carman?

A. He was at that time, and is now, my book-keeper at Menlo Park.

101 X Q. Does that memoranda show the correct date of the record of this paper?

A. It shows the date when it was recorded in the book, as set forth.

102 X Q. Why was it not recorded until September 28th, 1878?

A. Because about that date we commenced collecting all the scraps and memoranda relating to experiments together, for the purpose of preserving them, and especially those relating to telephones, of which there were several thousand, now used as exhibits in the interference on telephones.

3086 103 X Q. Have you got that book in which this paper is recorded, and, if so, will you produce it for my examination?

A. I have it at Menlo Park, I think. I will have it brought in.

104 X Q. It appears by this paper that some time previous to November 1st, 1877, you had "tried boron ruthenium, chromium, and the almost infusible metals for separators in my electric light device. Boron is very high resistance, and would do if arranged thus." Then follows a diagram. It is then stated that "silicium, on the other hand, is of very low resistance, and would have to be arranged thus." Then follows another diagram. Then follows these words: "I think powdered silicium, mixed with lime or other very infusible non-conductors or semi-conductors, would be good." Now, if previous to the making of this paper by you, you had attempted the use of carbonized paper for incandescent electric lighting, how did it happen that you didn't mention it on this paper with the other substances or materials referred to by the paper?

A. Because I had got done with my experiments on carbonized paper. The results were so unsatisfactory, even when the carbonized paper was in the vacuum which we obtained. Its sensitiveness to oxidation was one of the factors which led me to try experiments on silicon and boron, which were not so sensitive to oxidation. I thought that as we could not get carbon to stand, that these non-oxidizable materials might be made to stand. I have had pieces of silicon, separating the two electrodes, incandescent for an hour at a time. Had the carbon experiments been as satisfactory, I would undoubtedly be able to present an exhibit in which some of them would be recorded.

104 X Q. Do the experiments referred to by this paper, Exhibit No. 4, make part of your efforts at electric lighting by incandescence?

A. Yes, sir; as well as my Exhibit No. 5.

105 X Q. Did you, at the time referred to by this paper, keep written memoranda of all your attempts at electric lighting?

3087 A. No, sir, I do not think I did.

106 X Q. Did you keep a written memoranda of all the experiments that yielded results of any value?

A. No, sir; I do not think I did. The exhibits themselves state that I tried experiments, and yet I have no record of them.

107 X Q. What is there in the paper, Exhibit No. 4, that satisfies your mind, that your first and second attempt at electric lighting by incandescence with carbonized paper was previous to the date of the paper?

A. It refreshes my memory as to the fact that I was trying experiments on electric lighting by incandescence, and it permits me to remember that my first experiments were with platinum and carbonized paper.

108 X Q. Then, as I understand you, you know certainly by this paper, that the experiments noted on it were made on or before its date, which is November 1st, 1877, and to the best of your recollection, the experiments with the carbonized paper embraced in your first and second attempt at electric lighting by incandescence, were made previous to the date of the experiments noted on that paper?

A. Yes, sir; that allows me to fix the date.

109 X Q. Did Mr. Charles Batchelor and Mr. J. Kruesi sign their names upon this paper in your presence at the time the paper was made?

A. I cannot say; our habit was to have the papers witnessed within a day or two of the date placed upon them.

110 X Q. Please to mark the diagrams on this paper, Exhibit 4, figures 1 and 2 respectively?

A. I have done so, as requested.

111 X Q. Does Fig. 1 of these diagrams represent a number of lamps set in multiple arc, and if so, please to designate the lamps by letter *a*.

A. It does so represent, and I have designated them by letters a, a^1, a^2, a^3.

3088 112 X Q. State, if you please, whether figure 2 represents lamps set in series, and if so, please designate the lamps by letter *b*.

A. It does so represent, and I have designated the lamps b, b^1, b_2.

113 X Q. The word "magneto," as I understand it, written by the two diagrams, is intended to designate an electric generator?

A. Yes, sir.

114 X Q. Who is Mr. Charles Bat-helor?

A. He is one of my assistants.

115 X Q. How long has he been in your employ?

A. About ten (10) years.

116 X Q. Who is Mr. J. Kruesi?

A. A machinist in my employ.

117 X Q. How long has he been in your employ?

A. I think about seven (7) years.

118 X Q. In whose handwriting is Exhibit Edison No. 5?

A. Nearly all in my handwriting.

119 X Q. When was it made?

A. On the day of its date, that is, December 3d, 1877.

120 X Q. Was this paper, Exhibit No. 5, witnessed by Charles Batchelor, M. N. Force, and J. Kruesi in your presence?

A. I cannot say.

121 X Q. Do you know the signatures of those gentlemen?

A. Yes, sir.

122 X Q. Can you swear that their signatures are signed upon this paper?

A. Yes, sir.

123 X Q. Can you swear when the signatures were made?

A. No, sir; but my impression is, they were made within a day or two after the date on the paper; that was our habit.

3089 124 X Q. And this paper, Exhibit No. 5, assures you that the experiments noted on it were made on or before the day of its date, and that to the best of your recollection, your first and second attempt at electric lighting with carbonized paper was made before the date of that paper?

A. I have already testified that it was made before the date of Exhibit No. 4, which is an earlier date than Exhibit No. 5.

125 X Q. Does either Exhibit No. 4 or No. 5 make any reference to your experiment with carbonized paper in electric lighting?

A. No, sir; they merely refresh my recollection as to dates.

126 X Q. Who made Edison Exhibit First Incandescent Lamp?

A. I don't know; we bought it. It was a well-known school apparatus for illustrating the electric brush *in vacuo.* The changes necessary to try the experiment on carbonized paper were made by or through the orders of Mr. Charles Batchelor.

127 X Q. Did you buy the lamp yourself?

A. I do not know, I cannot remember, but my impression is I did.

128 X Q. Where did you buy it?

A. I cannot remember that, but my impression is I bought it of a firm called Luhme & Co.

129 X Q. Where?

A. New York.

130 X Q. Give the street and number in New York?

A. I don't know the street or number; it was down near the post office.

131 X Q. Do you recollect what you paid for it?

A. No, sir.

132 X Q. Was the place at which you purchased it north or south of the post office?

A. It was south of Chambers street and north of Vesey street.

133 X Q. Was it west of Broadway?

A. And west of Broadway.

3090 134 X Q. Is that as near as you can locate the place where you purchased the lamp?

A. Yes, sir.

135 X Q. Have you now a distinct recollection that you did purchase the lamp yourself?

A. No, sir; I have only an impression.

136 X Q. Who do you think would have purchased it if you did not?

A. It might have been purchased by letter or by messenger boy.

137 X Q. You are sure it was purchased of the firm of Luhme & Co. in the city of New York?

A. No, sir; I am not; but my impression is that it was.

138 X Q. Were you in the habit of dealing with that firm?

A. I was in the habit of dealing with that firm; and a firm named Benjamin & Co., I think.

139 X Q. Where is the firm of Benjamin & Co.?

A. I think it is somewhere south of Chambers, north of Vesey and west of Broadway.

140 X Q. What does Luhme & Co. deal in, and what does Benjamin & Co. deal in?

A. In philosophical apparatus.

141 X Q. This lamp, Edison's Exhibit First Incandescent Lamp, that you say you think you purchased; what was the name of the apparatus when you purchased it?

A. My impression is, it is called a "Gassiot cascade."

142 X Q. What alterations did you make in this cascade to adapt it to your purpose in making your experiments in incandescing electric lighting with carbonized paper?

A. Clamps were placed in it to hold the carbon, and binding posts outside to hold the conducting wires.

143 X Q. How many experiments did you try with this lamp?

3091 A. My impression is that we tried two or three experiments.

144 X Q. How large was the piece of carbonized paper which you used in this lamp; give the length, the bre-dth and the thickness of it?

A. My impression is that it was about an inch long, three-sixteenths broad, and I think somewhere less in width than three-sixteenths; I should say they were eight-thousandths of an inch thick.

145 X Q. Did you carbonize the paper especially for these experiments?

A. I do not remember whether we used some carbonized paper we had on hand, or carbonized it expressly for the occasion.

146 X Q. How did you get the carbonized paper in the lamp?

A. Mr. Batchelor put it in.

147 X Q. You don't know how he got it in?

A. No, sir, I don't.

148 X Q. What degree of vacuum did you get in this lamp?

A. My impression is we got two and a half millimeters of mercury on a gauge, which represents, if the gauge was correct, that the column of mercury was within two and a half millimeters of a perfect vacuum.

149 X Q. How much is a millimeter in inches?

A. It isn't an inch; two and a half millimeters are about a tenth of an inch.

150 X Q. What was the resistance of the carbonized-paper burner that you used in this lamp?

A. I did not measure it.

151 X Q. What strength of current did you have on it?

A. We had about 50 cells of carbon battery, but I do not remember how many we used on it.

152 X Q. Did you get the carbonized paper to brilliant incandescence?

A. No, I do not think so.

3092 153 X Q. How long did the carbonized paper last in the lamp?

A. My impression is that it only lasted six or eight minutes.

154 X Q. How long was you engaged upon these experiments with this lamp?

A. I do not think more than a day.

155 X Q. Were they made at your laboratory, Menlo Park?

A. Yes, sir.

156 X Q. How did you exhaust the air out of the lamp?

A. By an air pump.

157 X Q. Was it a pump you had on hand, or did you buy it for the occasion?

A. A pump I had on hand.

158 X Q. Did you prepare the lamp for the experiment yourself, or did Mr. Batchelor prepare it?

A. Mr. Batchelor.

159 X Q. Did you see Mr. Batchelor put in the paper carbons?

A. I don't remember it.

160 X Q. How do you know that paper carbons were actually put in the lamp?

A. Because I told him to put them in, and I saw them after they were in.

161 — Q. How could you distinguish a carbon made of paper from any other carbon?

A. Very easily, by its looks.

162 X Q. How does it differ in appearance from carbon made of wood?

A. It is very difficult to describe the difference in appearance, still when once a person has seen the two, he can distinguish them readily; the fibres of the paper are still visible after carbonization, while the wood shows the cellular formation.

163 X Q. Why did you not continue your experiments upon the use of carbonized paper for incandescent electric lighting, in this lamp?

3093 A. Because the results did not warrant it.

164 X Q. Upon the conclusion of your experiments with

No. 286
C. E. Light Co.
v.
McK. Light Co. } p. 3094

30/

July 20 1877

1 - Hammered Aluminium
2 - Platina
3 - Silver
4 - Phosphor Bronze
5 - Zinc
6 - Lead
7 - French Steel
8 - Wrought iron
9 - Nickel
10 - Russian leather
11 - White spruce shellaced
12 - Light Mahogany
13 - Rose wood
14 - Brass
15 - Walnut wood
16 - paper of all kinds
17 - Celluloid
18 - Hard Rubber
19 - Vulcanized fibre
20 - Cardboard
21 - Carbon paper
22 - Copper foil
23 - Mica
24 - Bastie Glass
25 - Papier Maché
26 - Veneering of different woods
27 - Plaster of Paris
28 - Crocodile skin
29 - Fish skin near tail (Mackerel)
30 - Paper barrel stock
31 - Iridium foil
32 - Collodionised paper
33 - Gelatine
34 - Oil board such as used for copy press
35 - Soft rubber thick
36 - Gold foil
37 - Thin slate
38 - Oil cloth

Chas Batchelor
James Adams

(Edison's Exhibit No. 14) W. H. M. notary public N.Y. Co.

this lamp did you abandon the attempt at electric lighting by incandescence with carbonized paper?

A. No, sir; we laid it aside, and took up what we thought at the time was more promising—the use of silicon and boron for incandescent lighting.

165 X Q. State, if you please, whether the paper marked Edison Exhibit No. 1, is an illustration of your first attempt at electric lighting by incandescence, with carbonized paper, in the fall of 1877, about which you have been testifying?

A. No, sir; it is an illustration of experiments conducted in the fall of 1878.

166 X Q. In answer to question 9 of your examination-in-chief, which is as follows (counsel reads question and answer to witness); state, if you please, whether in that answer you referred to Edison Exhibit First Incandescent Lamp, which you subsequently produced.

A. Yes, sir.

167 X Q. Then, as I understand you, the attempt illustrated by Edison Exhibit No. 1, followed the attempt embraced in Edison Exhibit First Incandescent Lamp; the latter being made in September or October of 1877, and the former in October or November of 1878; I mean, of course, in incandescent electric lighting with carbonized paper.

A. Yes; this Exhibit No. 1, is an illustration of experiments conducted in September or October, 1878, with incandescence of carbonized paper.

168 X Q. Then this paper Exhibit No. 1, as I understand you, presents your third attempt at incandescent electric lighting with carbonized paper?

(Here follows lithograph marked p. 3094.)

A. No, sir; it represents the second in point of date. My understanding of "attempt" at incandescent lighting is, that it means all
those experiments made within a few days of each other,
3095 forming a group. The experiments in 1877, are my first
attempt, those in 1878, my second attempt, and those in 1879
my third attempt.

169 X Q. Well, then, referring to Edison Exhibit No. 1 as your second attempt, please to state whether the exhibit is intended to represent the whole or a part of an experiment with carbonized paper in incandescent lighting in vacuum.

A. They represent a few of the experiments tried at that time on the incandescence of carbonized paper, but not *in vacuo.*

170 X Q. Please to describe the first electric lamp or apparatus in which you used carbonized paper for incandescent electric lighting *in vacuo*, in October or November of 1878?

A. My impression is that it consisted of a piece of carbonized paper coated with tar and lamp-black, and carbonized, placed in clamps connected to the circuit, and placed under the bell jar of the vacuum pump. I am not absolutely sure that this experiment was tried in September or October, but it was tried not later than December, 1878.

271 X Q. What do you mean by the "bell jar" of the vacuum pump?

A. The bell jar that usually accompanies vacuum pumps, in which the vacuum is obtained.

172 X Q. Was the bell jar of glass?

A. Yes, sir.

173 X Q. Please to illustrate the arrangement and describe it by letters of reference.

A. This sketch represents the arrangement as I recollect it. A represents the platen and bell jar of the vacuum pump; B is the bell jar, *c* is the platen, *d* and *e* are binding posts; *f* and *g* of figure 2 are metal pieces, connected through the iron of the platen to the binding posts; *h* and *k* are insulating pieces; *m* and *n* are metallic prongs which fit against these metallic pieces *f* and *g* when pressed down on their sides. This connects the circuit with *m* and
3097 *n*. The electrode, *p*, holding the carbon, is connected to *n*,
while the other electrode connecting the other end of the carbon, and marked Q, is connected by a wire with *m*. Thus the circuit was complete from one binding post to the other through the carbon when the bell jar was on. The bell jar represents the vacuum chamber of the pump in which the light was produced.

This sketch is put in evidence by counsel for Sawyer and Man as an illustration of the witness' testimony, and marked Edison Exhibit No. 9.

(Here follows diagram marked p. 3096.)

174 X Q. How many experiments did you make with carbonized paper in the vacuum chamber of this pump as you have described?

A. My impression is that we made three or four experiments.

175 X Q. Were the experiments made by you personally or in your presence?

A. I think they were made by myself and Mr. Batchelor, and perhaps Mr. Upton.

176 X Q. Who prepared the pump for the experiment?

A. I don't remember.

177 X Q. Did you witness the experiments yourself?

A. I witnessed some of them.

178 X Q. Did you see the carbonized paper put in the vacuum chamber?

A. I saw it in the chamber. I don't remember seeing it put in.

179 X Q. Are you able to swear of your own knowledge, that the carbon in the vacuum chamber was made of paper?

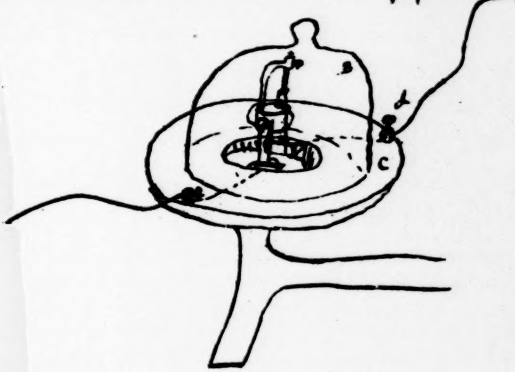
A. Yes, sir; some were made of paper and some of carbonized broom-corn.

180 X Q. Were the papers carbonized expressly for the experiment?

A. I think they were carbonized for the experiment shown in

Edison Exhibit No. 9.

A fig. 1.



No. 286.
C.E. Light Co.
v.
M.K. Light Co.
p. 3096

fig 2

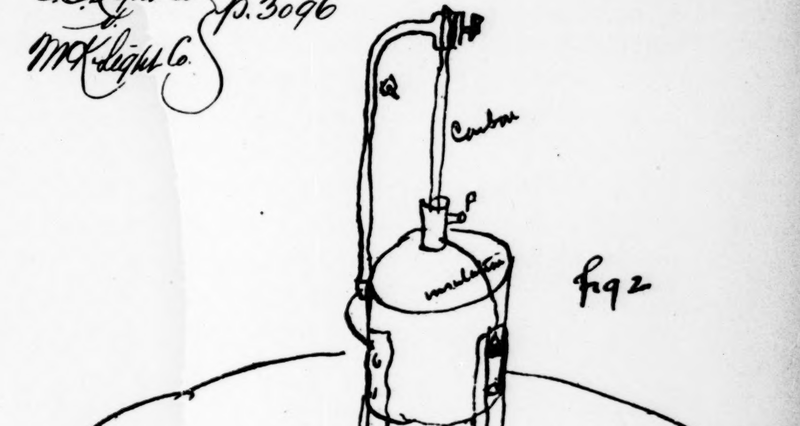

H
Q
Carbon
P
insulation
G
m
m
h
g
f
K

Exhibit 1, and had been carbonized previous to this last experiment.

3098 181 X Q. Do you mean that they were carbonized expressly for those experiments which you say were made in October or November of 1878, and were they carbonized at the time of the making of those experiments?

A. Mr. Batchelor, I believe, had made fifty or more of these carbons for experiments in September or October, 1878, some of which are illustrated as used in Exhibit No. 1.

182 X Q. What size were the carbons used in the experiments made with the pump?

A. My impression is that they were about one-thirty-second in diameter, and an inch or two inches in length.

183 X Q. Was the carbon that you used in Edison Exhibit First Incandescent Lamp, straight or curved?

A. Straight.

184 X Q. What was the success of your experiment with carbon in the vacuum chamber of the pump?

A. We could not make the carbon stand, although we had pieces of potassium, and also sodium within the chamber.

185 X Q. What was the resistance of the burner?

A. We didn't measure it.

186 X Q. What was the strength of the current?

A. I think the strength of the current was 4 or 5 vebers, or 4 or 5 thousand foot pounds.

187 X Q. What degree of vacuum did you have upon the burner?

A. I think about 2½ or 3 millimeters, which we read off from a mercury gauge which came with the pump, and was the best vacuum generally obtainable with a pump.

188 X Q. Please to describe the next lamp you made, if any, in October or November of 1878, in which you used carbonized paper for incandescent lighting in a vacuum.

A. I don't think we tried any other experiments than the ones I have here recited *in vacuo*, in 1878.

3099 189 X Q. That, then, as I understand you, completes what you call your second attempt at electric lighting by incandescence with carbonized paper?

A. That, and including the devices illustrated in Exhibit No. 1 and patent No. 224,329, this arrangement being similar to that shown in Mr. Sawyer's patent 219,771, dated September 16th, 1879.

190 X Q. Do you wish to be understood as saying that you made a lamp in the fall of 1878 like that shown and described substantially in patent 224,329, dated February 10, 1880, and used carbonized paper in it for incandescent electric lighting?

A. Yes, sir; we used carbonized paper and carbonized broomcorn in it in September, October or November, 1878.

191 X Q. Does the specification making part of that patent, make any reference to the use of carbon made of paper?

A. No, sir, it does not—it merely mentions carbon, and does not mention the kind of carbon.

192 X Q. Why did you not describe in that specification the use of carbon made of paper in that lamp?

A. Because that was not a part of the invention. We made these slender pencils of carbon, because it was the easiest way to make carbon, as we had no mill for grinding carbon or mold for molding it, and hence made the pencils in the most convenient way, such as coating paper with tar and rolling it up and carbonizing it, and also by carbonizing broom-corn.

193 X Q. Did you make and use an electric lamp like that of the patent last referred to in the fall of 1878?

A. Yes, sir.

194 X Q. Then, in addition to the experiments made with the paper carbons in the vacuum chamber of the pump in the fall of 1878, you also experimented with the same kind of carbons in the lamp of the patent 224,329, as I understand you?

A. Yes, sir.

3100 & 3101 195 X Q. Were the experiments with the lamp of the patent referred to made *in vacuo?*

A. No, sir; they were made in the open air, and were to obviate the use of a vacuum.

196 X Q. At the time you experimented with this lamp of the patent referred to, had you discovered the superiority of carbon made of paper for incandescent electric lighting over other carbon?

A. No; only it was very convenient material to use.

The taking of further testimony was adjourned by consent to Thursday, June 16, 1881, at 10 o'clock, a. m., at same place.

WM. H. MEADOWCROFT,
Notary Public, N. Y. Co.

Pursuant to adjournment this examination was resumed June 16, 1881, at 10 a. m., at No. 65 Fifth avenue, same counsel being present.

Cross-examination continued:

The witness desires to add to his last answer the following:

My answer is changed to this: No; only it was very convenient material to use, and was organic carbon.

198 X Q. Referring now to Edison's commercial incandescent electric lamp, state when it was that you first made a lamp of the form and substance of this exhibit?

A. I think duplicates of this lamp, as to form, shape and material, were made some time in October, 1879.

198 X Q. Have you got the original lamp of the form of this exhibit?

A. I have not been able to find it within the last two or three days, but my impression is that I can produce one of the first six made.

3102 199 X Q. Was the first one of the same size that this exhibit is?

A. The globe was about the same size. It was made in the same manner, except that the paper, which was parchmentized paper, was wider than it was thick, and was bent over in the form of an arch.

200 X Q. Were the metal conductors put in in the same way they are put in this exhibit?

A. Yes, sir.

201 X Q. Was there a section of platinum interposed in the conductor between the copper and the carbon?

A. Yes, sir.

202 X Q. And the interior glass bulb was contained in it the same as in this one, was it, and the lamp sealed in the same way?

A. Yes, sir.

203 X Q. Please to give the dimensions of the carbons used in those first lamps like this exhibit.

A. The first lamp of this peculiar character with paper carbon, had a carbon about a thirty-second of an inch wide, six or eight thousandths of an inch thick, and about two inches and a half to three inches in length before carbonization. It was cut straight and had thickened ends, and was bent in the form of an arch before carbonization. After being put in the lamp, the height of the arch, I should judge, was about an inch or an inch and an eighth. Within a day or two afterwards we cut loops out of paper of the form desired, the same as shown in my Exhibit Commercial Incandescent Electric Lamp, and the same as shown and described in my application in this interference.

204 X Q. Referring still to the first lamps like this exhibit, state, if you please, what resistance the carbon had in those lamps.

A. The resistance of a unit length and mass of paper carbon is generally the same, whether the lamp has one ohm or a thousand ohms' resistance. The resistance of the whole carbon probably was a hundred and twenty-five ohms cold, and perhaps 75 ohms
3103 at sixteen candles. Carbon decreases its resistance when
heated, but not in direct proportion to the rise of temperature. I do not think we measured the resistance of the carbon in the first lamp, but only judged it.

205 X Q. To what degree of perfection did you get the vacuum in the first lamps like this Exhibit Edison's Commercial Lamp?

A. My impression is that they were exhausted to the one-millionth of an atmosphere.

206 X Q. To what degree of luminosity did you raise the carbon?

A. I think we raised it as high as 30 or 40 candles.

207 X Q. How long did it last, raised up to that degree of luminosity?

A. We did not keep it for more than half an hour at that degree of luminosity. My impression is that at from 12 to 16 candles it lasted over a hundred hours.

208 X Q. Of continuous illumination?

A. Of continuous illumination, yes sir.

209 X Q. Referring now to this particular lamp, Edison's Exhibit Commercial Incandescent Lamp, you say in answer to Q. 33, exami-

nation-in-chief, that it burnt either 70 hours and 18 minutes, or 250 hours and 40 minutes. Can't you state any more definitely than that the time that the lamp did actually burn?

A. No, sir, I cannot. In my book, in which is recorded the life of 150 or more lamps, I find that the record of the life of this lamp is put down in ink as 251 hours and 41 minutes; but this has been partially scratched off, and 70 hours and 18 minutes substituted.

210 X Q. And you cannot tell which is the correct data, as I understand you?

A. No, sir.

211 X Q. Please to read from your record book all the memoranda and data you have in writing that refers to this particular lamp—Edison's Exhibit Commercial Incandescent Lamp.

A. I think I have other records of this lamp, and will
3104 try and find them. I read now from the book referred to, page 39:

"Street lamp top of stairs, right hand, 235.

Resist ——— January 2d, noon. Burnt. 40. January 3d, 19.30; Jan'y 4th, 9.58; Jan'y 5th, 20.50; Jan'y 5th, 3.47;

6, 20.26; 7, 12.15; 8, 22; 9, 9; 9, 6.50; 10, 19.15; 11, 7; 12, 11. Total time burnt, 70.18. Carbon bu-sted.

Total time burned, 207.36 up to 5 p. m.

251.41 up to noon."

A portion of the record is scratched out.

212 X Q. Please to permit me to examine the record from which you have read in answer to the last question.

(Witness hands the record to the counsel.)

213 X Q. Does this record show the resistance of the lamp?

A. No, sir.

214 X Q. Does it show the luminosity of the lamp?

A. No, sir.

215 X Q. Does it show the degree of vacuum in the illuminating chamber?

A. No, sir.

216 X Q. Does it show when the record was made?

A. It shows that it was January 2d, at noon, but does not state the year; but on page 38, one page before this record, lamp 153, a date, January 2d, 1880, is recorded, and I know that this was in 1880. Lamp 153 had a resistance of 132 ohms, and lasted over 200 hours.

Last part of answer objected to by counsel for Sawyer and Man as irresponsive and impertinent, as no inquiry is being made about the record of lamp 153.

217 X Q. Can you swear that this record you have quoted was made January 2d, 1880?

3105 A. I can swear it was made within four or five days of that date. I think I shall be able to produce a witness who made these records.

218 X Q. In whose handwriting is this record you have quoted?

A. In Mr. Batchelor's handwriting, and Mr. Herrick's, I think.

219 X Q. Which of it is in Mr. Charles Batchelor's handwriting and which of it is in Mr. Herrick's handwriting?

A. The words "Street lamp, top of stair, right hand. Resist. B*ru*nt 40," are in Mr. Charles Batchelor's handwriting, and all the rest is, I think, in Mr. Herrick's writing.

220 X Q. How does it happen that the date of the record is Jan. 2, noon, and the burning of the lamp appears to have commenced on January 3d, and continued down to January 12th, taking the whole of the dates into account, including those that are crossed out?

A. It could not have commenced on January 3d, because the record states that up to January 3d it had burned 19.30, which means 19 hours and 30 minutes from January 2d; it had also burned 40 hours before January 2d.

221 X Q. Apart from this record, have you any distinct recollection of the burning of this lamp?

A. I have an indistinct recollection. It would be a hard matter to recollect any particular lamp out of a hundred nearly all alike. Upon the lamp it is marked "Depot," and I remember it there. It was in a very conspicuous place and must have been seen by many thousand people.

222 X Q. You did not make this record yourself, as I understand you, and did not see it made?

A. I did not make it myself. I don't remember that I saw it made; but I remember that I watched these records pretty closely, and must have seen it within a day or so after it was made.

3106 223 X Q. How does it happen that the whole record was not made by one person?

A. I think because Mr. Batchelor started the record, and then got an assistant to carry it out more in detail. He will, doubtless, be able to testify on that subject.

224 X Q. Are you able to swear that the record was made as it appears here, all at one time, and that that time was during the performance of the lamp that is noted here?

A. I am able to swear that I believe it to have been made in the manner and on the dates set forth in the record.

225 A Q. Is part of the record in lead pencil and part of it in ink?

A. Yes, sir.

226 X Q. Please to state what part is in lead pencil?

A. Figures "235, street lamp, top of stairs, right hand. Resist. Burnt 40. January 2, noon, 70.18; and some cross pencil marks.

227 X Q. Please state what part of the record remains intact—that is, not crossed out?

A. "235, street lamp top of stairs, right hand. Resist. Burnt 40. January 3, 19.30; 4, 9.50; 5, 20.50. Total time burned: 70.18; January 2, noon."

228 X Q. Is the rest of the record crossed out with ink and lead pencil?

A. Yes, sir.

229 X Q. Who crossed it out, and when was it done?

A. I don't know who did it, or when it was done.

230 X Q. Now, this lamp, Edison's Exhibit Commercial Lamp, and those few that preceded it, about which you have testified this morning, embrace, as I understand you, your third attempt at electric lighting by incandescence, with carbonized paper?

A. I testified regarding a few, but there were more than a hundred made by the end of December, 1879, all of this character,
3107 with carbonized paper. These constitute my third attempt in connection with all that I have done since.

231 X Q. What I want to know, Mr. Edison, is whether this lamp and all the lamps that you made having the form and substance of this lamp, "Edison's Exhibit Commercial Incandescent Lamp," embraced your third attempt at electric lighting by incandescence, with carbonized paper?

A. In October we commenced making lamps of the same character as to form, with paper carbon, as shown in Exhibit Edison's Commercial Incandescent Lamp, and have continued to make them ever since. This is my third and successful attempt at lighting by the incandescence of carbon made from paper.

232 X Q. Do you mean to swear, now, that your first and second attempts at electric lighting by incandescence with carbonized paper, were successful?

A. The first attempt I did not consider successful, except that it showed that if carbon could be made to stand, that it could be made successful; and my second attempt was successful in the form shown in patent No. 224,329, but *in vacuo* it was not successful, except that it proved that carbon from paper or organic material, would be a success for lighting by incandescence, if it could be made to stand.

233 X Q. How long did you use the lamp of patent 224,329?

A. My impression is that we used it several days.

234 X Q. Have you got any memoranda in writing of its performance?

A. I do not think I have, that is dated.

235 X Q. Have you got any written record that you can swear represents the performance of this lamp?

A. I think among my records I may have something, but in hunting I neglect generally these records that have no dates.

236 X Q. How much of the time did you use this lamp with carbonized paper?

3108 A. I should say carbonized paper was used in it on and off several hours, burning. In this lamp we used both carbonized broom-corn and carbonized paper?

236½ X Q. Is the illuminating portion of this lamp intended to be inclosed in a glass chamber?

A. Yes, sir; partially of glass.

237 X Q. Between the time that you discontinued your experiments in electric lighting by incandescence with carbonized paper, in the fall of 1877, and the time you commenced to experiment again upon the same subject, in the fall of 1878, as you have testi-

fied, was you engaged any of the time in experimenting upon electric lighting by incandescence?

A. My impression is that I did try some experiments in electric lighting by incandescence, but I can find no record to refresh my memory.

238 X Q. If you have any distinct recollection of any experiments made within the period mentioned in my last question, please to describe them?

A. I only have an impression.

239 X Q. You can't describe any experiments.

A. No.

240 X Q. Now, between the time that you discontinued your experiments in incandescent electric lighting with carbonized paper, in the fall of 1878, and the time you commenced them again with carbonized paper, in the fall of 1879, did you make any experiments in electric lighting by incandescence?

A. Yes.

241 X Q. What substance or material did you use for the illuminating portion of your lamp in such experiments?

A. Platina and other materials.

242 X Q. How much of the time embraced within my question (240 X Q.) were you engaged in experimenting with platinum and material other than carbon?

A. Except perhaps some experiments with carbon in January, 1879, we were engaged night and day between the times named.

3109 243 X Q. During the period included in my X Q. 240, how many experiments did you make in incandescent electric lighting with carbon that was not made of paper?

A. I don't remember any experiment made with carbon that was not made with carbon paper or carbonized broom-corn.

244 X Q. What experiments did you make with carbon made of paper in January, 1879?

A. In some form of lamp anal*a*gous to that shown in patent 224,329.

245 X Q. Please to describe the lamp in which you employed carbon made *for* paper *from* incandescent lighting in January, 1879?

A. It was a lamp similar to Fig. 2 in the patent 224,329.

246 X Q. How did it differ from the lamp described in the patent mentioned in your last answer?

A. I think the carbon was shoved down by a spiral spring.

247 X Q. How much carbonized paper did you use in such lamp?

A. Perhaps a length of it; about two or three inches.

248 X Q. Can you produce that lamp?

A. No, sir; it is substantially the same kind of a lamp as that shown in Fig. 2, patent 224,329.

249 X Q. Was the carbonized paper used *in vacuo*?

A. No, sir.

250 X Q. What was your object in making this experiment with carbonized paper in January, 1879?

A. To make what we called a "shop lamp"—one in which the current only had to be subdivided in a shop and not over a large area, where high resistance was not absolutely essential.

251 X Q. Why did you use carbon made of paper in preference to carbon made of anything else in that lamp and for that experiment?

3110 A. Because it was easy to make and produced the proper kind of contact desired, and we had no means of making hard carbons with any degree of facility.

252 X Q. Was the paper specially carbonized for that experiment?

A. I cannot remember.

253 X Q. Was the experiment made in your presence?

A. I think I made it myself.

254 X Q. What was the result?

A. It worked fairly.

255 X Q. Why have you not mentioned this experiment in your previous testimony?

A. I forget why; perhaps because the question has not been asked me.

256 X Q. Did you make any other experiments between the fall of 1878 and the fall of 1879 with carbonized paper for incandescent electric lighting than those you have already testified about?

A. No; I think not with carbonized paper.

257 X Q. Have all of your attempts of electric lighting been by incandescence?

A. No, sir; not all, but most all.

258 X Q. Is it your conviction now that electric lighting by incandescence can be successfully accomplished with carbon made of paper *in vacuo?*

A. Yes, sir; it was successfully accomplished by me.

259 X Q. State, if you please, when it was that you first reached the conviction that electric lighting could be successfully accomplished by carbonized paper *in vacuo.*

A. In September or October, 1879; that it could be accomplished by the use of carbonized paper in high and stable *vacuo*, which were the proper conditions.

260 X Q. Did you, previous to September or October, 1879, make and use carbonized paper for electric lighting by incandescence *in vacuo*, successfully?

A. I have already testified on that point quite clearly. My answer will be the same as answer to X Q. 232.

3111 261 X Q. The answer to X Q. 232 does not answer my last question which is repeated.

A. My previous answer answers it perfectly.

262 X Q. What do you understand by the word "successful," in the relation that I used it in X Q. 260?

A. Several understandings have passed through my mind. Sometimes an experiment is a successful experiment when it don't work, if it proves positively or negatively, or shows possibilities. It may or may not be considered successful, and in my answer to X Q. 232

I have stated fully about the success and non-success of these experiments.

263 X Q. In cross-question 260 I did not ask you anything about experiments, but about successful lighting, and I now ask you again, when you first succeeded in lighting successfully by incandescence with carbonized paper *in vacuo?*

A. If you mean when I first succeeded successfully in lighting up a piece of carbonized paper *in vacuo* by electrical incandescence, I will state that it was done in Edison's Exhibit First Incandescent Lamp.

264 X Q. How long did you say you succeeded in illuminating that lamp with carbonized paper *in vacuo?*

A. Several minutes, but the vacuum was a poor one.

265 X Q. Well, how many minutes?

A. Perhaps ten minutes.

266 X Q. Do you consider an electric lamp that goes out in ten minutes successful lighting by electricity?

A. It is the successful lighting of the lamp for ten minutes by electricity.

267 X Q. Are you now making and using incandescent electric lamps in which you use carbonized paper for the illuminating portion of the lamp *in vacuo?*

A. Yes, sir.

268 X Q. How do the lamps you are now making and using differ from the Exhibit Edison's Commercial Incandescent Lamp?

3112 A. Differ only in shape.

269 X Q. How does the shape differ from the exhibit?

A. The carbon is in the form of an arch, but does not come together at the electrodes so near as in the exhibit.

270 X Q Is the glass chamber of the same form?

A. Some lamps are, and some are pear-shaped.

271 X Q. Is the carbon of the same dimensions that you have given of the carbon in the exhibit?

A. Pretty near the same, I think; I have none here for comparison.

272 X Q. How many of these lamps have you in use?

A. I cannot say; they have been sent all over the world. We have a stock on hand for use when other necessary appliances are ready.

273 X Q. State approximately how many you have sold or have in use?

A. We have sold three or four hundred.

The taking of further testimony was adjourned by consent to Friday, June 17th, 1881, at 10 o'clock, at same place.

WM. H. MEADOWCROFT,
Notary Public, N. Y. Co.

Pursuant to adjournment, the examination was resumed June 17th, 1881, at 10 a. m., at No. 65 Fifth avenue, same counsel being present.

Counsel for Edison produces record book containing the copy of

Edison's Exhibits Nos. 4 and 5, and submits it to the inspection of counsel for Sawyer and Man.

3113 274 X Q. Referring now to your Record Book No. 67, pages 1 to 15, inclusive, of which Exhibit No. 3 is an alleged copy, please to state whether this record was kept by you personally.

A. No, sir; it was not.

275 X Q. Please to state by whom it was kept.

A. Partially by Charles Batchelor, and partially by a man named Herrick, I think.

276 X Q. Was it kept by those persons in your presence?

A. I was present; I should say almost all the time in the room with the parties when this record was made.

277 X Q. In whose handwriting is the record?

A. Partially in Batchelor's, partially in Herrick's, I think, and some of my writing is on it.

278 X Q. Were the entries made in that record by the different persons mentioned all made at the same time?

A. About January 1st, 1880, it was decided to keep the burning time of the lamps manufactured, and this record was the starting point of the time, and was started in a systematic manner by Mr. Batchelor, I believe, on January 2d, 1880, and he, I believe, put down on January 2d the numbers of the lamps, their position, and the time they had burned previous to January 2d; and thereafter the exact burning hours were kept by him and Mr. Herrick, and the entries, I believe, were made the day after the date on the entries.

279 X Q. These lamps to which the record refers, when were they made?

A. Some time in December, 1879.

280 X Q. Is a portion of this original record in lead pencil?

A. Yes; a very small portion.

281 X Q. By whom was that portion of it made?

A. One portion by myself, and the other portion by Charles Batchelor.

3114 282 X Q. When did Mr. Batchelor make his entries in lead pencil, and when did you make yours?

A. I made mine January 5th, 1880. Mr. Batchelor has dated his entry January 2d, 1880, 8 p. m. I believe that I know that he made that entry at that time.

283 X Q. Are the figures in ink that note the day of the month, the number of hours and minutes the respective lamps burned, in the handwriting of Mr. Herrick?

A. I think a part of them are in Mr. Batchelor's handwriting, and part in the writing of Mr. Herrick.

284 X Q. And these figures were made, you think, either on the day of the date or the day after?

A. Yes, sir; I think they were.

275 X Q. Do you know that of your own knowledge?

A. Yes, sir; I am almost certain.

286 X Q. When did you get the vacuum pump illustrated by Edison Exhibit No. 6?

A. That particular shape of vacuum pump was made some time in September, 1879.

287 X Q. Previous to getting that pump, did you succeed in getting a satisfactory vacuum in your lamps? I mean a vacuum in which your carbon burners would endure incandescent for any reasonable length of time?

A. Yes, sir.

288 X Q. When did you first succeed in getting such a vacuum?

A. I think it was in August, 1879, that we had a pump that would produce a vacuum up to perhaps the hundred-thousandth part of an atmosphere.

289 X Q. Was that the first you obtained the necessary vacuum in your lamp?

A. My impression is that that was the first pump by which a partially satisfactory vaccuum was obtained.

290 X Q. Referring now to Edison Exhibit No. 2, being the New
York Herald, or part of it, dated December 21st, 1879, state,
3115 if you please, whether you wrote or caused to be written the
article headed "Edison's light," on page five, and to be illus-
trated as there illustrated?

A. No, sir: I did not write it, nor did I cause it to be written.

291 X Q. Did you revise or examine it after it was written, and approve of it?

A. No, sir; I did not.

292 X Q. Are the statements true?

A. Some are, and some are not. The article seems mostly to be made up from my patents, into which a great deal of romance has been injected.

293 X Q. Are the illustrations true illustrations of the lamp referred to in the article?

A. Not strictly true. Most of them have been taken from the patents. Two I recognize as having been taken from the Scientific American.

295 X Q. Which of the illustrations are correct, and which erroneous? Please mark the figures.

A. The figures are substantially correct as illustrations. Figures eight and nine are copied from the Scientific American's articles. Figures 1, 2, 3, 4, 5 and 6 seem to be taken from patents or caveats. Figure 7, I do not know how that was obtained. It is substantially correct, but not correct in detail.

296 X Q. State, if you know, who is the author of the article.

A. I believe a reporter of the New York Herald, named Edwin Fox, was the author.

297 X Q. What part of the article is true, and what part romance?

A. That which is descriptive of the apparatus is substantially correct. The rest is an ingenious weaving in of the experiments and talk at the laboratory, and imagination of the reporter, into a separate article, in a proper form to appeal to the imagination.

298 X Q. Within a few days after the publication of that article, do you recollect of telling any one, that it was true every word of it, or something to that effect?

3116 A. No, sir; I don't recollect of telling any one that it was true every word of it. I might have been asked by a number of people if that Herald article was correct, and might have replied that it was correct, meaning that the results I had attained had been attained.

299 X Q. What degree of vacuum is it necessary to maintain in the chamber of your lamp to make the carbon endure in a state of incandescence for one hour, so as to produce a luminosity equal to 15 candles?

A. Never having tried that exact experiment I cannot state.

300 X Q. What degree of vacuum would be necessary to be maintained to ensure the endurance of the carbon in a state of incandescence equal to a luminosity of 15 candles for two hours?

A. Never having tried that exact experiment I cannot say.

301 X Q. Same question, during a period of three hours, or four hours, or five hours, or any number of hours of which you have actual knowledge, as to the endurance of the carbon illuminated to the degree of incandescence mentioned in my question No. 299?

A. I cannot give exact results, but my impression is from noticing lamps having poor vacuums, and lamps on the pump where there was a g*ua*ge, that generally the carbon would not last at that incandescence more than four or five hours when the barometrical mercury column showed a vacuum of only about a millimeter. This has reference to my lamp, when it is to be worked in vacuum.

302 X Q. Does the invention described in your application for a patent in this interference include a vacuum in the illuminating chamber of the lamp?

Question is objected to upon the ground that as the application itself is in testimony, it is the best evidence.

A. The application itself is the best evidence of that.

3117 302 X Q. What does the application say upon the subject?

Same objection as before.

A. Being in evidence it can be referred to, to ascertain what it says.

304 X Q. I have no complete copy of the application, nor has any been put in evidence; please to read from the specification, if you have one, what is said upon that subject.

Question objected to for the reason that the application by the rules of the Patent Office is a part of the record testimony, and counsel for Sawyer and Man is entitled to a copy at any time by asking for it at the Patent Office and paying for it.

Counsel for Sawyer and Man states that counsel for Mr. Edison prompts the witness by putting a copy of the specification in his hands and telling the witness to say that he would very cheerfully read the specification if he had a copy of it, but does not know whether his copy is a correct copy, his copy being the retained papers or roughs of the specification, in which many alterations seem to have been made.

A. I have no specification which I am sure is a correct one.

304 X Q. Do you know whether the carbonized-paper burner, making the subject-matter of this interference, is intended to be illuminated in vacuum?

A. That is one of the intentions according to my recollection.

306 X Q. Do you know whether the carbonized burner making the subject-matter of this interference is intended to be illuminated in a glass chamber from whence the air has been exhausted, and an inert gas substituted in the chamber? 3118

A. It was intended mainly to be worked in vacuum but I also intended and did try some of these paper-carbon loops in a sealed glass receiver containing an inert gas, or intended to be inert.

307 X Q. How long did the paper-carbon loops, tried in inert gas, endure when they were illuminated?

Question objected to as not being proper cross-examination.

A. I do not remember.

308 X Q. State as nearly as you recollect?

A. The ones I saw, I think, lasted five minutes; and perhaps, one of them lasted an hour, or even two hours.

309 X Q. Did you make the experiments yourself?

A. No, sir.

310 X Q. Who made them?

A. I think one of the parties was named Francis Jehl.

311 X Q. Where were they made?

A. At my laboratory at Menlo Park?

312 X Q. When were they made?

A. My impression is they were made either in December, 1879, or January, 1880.

313 X Q. What gas was used in the chamber?

A. I did not analyze it.

314 X Q. Don't you know?

A. I know what we intended to use.

315 X Q. What did you intend to use?

A. Hydrocarbon gas, hydrogen gas, nitrogen gas, hydrochloric acid gas and chlorine gas, I think.

316 X Q. How many experiments did you make?

A. I saw two or three.

317 X Q. What kind of gas was the chambers filled with in the experiments that you saw?

A. I didn't analyze it.

318 X Q. Don't you know?

3119 A. I would not absolutely know without analyzing it.

319 X Q. Do you know that was intended to be used?

A. I have already testified that gases were intended to be used, but cannot be certain as to which gas was used in the experiments I saw.

320 X Q. Do you know whether any of these gases were used in a state of purity in charging the illuminating chamber of the lamp?

A. I don't know that they were pure.

321 X Q. Do you know at what pressure the gas was put in the chambers of the lamps?

A. My impression is at atmos-heric pressure.

322 X Q. Have you made or caused to be made any other experiments in illuminating by incandescence with paper carbon in a sealed lamp filled with inert gas, than those you have referred to in the immediate preceding answers?

A. Yes, sir; I have made them with a gas which is supposed to be inert.

323 X Q. When were these other experiments made?

A. While not intended, the lamp Exhibit Edison's First Incandescent Lamp did have a gas in it formed by the decomposition of the grease used in the lamps at the joints, as I have already stated in my evidence, and at times, since January, 1880, lamps have been made in which simple and compound gases have been used, experimentally, to determine theoretical points. I have also used in the early part of 1879, perhaps in December, 1878, gases, especially hydrogen, in a lamp giving light by incandescence, but in this case platinum was used.

424 X Q. Does electric lighting by incandescence with carbon in sealed lamps charged with inert gas, make any part of the invention described in your application for a patent in this interference, or intended to be described in that application, or does it make any part of your system of electric lighting by incandescence?

3120 Counsel for Mr. Edison objects to all that portion of the question which relates to the specification, on the ground that the specification itself is the best evidence.

A. The specification itself will be the best answer that I can give to the question, and I do not desire to state what I intend or what I do not intend to use in my system of electric lighting.

325 X Q. Has electric lighting by incandescence with carbon in sealed lamps charged with inert gas, heretofore made any part of your system of electric lighting by incandescence?

A. I have already testified that I have tried the same and as I had a system of electric lighting at Menlo Park at the time, these formed a part of the system at that time.

326 X Q. Do you mean to swear that you have used at Menlo Park a system of electric lighting by incandescence, in which carbon was used as the illuminating portion of the lamp, in an atmosphere of inert gas in a sealed lamp?

A. Yes, sir; such lamp formed part of a system of lighting by incandescence of carbon at Menlo Park.

327 X Q. When?

A. In December, 1879, or in January, 1880, I think.

328 X Q. What kind of carbon did you use?

A. Carbon made out of paper.

329 X Q. How long did you use that system?

A. The system is still there.

330 X Q. How many lamps did you use of the kind I have described in my question No. 326?

A. We have used on that system at Menlo Park, I should say, as many as thirty lamps, but as to the inertness of the gas on the carbon, I am not sure as any gas whatsoever has an effect on the carbon.

331 X Q. How many sealed lamps have you used that were charged with gas that was intended to be inert, and the illuminating part of which was made of carbonized paper?

A. I have already testified that no gas is inert, and there-
3121 fore I could have made no lamps in which it was inert.

332 X Q. Question repeated.

A. No lamps that were inert because I knew that no gas could be used that was inert, all gases having effect on the carbon.

Answer objected to as irresponsive.

333 X Q. Question repeated.

A. I have already testified to that question.

334 X Q. How many sealed lamps have you used that was charged with gas commonly called inert, and the illuminating part of which was made of carbonized paper?

A. My impression is that a half a dozen were made.

335 X Q. How long did you continue to use them?

A. I did not see more than two or three, and those didn't last more than from fifteen minutes to an hour.

336 X Q. State, if you please, whether the Exhibit Edison's First Incandescent Lamp is the apparatus referred to in answer 9 of your examination-in-chief.

A. Yes, sir.

337 X Q. What experiments have you made in treating carbons for electric lighting, made of paper, electrically in a hydrocarbon gas?

A. The experiment with the first incandescene lamp might be considered an experiment with a hydrocarbon gas; I have tried other experiments in treating paper with an atmosphere of hydrocarbon gas since that time.

338 X Q. Please to relate what experience you have had in treating carbon electrically in a hydrocarbon gas, for the purpose of enlarging or purifying the carbon, or consolidating it?

Question objected to as a cross-examination upon matters not involved in this interference, and involved in another interference to which Sawyer and Man are not parties.

3122 Counsel for Sawyer — Man says that the witness in his examination-in-chief has expressed opinions about the utility and practicability of treating carbons in that way, and that the question is pertinent to matters testified to by the witness in his examination-in-chief.

A. I have brought up to incandescence a carbon within a lamp containing a hydrocarbon; I have *node* it in a great number of lamps, a hundred or more; I have tested the economy, the conductivity and other properties of the carbon, and have examined the same many times under a powerful microscope.

339 X Q. When did you make the experiments?

A. They were made previous to the declaration of this interference; a hydrocarbon gas was used, I think, in December, 1879 and '80, but not for the purpose set forth in your question.

The taking of further testimony was adjourned by consent to Saturday, June 18, 1881, at 10 o'clock, at same place.

WM. H. MEADOWCROFT,
Notary Public, N. Y. Co.

Pursuant to adjournment, this examination was continued June 18, 1881, at 65 Fifth avenue, New York, same counsel being present.

340 X Q. Have you had any experience in treating carbon for illuminating purposes in electric lamps, electrically in the presence of hydrocarbon gas or fluid, previous to putting them in the sealed illuminating chamber of the lamp?

Question objected to as improper cross-examination, no inquiry having been made about the same in the examination-in-chief.

3123 A. Yes, sir.

341 X Q. Please to relate what experience you have had in treating carbons in that way, and give the dates of your experiments.

A. I have no memorandum with me which would refresh my memory as to the dates, but it was previous to the declaration of this interference that I tried experiments of heating to incandescence a carbon conductor in a hydrocarbon gas within a fluid, and also heating a carbon conductor to incandescence by an electric current in a gas within a chamber not sealed.

342 X Q. How many carbon burners have you treated in that way?

A. I should say twenty or thirty.

343 X Q. When did you do it? State as nearly as you can recollect.

A. Some time between March and September, 1880.

344 X Q. Is that as near as you can give the date?

A. Yes, sir, as I have no memoranda here, not thinking that this question would come up.

345 X Q. Please to describe your method of treating these carbons in hydrocarbon gas electrically, including the apparatus you used in your experiments.

Same objection as before was repeated.

A. As the details of the mechanism which I used is the subject-matter of another interference, I refuse to answer.

Counsel for Sawyer and Man insists upon a responsive answer to this question, and gives notice that unless the witness answer the question he will move to strike out the deposition.

346 X Q. Question repeated.

A. I have already described them sufficiently. I stated that the carbon was brought to incandescence by electricity when within a gas within a liquid, and also when within a gas within a chamber not sealed.

3124 347 X Q. What kind of a chamber was it, and how was the carbon conductor arranged in the chamber, and what kind of hydrocarbon fluid and gas did you use?

A. It was a glass chamber, the carbon was within the chamber arranged so that the electricity would pass through it, and gasoline was used.

348 X Q. How did the treatment affect the carbon treated?

A. It brought its resistance down and deposited a crust of hard carbon over its surface which under the microscope showed a multitude of projecting points which were found to be hollow when broken.

349 X Q. Of what material was the carbon made that you treated?

A. Both paper and bamboo.

350 X Q. After you had treated the carbon did you put it in the sealed chamber of an electric lamp and raise it to incandescence, and if so, with what result?

A. Yes, sir; some of them we did. The result was that it was lower resistance and seemed to be more susceptible to destruction by electrical carrying than the untreated carbons.

351 X Q. To what degree of luminosity did you raise it?

A. Varying degrees of luminosity.

352 X Q. Please to name them.

A. I think as high as a hundred candles.

353 X Q. How long did the carbon burner last raised to the luminosity of a hundred candles?

A. My impression is that it lasted about two hours. It was a very fine filament.

354 X Q. Please to give its dimensions.

A. I cannot give its dimensions. We had carbons of various dimensions. These were tried on very fine filaments. It was a thinner one than that shown in the Exhibit "Edison's Commercial Incandescent Electric Lamp." It was a little longer. I should say it was a quarter of an inch longer. I am referring to
3125 the one that lasted two hours yielding a hundred candle power.

355 X Q. Was it in vacuum?

A. Yes, in very high vacuum.

356 X Q. Does the successful use of the lamp described and illustrated in the application for the patent involved in this interference necessitate a high vacuum in the illuminating chamber?

A. In a commercial sense it is my opinion, which results from my experiments, that it is essential to have a high vacuum in the lamp chamber, for the reasons I have heretofore stated.

357 X Q. Are you now manufacturing incandescent electric lamps substantially like that described and illustrated in the application for the patent involved in this interference, commercially?

A. The electric lamp company, with which I am connected, are manufacturing lamps of this kind and selling them to electric light companies.

358 X Q. What company do you refer to as that with which you are connected, that is manufacturing these lamps commercially?

A. The Edison Electric Light Company.

359 X Q. What proportion of the lamps so manufactured by the Edison Electric Light Company are fitted with carbon burners made of paper?

A. From one and a half to two per cent., I should say. I have not looked over their books lately. I know that a man is now engaged, and has been at different times in the last three months, in making paper carbons for use at the lamp factory.

360 X Q. Are the carbon burners with which these lamps are fitted made upon the plan described in the application for the patent involved in this interference?

A. Yes.

361 X Q. Please to give the dimensions of these carbon burners.

3126 A. I should say they were about an eighth of an inch, perhaps a quarter of an inch, shorter than the one shown in the Exhibit Edison's Commercial Incandescent Lamp.

362 X Q. How does it compare in diameter to the burner referred to in your last answer?

A. I should judge that it was a shade wider, but have no idea as to how thick it is.

363 X Q. What, no idea as to how thick it is?

A. If it was a foot thick, I think I should probably have an idea; but as these filaments are always made out of thin paper, I cannot state whether it is thicker or thinner than the one in Edison's commercial incandescent lamp.

364 X Q. Please to give, as nearly as you can, the dimensions of the carbon burner in Edison's commercial incandescent electric lamp.

A. I guess it is about an inch and a quarter from the top of the clamps to the top of the loop; about seven-eight-s of an inch from one side of the loop to the other. I should judge that the width was twenty-thousandths of an inch, and five-thousandths of an inch thick.

365 X Q. To what degree of luminosity are these lamps which you say the Edison Lamp Company are manufacturing commercially, fitted with carbonized-paper burners, brought or intended to be brought in practical use?

A. Sixteen candles, I believe.

366 X Q. How do you measure the candle power of a burner?

A. With a photometer.

367 X Q. What photometer do you use to measure your candle power?

A. The Bunsen spot photometer.

368 X Q. Referring again to the Exhibit Edison's Commercial Incandescent Electric Lamp, please to state, as near as you can, what

its luminosity was during the time of its burning, as noted
3127 in the record about which you have heretofore testified, and
of which you have given a transcript of, page 39.

A. My impression is that the average candle power would be about from twelve to sixteen candles.

369 X Q. You say that about one or one and a half per cent. of the lamps that are manufactured by the Edison Electric Lamp Company are fitted with carbonized-paper burners. Please to state what is the whole number of lamps manufactured by that company per day.

A. About a thousand per day.

370 X Q. Have you ever made any carbons from several thicknesses of blotting paper, pressed together under a hydraulic press?

A. I have made carbons of several thicknesses of blotting paper pressed together under a screw-press, but not under a hydraulic press.

371 X Q. Where is the Edison Electric Lamp Company situated—I mean its factory?

A. At Menlo Park and at Newark.

372 X Q. Does that company sell lamps to any one who may wish to purchase them?

A. Yes, in foreign countries and in this country, by the permission of another company—the Edison Electric Light Company.

373 X Q. Does that company treat the carbon burners of their lamps electrically in the presence of hydrocarbon gas before they use them for illumination—I mean the Edison Electric Lamp Company?

A. Not lately.

Cross-examination ended.

Counsel for Edison, in pursuance with the notice given at the close of his examination-in-chief, puts in evidence letters patent of Thomas A. Edison, No. 224,329, dated Feb. 10, 1880; 227,227, dated May 4, 1880; 227,228, dated May 4, 1880; 227,229, dated May 4, 1880;
223,898, dated January 27, 1880; also specification of English
3128 patent of Thomas A. Edison, No. 2402, June 17, 1879, also
letters patent 205,144 of Sawyer and Man, dated June 18, 1878; 210,152 of Sawyer and Man, dated November 19, 1878; 210,809, of Sawyer and Man, dated December 10, 1878; 219,771 of Wm. E. Sawyer, dated September 16, 1879; 211,262 of Sawyer and Man, dated January 7, 1879; 229,335 of Sawyer and Man, dated June 29, 1880; 227,118 of Albon Man, dated May 4, 1880.

It is stipulated between counsel for Edison and Sawyer and Man, that the Government-printed copies of these patents may be read in evidence with the same force and effect as if they were certified copies put in evidence and marked as exhibits in the case, counsel for Edison agreeing to furnish counsel for Sawyer and Man, with at least three of each of such printed copies; and it is further stipulated that the said Government-printed copies of all the patents — put in and referred to as evidence on behalf of Sawyer and Man, with like effect, counsel for Sawyer and Man agreeing to furnish counsel for Edison, with at least three of such printed copies. Said patents to be subject to all legal objections, nevertheless, that might be taken or urged against them if they were regularly put in evidence as exhibits; and counsel for Sawyer and Man objects to the above-mentioned patents as evidence in this case, on the ground that they are not pertinent or relevant or competent as evidence upon any issue in this controversy, and request counsel for Edison to state upon the record how such patents are competent, relevant, or material upon any issue in this controversy.

3129 Counsel for Edison replies that when the matter comes up for hearing an attempt will be made to show that such evidence is material.

Re-examination of the witness by GEORGE W. DYER, of counsel for Edison:

371 Q. Referring to your answers on cross-examination, as to your experience in making and using carbons of paper in 1876 and 1877, did anything remain to be done by you prior to 1878, to determine the qualities essential in the paper carbon for an incandescent conductor for an electric lamp?

Question is objected to upon the ground that it does not appear by any of the witness' answers on cross-examination that he made any carbons of paper in 1876 and 1877, for electric lamps, nor does it appear from anything the witness has said, either upon his examination-in-chief or his cross-examination, that he successfully used carbonized paper for electric lighting by incandescence previous to the fall of 1879, and upon the further ground that all of the witness' testimony intended to prove or going to prove that he made the invention, or any part of it, previous to the date alleged in his preliminary statement, is inadmissable under the rules of the Patent Office and its well-established practice; and upon the further ground that the question is intended to bring out matter upon which the witness was previously examined in chief, and not upon anything new brought out in cross-examination.

A. No, sir.

3130 & 3131 372 Q. Referring now to your answers upon cross-examination, when did you first determine the sufficiency of carbonized paper, *per se*, for an incandescent conductor for an electric lamp?

Question objected to because it is indefinite as not referring to any particular answer to any question on cross-examination; and upon the further ground that the question is not when he first determined the sufficiency of the carbonized-paper burner, but when he first proved its sufficiency by actual use; and upon the further ground that the question refers to experiments made before the time given in the preliminary statement.

A. I knew from my experiments in 1876 and 1877, where I employed carbonized paper and other carbonized organic substances for resistances, that carbon in that state of aggregation had high resistance as compared to hard or coke carbon, and was the proper form to use for incandescent conductors for electric lamps, if they were to be worked in multiple arc, and the experiment with the strip of carbon in the open air, and in the Exhibit Edison's First Incandescent Electric Lamp, used in 1877, also showed its adaptability and sufficiency for multiple-arc lighting.

373 Q. In 1877, did you require any further information or experiments to determine the sufficiency of incandescent conductors for electric lamps made with carbonized paper?

Question objected to as referring to a date previous to the date of the preliminary statement, and also as not bearing upon the question of when witness did make the invention in the interference by its actual and successful use, and on the further ground that the witness has already been examined in chief on that very point.

A. No, sir.

3132 374 Q. Referring again to your answer upon cross-examination, wherein you stated that since your experiments in electric lights had been resumed in 1878, you had been working upon the same day and night, please give in a general way the nature of your labors in electric lights up to 1880, and the assistants employed by you and the general nature of their duties.

A. In the fall of 1877, having about finished my labors with my carbon telephone, I had several ideas which I desired to work up, one of them being the subdivision of the electric light, hence, I commenced experimenting for that purpose, as my testimony and exhibits show. These experiments continued, I think, until January, 1878, when my time and attention was absorbed by the excitement caused by the invention and exhibition of the phonograph. This continued until July, when my health being broken down by several years of continuous labor, I went to California and other places West, spending about two months. On my return, in August, 1878, I immediately took up the experiments made in 1877, but interrupted by the phonograph and the state of my health, and have continued them night and day ever since. About December, 1878, I engaged a mathematician named Mr. Upton, to assist me in working out the complicated problems as to economy and adaptability of the various devices necessary to make a complete system of electric light by incandescence, which would be capable of replacing or competing with gas, over large areas, such a system comprising main conductors, house conductors, lamps of various characters, meters, dynamos, electro-motors of various kinds and characters, apparatus for regulating the pressure of the flow of electricity through such system, arrangement of the system of conductors for equal distribution of the electricity, safety devices, boilers, steam-engines, electro-meters, photometers and other appliances. I had other assistants, among whom may be mentioned Francis Jehl, John Kruesi, Charles Clarke, Charles Batchelor, William Hammer, Mr. Herrick, Dr. Haid, Mr. Lawson, Martin Force, Dr. Moses,
3133 E. H. Johnson and many others who were employed in 1878

and 1879. Possibly Clarke and Hammer may have started work in the early part of 1880.

Answer objected to, as to all work and experiments made before the date given in the preliminary statement, in so far as such relates to the issue in controversy.

Postponed until Monday, June 27th, 1881, at 10 a. m., at 65 Fifth avenue, N. Y , by consent.

WM. H. MEADOWCROFT,
Notary Public, N. Y. Co.

3134

Edison Exhibit No. 3.

(Book No. 67. Pages 1 to 15, inclusive.)

Record of Lamps.

No. 142. Resistance, 150 ohms. } 1880. Jan. 2.
Has burnt at least 200 hours. } 12 noon.

This lamp is hung on the two main wires over the pumps.

Jan'y 5, measured resistance; no change.

Hours.		
200.00.	Jan. 2.	
19.30.	3.	
9.58.	4.	
20.50.	5.	
3.47.	5.	
20.26.	6.	
12.15.	7.	
22.00.	8.	
9.00.	9.	Till 5 o'clock.
360.00.		

Jan. 9.	6.50.	
Jan. 10.	19.15.	
Jan. 11.	7.00.	
Jan. 12.	11.00.	Total, 404.05, up to noon.

Bu-sted Jan. 13, 2 a. m.

3135 No. 159. Hung on leading, over pumps:

Resist., 153 ohms. } Jan. 2, 1880,
Has burnt 200 hours. } noon.

Jan'y 5, measured resistance; no change.

	Hours.
Jan. 2.	200.00.
3.	19.30.
4.	9.58.
5.	20.50.
5.	3.47.

Jan. 6. 20.26.
7. 12.15.
8. 22.00.
9. 9.00. Total time, 360.12. Jan. 9, 5 p. m.
Jan. 8. Resistance same.
9. 6.50.
10. 19.15.
11. 7.00.
12. 11.00. Total, 404 05 up to 12 o'clock.
12. 9.30.
13. 11.00. " 424.35 " 12 "
13. 11.30.
14. 22.30.
15. 11.30. " 480.30 " 12 "

3136 No. 189. Chandelier in top room nearest pumps:

Resist., 149.
Has run 13 hours. } Jan. 2, 1880, noon.

Hours.
Jan. 2. 13.00.
3. 19.30.
4. 9.58.
5. 20.50.
5. 3.47.
6. 20.26.
7. 12.15.
8. 22.00.
9. 9.00. Total time burned 173.12 at 5 o'clock p. m.
9. 6.50.
10. 19.15.
11. 7.00.
12. 11.00. Total time burned 217.17 up to noon.

Busted at 8.30.

3137 No 275. Second chandelier, top room:

Resist, 142. } Jan. 2, 18*00*.
Has run 13 hours. } 12 noon.
Has run since 8.21, total running.

Broke by vibration in taking off, and on ¼ in. above center (Edison saw this Jan. 2, 1880, 8 p. m.) Edison says not quite sure about this.

No. 255. Second chandelier, top room:

Resist., 200. } Jan. 2, 1880.
Has run 13 hours. } 12 noon.
Jan. 3. 19.30.
4. 9.58.
5. 20.50.
5. 3.47.
6. 20.26.

Jan. 7. 12.15.
8. 22.00.
9. 9.00. Total time burned 173.12 at 5.00 p. m.
9. 6.50.
10. 19.15.
11. 7.00.
12. 11.00. “ “ “ 217.17 up to 12 o'c'k.
12. 9.30.
13. 11.00. “ “ “ 237.47 “ “ “
13. 11.30.
14. 22.30.
15. 11.30. “ “ “ 294.17 “ “ “
Bu-sted

3138 223. Third chandelier, top room :

Resist., 140. } Jan. 2, 1880,
Burnt 13 hours. } noon.
Jan. 3. 19.30.
4. 9.58.
5. 20.50.
5. 3.47.
6. 20.26.
7. 12.15.
8. 22.00.
9. 9.00. Total time burned 143.12 at 5.00 p. m.
9. 6.50.
10. 19.15.
11. 7.00.
12. 11.00. “ “ “ 187.17 up to noon.
12. 9.30.
13. 11.00. “ “ “ 207.47 “ “ “
13. 11.30.
14. 22.30.
15. 11.30. “ “ “ 262.17 “ “ “.
Bu-sted.
Bu-sted.

3139 193. Chandelier, near organ :

Resist., 154. } Jan. 2, 1880,
Burnt 13 hours. } noon.
Jan. 3. 19.30.
4. 9.58.
5. 20.50.
5. 3.47.

Taken out on Jan. 9, 1880, to put in street lamps replaced by 376 experiment.

162. Chandelier, near organ :

Resist., 147. } Jan. 2, 1880,
Burnt 13 hours. } noon.
Jan. 3. 19.30.

Jan. 4. 9.58.
5. 20.50.
5. 3.47.

Taken out on Jan. 9, 1880, replaced by 375 experiment bent on end of tip taken to Cornishes, where it burnt 102.00 total. Brought up for diver light.

3140 167. Third chandelier, top room, north side:

Resist., 136. } Jan. 2, 1880,
Burnt 13 hours. } noon.

Saw this burst at 3 p. m., Jan. 2. Inside glass broke. Total length of burning, 15 hours.

204. Flammer's bench:

Resist., —. } Jan. 2, 1880.
Burning 13 hours. } noon.

January 2, 1880. taken out by Edison and 5 p. r. given Upton to make test for rupture.

Total burning, 16 hours.

203. Flammer's bench:

142 resist. } Jan. 2, 1880,
Burnt 5½ hours. } noon.

After burning a total of 17½ hours it broke.

3141 155. Over Carman's desk, office:

Resist., 126 ohms. } Jan. 2, 1880,
Burnt 50 hours. } noon.
Jan. 3. 19.30.
4. 9.58.
5. 20.50.
5. 3.47.
6. 20.26.
7. 12.15.
8. 22.00.
9. 9.00. Total time burned, 160 hours up to 5.00.
9. 6.50.
10. 19.15.
11. 7.00.
12. 11.00. " " " 204.05 up to noon.
12. 9.30.
13. 11.30. " " " 224.35 " " "
13. 11.30.
14. 22.30.
15. 11.30. " " " 280.05 " " "

3142 201. Over Carman's desk, office:

Resist., 147. } Jan. 2, 1880,
Burnt 50 hours. } noon.
Jan. 3. 19.30.
4. 9.58.

Jan. 5.	20.50.	
5.	3.47.	
6.	20.26.	
7.	12.15.	
8.	22.00.	
9.	9.00.	Total time burned, 160 h'rs up to 5 p. m.
9.	6.00.	
10.	19.15.	
11.	7.00.	
12.	11.00.	" " " 204.05 up to noon.
12.	9.30.	
13.	11.00.	" " " 224.30 " "
13.	11.30.	
14.	22.30.	
15.	11.30.	" " " 280.00 " "

3143 164. Office chandelier near door:

Resist., 182.
Burnt 50 hours. } Jan. 2, 1880, noon.

Jan. 3.	19.30.	
4.	9.50.	
5.	20.50.	
5.	3.47.	
6.	20.26.	
7.	12.15.	
8.	22.00.	
9.	9.00.	Total time burned, 160 h'rs up to 5 p. m.
9.	6.50.	
10.	19.15.	
11.	7.00.	
12.	20.00.	" " " 224.05 up to noon.
13.	22.30.	
14.	22.30.	" " " 234.05 " "
15.	11.30.	" " " Correct total. 322.13 " "

3144 172. Chandelier over Griff's desk:

Resist., 135.
Burnt 50 hours. } Jan. 2, 1880, noon.

Jan. 3.	19.30.	
4.	9.50.	
5.	20.50.	
5.	3.47.	
6.	20.26.	
7.	12.15.	
8.	22.00.	
9.	9 00.	Total time burned, 160 h'rs up to 5 p. m.
9.	6.50.	
10.	19.15.	
11.	7.00.	

Jan. 12.	11.00.	Total time burned, 204.15 up to noon.
12.	11.30.	
13.	22.30.	
14.	11.30.	" " " 259.45 " "

3145 Edison's Exhibit No. 7.

Extract from Records of Experiments, Book No. 85.

"All pumps give a great deal of trouble at F where a contraction is made so that the air in G may be forced out from H.

B. This stop-cock placed too far from the main reservoir so that the tube near it caught air. This could be worked out by letting the Hg work up and down. The MacLleod should not be used until a high vacuum has been attained. For if this has not been done the Hg sticks in the side tube. Last evening a vacuum was obtained so that the spark jumped five inches outside of the tube rather than across ¼ inch in vacuum. The changes in vacuum were extremely rapid from green to preventing a small spark in a few seconds and then in a few minutes to stopping the large spark. The finely divided copper and sulphuric acid may have had a strong influence on this F, the tube contracted here so that a pressure can be obtained in G to drive the air out through the stopcock H.

The enlargement of the tubes at L and L^1 is a mistake, as a bubble of air collects here and is drawn up into the pump. Making stop-cock D with tube to left inclined upwards may be a mistake, as the Hg collects above the cock and stops the Geissler. Pure black rubber tube placed inside of white rubber to prevent soiling Hg.

3146 Edison's Exhibit No. 8.

(New York Sun, December 22d, 1879.)

Electrician Sawyer's Challenge to Electrician Edison.

If a party possesses an interest in something that he considers valuable, he is not very likely to part with it, especially if it be something in the line of electric lighting, where what may nominally be $1 may really be $1,000. Therefore, when Mr. Edison sells out all his interest in his electric light there is a reasonable chance for a suspicion that he considers his invention worth very little.

Mr. Edison's reputation before the public is founded upon the newspaper publications about: 1. The quadruplex telegraph; 2. The telephone; and 3. The phonograph.

As to the quadruple telegraph, I may say that it was an adaptation of the French and German systems. When Mr. Edison took hold of the 4-plex, there were already known five systems of 2-plex, three of 4-plex, and three of 6-plex and 8-plex.

The 4-plex of Edison was a failure. A modest young gentleman, assistant electrician of the Western Union Telegraph Company, whom I have not seen for several years (Mr. Gerritt Smith), made it a success, and some day he will get the credit for this invention; for he, and not Edison, is the genius in this case.

As to the telephone, Mr. Edison is not the inventor. Andrew Graham Bell is the inventor of the telephone.

As to the phonograph, which really made Mr. Edison's reputation, it is of no earthly value, and the manufacture by Bergman has practically been dropped. The real inventor of the phonograph will never be known, in all probability, for I understand that Mr. Edison anticipates a Western man but three days in priority of invention.

3147 Now, all that remains for Mr. Edison is electric light. He is going over the same ground that Bouliguine, Lodygreine, Kosloff, Koun, Starr, King, myself and others have traversed—first, iron; second, platinum; third, carbon in different shapes. And Edison has failed, in my opinion. To show that I mean what I say, I deny every one of his allegations made at the Saratoga convention of the American Society for the Advancement of Science, and, specifically, I challenge him:

First. To maintain a vacuum in his lamps.

Second. To run his carbonized-paper lamp three hours. (In practice, in a perfect vacuum, it will last twenty minutes.)

Third. To consolidate platinum by heating electrically in the Sprengel vacuum, as he claims.

Fourth. To prove that his dynamo-electric machine develops not ninety, but even forty-five per cent. of the feet pounds applied to it.

Fifth. To show that he can obtain a light of twenty-five candles from platinum with less than three horse power.

Sixth. To show that platinum or iridium will not disintegrate in twenty hours' actual running.

Seventh. To prove that with this carbonized-paper lamp he can obtain two lights of ten candles each per horse power.

Eighth. To show that the effect of the oxide of magnesium is to harden his wire, and make it more refractory.

And I further allege that all Mr. Edison's statements are erroneous, and I offer $100 as a prize for him to prove each of the above eight allegations. Let him run one of his lamps three hours and the public will be satisfied that I am correct.

W. E. SAWYER.

78 Walker street, New York, Dec. 21.

3148 Pursuant to adjournment this testimony was continued June 27, 1881, at 10 a. m., at No. 65 Fifth avenue, New York city, same counsel being present.

Martin N. Force, a witness produced in behalf of Mr. Edison, being duly sworn, testified as follows in answer to questions proposed to him by George W. Dyer, counsel for Edison:

1 Q. What is your residence and occupation; by whom are you employed, and how long have you been so employed?

A. My residence is Menlo Park, N. J.; my occupation is assisting Mr. Edison in his experiments; I have been so employed since about 1875.

2 Q. What sort of work did you first do for Mr. Edison?

A. I did carpenter work.

3 Q. If you did any particular carpenter work for him in relation to the laboratory, please state what it was and when it was done?

A. I helped to erect the laboratory, putting up shelves in the same, and I did carpenter work at his pen factory; about in the fall of '75 and the spring of '76.

4. If at any time you changed the nature of your work for Mr. Edison, what new work did you enter upon, and when did you do so?

A. I was at the pen factory packing the pens, and some of the time I ran the engine. Then I went in the laboratory to assist in the laboratory, about the spring of '78. My duties were anything I was asked to do; assisting at making and charging batteries, cleaning the laboratory, and such work. And since that time my work has been general in the laboratory, assisting wherever I was called upon.

3149 5 Q. Please examine the paper now shown you, marked Edison's Exhibit No. 5. State whether the signature M. N. Force upon the same is your signature and when was the same made?

Question objected to as going to show that the invention in question was made before the date alleged in the preliminary statement of Mr. Edison.

A. I have examined the paper; the signature is mine. It was made at the date of this paper, December 3d, 1877.

6 Q. Please look at exhibit marked Edison's First Incandescent Lamp, and state whether you have seen the same before, and if so, when and where?

Same objection as to previous question.

A. I have looked at the instrument. I have seen it in the laboratory at Menlo Park. I have seen the instrument setting on the shelf at the upper part of the laboratory. I should say it was about three years ago, as near as I can remember.

7 Q. Have you assisted at any experiments in electric lighting with incandescent paper carbons or witnessed such experiments at Menlo Park; if so, state the earliest times of the same?

A. I assisted Mr. Batchelor about September or October, 1878, I don't exactly know which, to make some carbons. The carbons were rolled with a sort of coating of tar, and carbonized in a crucible filled with charcoal or something of that description, and also carbonized in a combustion tube. As near as I can remember at that time they were put in the bell jar of a vacuum pump. The air was then exhausted, and an electric current passed through the carbon.

7½ Q. Please examine the paper now shown you marked Edison

Exhibit No. 9. State whether or not sketches on that paper represent the bell jar employed in the experiments you have related.

3150 A. I have examined the Exhibit No. 9 and find it to be, as near as I can remember, a drawing of the vacuum pump which we used at that time.

Counsel for Edison gives notice that he here closes his examination-in-chief of this witness, and gives him over for cross-exami-tion.

Cross-examination by Amos Broadnax, Esq., counsel for Sawyer and Man:

Counsel for Sawyer and Man gives notice that his cross-examination is not intended to waive any objection taken to the testimony.

8 X Q. Did you sign your name on this paper, Edison Exhibit No. 5, in presence of Mr. Edison and Mr. Batchelor?

A. Yes, sir.

9 X Q. Where were they?

A. In the laboratory at Menlo Park.

10 X Q. Was it in the morning or in the evening?

A. In the evening.

11 X Q. Was it by gas light or by daylight?

A. I don't exactly remember whether it was by gas light or by daylight.

12 X Q. What was the object of making that paper?

A. As a record. I suppose, of the experiment.

13 X Q. What experiment?

A. The experiment shown on the paper.

14 X Q. In whose handwriting is this paper?

A. It looks like Mr. Edison's handwriting somewhat.

15 X Q. Did you see him write it?

A. I do not remember seeing him write it.

16 X Q. Can you swear that that is his handwriting?

A. No, sir; I wouldn't swear that it's his handwriting.

17 X Q. Can you swear that that paper was written December 3d, 1877?

3151 A. No, sir; I wouldn't swear that it was written at that date, of course.

18 X Q. Can you swear that you signed your name on it December 3d, 1877?

A. I can swear that that's my signature.

19 X Q. Can you swear that you made this signature on December 3d, 1877?

A. I made that signature at that time; yes, sir.

20 X Q. How do you fix the date of the making of that signature on that paper?

A. I have no particular way of fixing the date, but generally at the time an experiment is tried, we always sign, and I never sign unless I see the experiment.

21 X Q. Did you witness the experiment referred to on that paper?

A. Yes, sir; I was there at the time, but I don't know the details of the experiment.

22 X Q. What was intended to be proved by the experiment?

A. I couldn't say what he intended to prove.

23 X Q. What did the experiment consist of? What did he do?

A. I don't remember. I can't give the details of the experiment.

24 X Q. How do you know that the experiment referred to on that paper was made on or about December 3d, 1877? What circumstance can you mention that was contemporaneous with that experiment?

A. I do not know that I have anything particular to call the same to my mind. I used to frequent the laboratory to see them experiments, but did not enter into the details of the experimenting. There is no particular circumstance that I recall to my mind.

25 X Q. Did you see Mr. Edison make any experiments with the Exhibit Edison's First Incandescent Lamp?

A. No, sir; I don't remember seeing any.

26 X Q. You say you assisted Mr. Batchelor to make some carbons out of paper coated with tar. Did you mean to be un-
3152 derstood as saying that the carbon you assisted Mr. Batchelor
to make was in the form of a knitting needle?

A. The carbons that I assisted Mr. Batchelor to make were rolled by the hand, coated with tar, and in the form of a small cylinder.

27 X Q. How big were they?

A. They were different sizes. They may have been the size of a quill, or the size of a finger, or smaller.

28 X Q. How much smaller were they? Were any of them as small as an eighth of an inch in diameter?

A. I don't just remember the sizes, and couldn't say as to that. We didn't care particularly as to the size.

29 X Q. Can you state how long they were?

A. They may have been an inch, or two inches, or three inches.

30 X. Q. How many of them did you make?

A. I would not say as to the number. There may have been ten, or there may have been fifty.

31 X Q. Did you see any of these carbons put in the vacuum chamber of the pump represented by Edison Exhibit No. 9?

A. Yes, sir; I think I saw those put in.

32 X Q. Are you sure you saw those carbons put in that chamber?

A. Yes, sir; in a chamber similar to this drawing.

33 X Q. How many did you see put in?

A. I don't just remember the number. I think there were more than one.

33½ X Q. Can you swear that there was more than two put in?

A. I wouldn't swear that there were more than two; there may have been. My memory don't serve me as to that point.

34 X Q. Was you present during the whole of the experiment?

A. I was present with Mr. Batchelor at the carbonizing and at the vacuum pump. I wouldn't say that I was always at that place, but I was usually present.

3153 35 X Q. Did you work the vacuum pump?

A. Yes, sir; I used to do the pumping most of the time.

36 X Q. Did you see those carbons illuminated by the electric current in the vacuum chamber of the pump?

A. Yes, sir; I remember of seeing them lighted.

37 X Q. Did you see more than one of them lighted?

A. I don't say as to the number I have seen lit, but I remember seeing the carbons illuminated in that chamber.

38 X Q. Was there more than one pump in the vacuum chamber of which you saw these carbons placed and illuminated?

A. No, sir; there was only the one pump at that time.

39 X Q. Was there more than one carbon in the chamber at any one time?

A. I don't remember more than one at a time, but there may have been more.

40 X Q. Did the experiments last more than one day?

A. I would not say as to that; I don't remember how many days.

41 X Q. Who was present during these experiments beside yourself and Mr. Bachelor?

A. I think Mr. Edison was present; I don't call to mind any others.

42 X Q. Were the experiments continued more than two days?

A. I don't remember how many days; it may have been one or two, or perhaps a week.

43 X Q. Can you swear that these experiments continued for more than two days in the fall of 1878?

A. I would not swear that they were continued more than two days, although they may have been.

44 X Q. Can you swear that they were continued for two days?

3154 A. I think, as near as I can remember, they were continued for that length of time.

45 X Q. When the carbons were illuminated by the electric current, how long did they last?

A. I would not say as to how long they lasted exactly.

46 X Q. Well, about how long?

A. As near as I can remember, they lasted probably a minute, or a couple of minutes, or five minutes.

47 X Q. These paper carbons about which you have been testifying, are they the first which you saw made at Menlo Park by Mr. Edison and Mr. Batchelor?

A. As near as I can remember, they were about the first.

48 X Q. And you are certain that that was in the fall of 1878?

A. Yes, sir; it was in September or October of 1878, to the best of my recollection?

MARTIN N. FORCE.

3155 EDWARD H. JOHNSON, a witness produced in behalf of Mr. Edison, being duly sworn, testified as follows in answer to questions proposed by GEORGE W. DYER, counsel for Edison:

1 Q. State your residence and occupation, and whether or not you

are one of the assistants of Mr. Edison, and if so, how long you have been with him in that capacity?

A. I reside in New York city; my occupation is that of a practical electrical engineer; I have been engaged for the past ten years in practically applying Mr. Edison's inventions in telegraphy, telephony, and now in the electric light, and in such capacity I have been his assistant, not directly employed in his laboratory until September last, but always with the parties who were putting Mr. Edison's inventions on the market; my relations with him and his work were such that I was a very frequent visitor at his laboratory.

2 Q. What, if anything, do you know of the experiments of Mr. Edison in the summer of 1876, in the carbonization of paper for various purposes?

Question objected to in so far as it applies to electric lighting, if it is intended to show that Mr. Edison carbonized paper for that purpose in 1876.

A. In the fall or winter of 1876, I sought to organize a small business for myself under the name of the American Novelty Company, the object of which was to acquire numerous inventions of Mr. Edison, Mr. Batchelor, Mr. Adams, my own, and others; and to put them upon the market. Several such were acquired, namely, Edison's duplicating ink, Edison's battery carbons, Edison's jeweller's engraving machines and others which I cannot now recall. The attempt to form a company to carry on such a business was practically a failure, owing to the lack of funds. I remember, in discussing with Mr. Edison at his laboratory, quite prominent mention was made of numerous articles, which he, Mr. 3156 Edison, was intending to manufacture of carbon. I cannot now recall all of them in detail, but they were such articles as dishes, small vessels, resistance coils, battery carbons, etc. I remember, on frequent occasions, seeing Mr. Edison carbonizing certain of these articles under pressure, that being the particular feature of the invention. In discussing the matter with Mr. Edison, Mr. Batchelor and Mr. Adams, they informed me that they purposed making such carbons of bituminous coal, paper and wood. My knowledge of the experiments was necessarily confined to information given me at the time by these gentlemen, as I was so occupied in New York that my visits to the laboratory were mainly for the purpose and with the object of consulting with Mr. Edison, and not in assisting him in his experimental work.

3 Q. At what date do you know, of your own knowledge, of Mr. Edison engaging in experiments in the electric lights, with incandescent conductors made of paper carbon?

A. I fail to recall now the exact date when I first saw Mr. Edison's paper-carbon experiments.

4 Q. When was your first knowledge of Mr. Edison's experiments in electric lights?

A. In the summer of 1878, on his return from the Colorado scientific expedition, which he had accompanied for the purpose of endeavoring to measure the heat of the corona during the sun's eclipse, with the tasimeter which he had invented. It is from this date that my recollection runs freely as to Mr. Edison's electric light work. Prior to that, anything that he did did not sufficiently attract my attention to fix either the date or the experiment on my mind.

5 Q. Since the summer of 1878, what has been your knowledge with regard to persistent and continuous work on the part of Mr. Edison in incandescent electrical lights?

3157 A. That Mr. Edison pursued experimentation in this direction uninterruptedly night and day, from that date to this, with his customary energy and persistence, when fully started in a given direction for a given object.

6 Q. What is the earliest date within your recollection of the employment of paper-carbon conductors for incandescent electric lights by Mr. Edison?

A. I have a not well-defined recollection of witnessing certain experiments with paper carbons for this purpose in the winter of 1878–'79. In the summer of '79 I went to Europe, and saw nothing more of Mr. Edison's experiments until January, 1880, when I visited Mr. Edison's laboratory upon a mission from England, and there saw a large number of paper-carbon lamps, in actual operation. I returned to England within a fortnight, taking six of the paper-carbon lamps with me, and did not again visit the laboratory until September 1st, 1880.

Counsel for Edison closes the examination-in-chief of this witness and offers him for cross-examination.

Cross-examination by AMOS BROADNAX, counsel for Sawyer and Man:

7 X Q. Please state your name and age, Mr. Johnson.

A. My name is Edward H. Johnson, and my age is 35 years.

8 X Q. Please to fix the date exactly when Mr. Edison returned from the scientific expedition organized to observe the sun's eclipse.

A. I can't fix that date from memory.

9 X Q. Have you any memoranda to which you can refer, by which you can fix the date?

A. Not to my knowledge. I do not make it a rule to preserve memoranda or papers of any description.

3158 10 X Q. You say, in answer to Q. 4 of your examination-in-chief, that the first knowledge you had of Mr. Edison's experiments in electric lights was in the summer of 1878, after his return from the scientific expedition to which I have referred. Please to state whether you derived that knowledge from others, or whether you witnessed those experiments yourself.

A. I witnessed numerous experiments myself.

11 X Q. These experiments that you say you witnessed yourself, were they made immediately upon his return from the scientific expedition referred to?

A. I cannot now recollect whether they were or were not.

12 X Q. State how long after his return you witnessed these experiments, as nearly as you can recollect.

A. I am unable to do that, being wholly without other guide to my recollection than my memory that it was immediately upon his return that he began active experimentation on the electric light.

13 X Q. These experiments that you say you witnessed, is your recollection of them sufficiently distinct to enable you to describe them? If so, please do so.

A. No, sir; it is not. I only remember the fact of frequently seeing Mr. Edison and his assistants occupied with them. My interest was not enlisted; and I did not particularly examine into or investigate this branch of the laboratory work.

14 X Q. In answer to Q. 6 of your examination-in-chief you say you have "a not well-defined recollection of witnessing certain experiments with paper carbons for this purpose in the winter of 1878–'79." Please to state whether your recollection of the experiments referred to by you in that answer is distinct enough to enable you to describe them, and if so, please describe them?

A. My recollection is of seeing a feeble light, and of Mr. Edison remarking that here might grow out something from the American
Novelty Company experiments. I cannot say what his exact
3159 words were but this is the purport of them; nor can I describe otherwise the light that was shown.

15 X Q. How often did you witness experiments made by Mr. Edison in incandescent electric lighting with carbonized paper in the winter of 1878–'79?

A. I cannot say positively that such experiments as I saw were upon the incandescent principle at all, my recollection of these experiments being too indefinite to enable me to describe either the principle or the method of its application.

16 X Q. State, if you please, when you first saw this Exhibit Edison's First Incandescent Lamp.

A. It is impossible for me to state when I first saw it, Mr. Edison showed me the light on more than one occasion in its earlier stages. I have no recollection of the shape or design of the lamp referred to in your question.

17 X Q. State, if you know, when it was that Mr. Edison invented and made the tasimeter to which you have referred, for measuring the heat of the corona of the sun during the expedition to Colorado.

A. I cannot fix the date other than that it was during the time of his telephone experimentation, the tasimeter being an invention coincident with the telephone. It was some time during the latter half of the year '77 or early part of the year '78. This is my best recollection.

EDW'D H. JOHNSON.

3160 JOHN KRUESI, a witness produced in behalf of Mr. Edison, being duly sworn, testified as follows in answer to question proposed to him by GEORGE W. DYER, counsel for Edison:

1 Q. State your age, residence and occupation.

A. Age, 38; residence, Menlo Park, N. J.; I am a machinist, at present engaged in the Electric tube works, at 65 Washington street, New York, as manager.

2 Q. State how long you have been connected with Mr. Edison, and in what capacity.

A. For nearly nine years. About five years as machinist and four years as foreman of the machine shop.

3 Q. Please look at the paper which I now hand you marked Edison's Exhibit No. 4, and state whether the signature J. Kruesi, upon the same, is your own handwriting and when it was made.

Question objected to as immaterial.

A. I have examined the paper. The signature is my own handwrittng. I think it was made about the time the paper is dated. That is November, 1877.

3½ Q. Have you any doubt upon that point?

A. I have no reason to be doubtful about it, but I don't remember when I signed it.

4 Q. What was your habit or practice about signing similar papers?

Objected to as not competent. The question is as to when he signed this paper.

A. I generally signed them within a few days after they were written, or after the instrument was made.

5 Q. What is the earliest date which you remember, of Mr. Edison experimenting with electric lights?

A. I am not sure whether it was the summer of '77 or summer of '78.

3161 6 Q. What is the earliest date you remember of his experimenting with paper carbons for electric lights?

A. I don't remember the date when he began. When he experimented with paper carbon was in 1877, but I don't know what the paper carbons were for.

Counsel for Edison here closes his examination-in-chief of this witness, and submits him to counsel for Sawyer and Man for cross-examination.

Cross-examination by AMOS BROADNAX, counsel for Sawyer and Man:

7 X Q. What experiments did you see Mr. Edison make with paper carbons in 1877?

A. I don't remember any experiments.

8 X Q. Was you foreman of Mr. Edison's machine shop and his laboratory, and generally of his mechanical works at Menlo Park?

A. Yes, sir.

9 X Q. When did you commence to be foreman and when did you cease to be foreman?

A. I commenced in December of 1877, and ceased to be foreman in February, 1881.

10 X Q. Do you recollect seeing Mr. Edison make any experiments in electric lighting with carbonized paper during the time that you was foreman?

A. Yes, sir.

11 X Q. When did you first witness such an experiment?

A. The earliest I remember was in 1879.

12 X Q. What time was it in 1879?

A. I think it was in summer.

13 X Q. What was the experiment?

A. Paper-carbon horseshoe, substantially like this in Exhibit Edison's Commercial Incandescent Electric Lamp.

14 X Q. Do you recollect seeing Mr. Edison experiment with carbonized paper in this lamp marked Edison's Exhibit First Incandescent Lamp?

3162 A. I do not recollect it.

15 X Q. State where you first saw that lamp.

A. In Newark, N. J.

16 X Q. When?

A. Before we moved to Menlo Park.

17 X Q. What was it used for?

A. It is used with an air pump for experiments.

18 X Q. Have you seen the lamp frequently since?

A. No.

19 X Q. Did you ever see it in the laboratory at Menlo Park?

A. I recollect to have seen it at Menlo Park; yes, sir.

20 X Q. Whereabouts did you see it in Menlo Park—in the laboratory?

A. Yes; in that building which we call the laboratory.

21 X Q. Whereabouts was it kept in the laboratory?

A. I don't know that it ever had a certain place.

22 X Q. Was it in plain sight most of the time?

A. Yes, sir; I think so. Everything was in plain sight. There was nothing stowed away.

33 X Q. During the time that you was machinist, and before you became foreman, was you frequently and constantly going in and out of the laboratory as a workman?

A. Yes, sir.

24 X Q. And the same is true during the time that you was foreman?

A. Yes, sir.

25 X Q. Did you put these binding posts on this lamp, Edison's first incandescent lamp?

A. No; I did not put them on personally?

26 X Q. Did you see them put on?

A. No. I do not recollect.

27 X Q. Do you know who put them on?

A. No; I do not recollect who put them on.

28 X Q. Do you know when they were put on?

3163 A. No.

29 X Q. Who did you have in the machine shop at Menlo Park that done that kind of work during the time that you was machinist there?

A. I had several workmen at that kind of work.

30 X Q. Please to give the names of those workmen, and where they are now.

Q. Rudolph Heuse, who is dead. Echron, I don't know where he is. I think his first name was Albert, but am not quite sure. Baer was the name of another, I don't remember his first name, and I don't know where he is.

31 X Q. Referring now to Edison's Exhibit No. 4, do you know in whose handwriting it is?

A. Yes, I recognise it as Mr. Edison's own handwriting.

32 X Q. When was it written?

A. I think previous to that date there, or at the time of that date.

33 X Q. Do you know of your own knowledge that it was written then?

A. No, I do not.

34 X Q. Have you a distinct recollection of the experiments referred to by this paper?

A. No, sir.

35 X Q. Have you such a recollection of them as to enable you to state when they were made?

A. No.

36 X Q. At the time you signed this paper was that piece torn out between your name and Mr. Batchelor?

A. I do not recollect, but I don't think so.

37 X Q. Do you recollect whether anybody else's name was signed between yours and Mr. Batchelor's?

A. I do not recollect.

Cross-examination ended.

Re-examination by George W. Dyer, counsel for Edison:

3164 38 Q. How early do you remember seeing the lamp, Edison's Exhibit First Incandescent Lamp, with the binding posts on it, and the clamps inside of it?

A. I couldn't state the date. I recollect the lamp from general appearance.

JOHN KRUESI.

The taking of further testimony herein was adjourned by consent to Tuesday, June 28, 1881, at 10 o'clock.

WM. H. MEADOWCROFT,
Notary Public, N. Y. Co.

3165 Pursuant to adjournment this testimony was continued June 28, 1881, at 10 a. m., at same place, the same counsel being present.

FRANCIS R. UPTON, a witness produced in behalf of Mr. Edison, being duly sworn, testifies as follows in answer to questions proposed to him by GEORGE W. DYER, counsel for Edison:

1 Q. Please state your age, residence and occupation.

A. Age, twenty-eight; residence, Menlo Park, N. J.; occupation manufacturer of electric lamps.

2 Q. State whether at any time you went into the employment of Mr. Edison, and what your duties were.

A. I entered the employment of Mr. Edison about November, 1878. I can fix the date exactly by reference to my accounts, and will do so. My first occupation was making a search through the records of electric lighting in the Astor library. When this was completed to Mr. Edison's satisfaction, I entered his employ at Menlo Park to assist him in making calculations.

3 Q. What special training or acquirements had you for making such calculations?

A. Before entering college and while in college, I gave special attention to the mathematical branches. After leaving college I studied two years under Professor Brackett of Princeton, learning how to use physical apparatus, and becoming proficient in algebra and calculus. After that I spent one year in Berlin in the laboratory of Professor Helmholz.

4 Q. Please state now the particular branches connected with the electric light, which come under your immediate supervision after entering the employment of Mr. Edison.

A. In the first place, I made such calculations as were in my power regarding the electrical conditions necessary in a
3166 system of electric lighting in answer to questions asked by Mr. Edison, as, for instance, I have the memorandum, December 15, 1878, this problem given to me when I first came into the laboratory: "Example No. 1. 100 lamps, 10,000 ohms," (diagram shows lamps in multiple arc). "100 lamps, 1 ohm," (diagram shows lamps in series). "How much heat in each lamp. Heat=C^2R. Ans. the same." This problem is an example of the work I had to do. Besides calculations I assisted Mr. Edison in experimenting, translating and keeping records.

5 Q. At the time of entering into the direct employment of Mr. Edison in the latter part of 1878, what, if anything, was he doing in experimenting and perfecting electric lighting?

A. He was experimenting with the platinum spiral lamp with a thermal regulator. I remember helping to measure the expansion of the heated spiral of platinum. Besides this, Mr. Edison was making an extended series of experiments to find the laws of magnetism. He was also studying publications referring to constructions of dynamo machines.

6 Q. I wish to call your attention to experiments connected with determining the laws of resistance as applied to carbons, particularly those made of paper, and the mechanism and apparatus essential for the production of incandescent electric lighting.

Objected to by counsel for Sawyer and Man as impertinent.

A. Mr. Edison had me calculate the size and weight of cables necessary to carry the current to a certain number of lamps of given resistance (my impression is 100 ohms) at various distances from the machine, so that a certain per cent. of the energy in the circuit could be used in the lamps; he also had me construct tables showing the joint resistance of a number of lamps in multiple arc; Mr. Edison concluded that to make a successful electric lamp it should have in the neighborhood of 100 ohms resistance; he tried a
3167 large number of devices for obtaining this resistance from metal wire; at the same time he was carrying on experiments with the telephone; in the course of these experiments with the telephone, threads of carbon were made; he had these tested for resistance, and found them very high; this suggested to him the possibility of successfully making high-resistance carbon lamps; he, with the assistance of Mr. Batchelor, made a large number of lamps with carbon filaments; at that time my attention was more particularly drawn to the vacuum pumps and the construction of dynamo machines; I was employed in testing the efficacy of Mr. Edison's machine, and did not follow all the experiments that led to the paper loop; I recollect when one of the first successful loops was made; Francis Jehl and I measured the resistance, cold, of the carbon; my recollection is that it was about 140 ohms; the carbon was burnt for a number of hours and again tested, and no change found in its resistance; this was repeated several times, burning and testing until the lamp gave out. I remember that we all felt very much elated at the fact of the carbon not changing its resistance, for it showed that there was no wasting away of the carbon; we then felt that it was possible to make a system of the electric lighting, simply by adding to the life of the lamp, which we have since done.

7 Q. Of what material were the threads or filaments of carbon made, referred to in your previous answer?

A. My impression is, from ordinary sewing cotton; I recollect that Mr. Batchelor procured from the Clark thread works, special samples of cotton thread, afterward.

8 Q. When did you know of Mr. Edison's experiments on conductors made of carbonized paper?

A. I can only recollect now the finished loops as mentioned in a previous answer.

9 Q. When, to the best of your recollection, did Mr. Edison
3168 determine the prerequisite of high resistance for a successful incandescent electric light?

A. Early in 1879.

10 Q. How early was his attention turned to the production of more perfect dynamo machines?

A. He was experimenting on them before I entered his employ.

11 Q. When, so far as you know, did Mr. Edison turn his attention to improved means for producing a vacuum in electric lamps?

A. The first recollection that I have is when he sent me to Princeton to borrow a Geissler pump; I can't fix the date now, but may be able to do so.

12 Q. Did you at any time, under Mr. Edison's direction, experi-

ment on improved means for producing a vacuum in incandescent lamps, and if so, at what time?

A. By his wish I commenced to learn to blow glass; not succeeding at this, he advertised for a competent glass-blower, and the first glass-blower was a German from New York, and then a young man by the name of Boehm; I worked with these, helping to the best of my ability, in making pumps for producing a vacuum in incandescent lamps; before September 16th, 1879, pumps had been made that worked satisfactorily.

13 Q. At the time these means of producing vacuum had been determined, had resistance of carbon filaments been determined?

A. I cannot recollect.

14 Q. At this same time had the dynamo machines been satisfactorily perfected?

A. They were perfect enough to make us sure that if a lamp of sufficiently high resistance could be made, it could be used successfully in a system of electric lighting.

3169 15 Q. At what date did Mr. Edison produce an incandescent electric lamp, fit to compete commercially with gas?

Counsel for Saw-er and Man objects to the question as immaterial.

A. To the best of my recollection it was in November, 1879, when the stable resistance of a paper-carbon loop was determined.

16 Q. At that time was the system worked out, and the various forms of apparatus essential to carry it into successful use?

Objected to as immaterial.

A. Yes.

17 Q. From the date of your employment by Mr. Edison, have you labored constantly and incessantly under his direction in the perfection and production of incandescent lights, and the apparatus necessary to make them available?

A. With the exception of about two weeks, yes.

18 Q. When did Mr. Edison first produce for public exhibition his incandescent electric lamps with paper-carbon conductors?

A. The next day after the publication of the article in the New York Herald, which I find here, marked Edison Exhibit No. 2, dated December 21, 1879.

19 Q. Please look at the lamp now shown you, which is marked "Exhibit Edison's Commercial Incandescent Electric Lamp." State whether that represents the character of lamp referred to in your previous answer?

A. Yes.

20 Q. State, if you please, about the extent and kind of use made then and afterwards with that kind of lamp?

A. Wires had been run in the laboratory building. In connection with these, chandeliers had been placed so that the light from the lamps could be used while experimenting. Lamp posts were placed on the road to the depot. My impression is that this
3170 was all done before December 21st. The dynamo machines were in place. Mr. Edison was waiting for his foreign patents

to be issued, I understood at the time. Wires were also run to my house, and to Mr. Edison's house; in one case using a special line of poles, in the other the Western Union poles. The light was used in the hall and two rooms of my house, for all ordinary purposes, and while tests were being made, burned continually and without interruption for several weeks, from dark until ten or eleven o'clock. There were, I think, from sixty to over one hundred lamps in the circuit. While the public exhibitions were given my duty was to watch the dynamo machines, to see that no harm was done them, and to explain to visitors their working and the working of the light. I had a lamp hung over my dining-room table, which we used regularly to eat by at night. I remember having a dinner party, with one lamp hung over the table giving sufficient light. This was all done within three weeks after that publication.

21 Q. State, if you please, whether the data relating to these lamps was put in your charge. If so, about what time was it?

A. Mr. Batchelor started the book giving the hours burned of the lamps. The records of the lamps, I notice, is in Mr. Batchelor's handwriting until January 5th, 1880. After that time a young man named Herrick kept the record. I helped him at various intervals while he was keeping the record, examining into the accuracy of his records, and checking his figures. The record was kept for Mr. Edison, who wished to know the life of the lamps. If the lamps were scattered it required constant watching to make the record exact. The machines were run during the day and night. When Herrick was absent a slip was left for him giving the number of hours which the machines ran. If any lamp broke, notice was given him as soon as discovered. All the lamps were numbered, so that they could be recognized. The record I refer to is that from which Edison Exhibit No. 3 is taken.

3171 22 Q. When did you begin to manufacture lamps especially adapted for incandescent electric lights?

Question objected to as utterly immaterial.

A. About November, 1879.

23 Q. From an examination of the record of lamps before referred to, can you state about the average life of the lamp used in the latter part of 1879 and the early part of 1880, at Menlo Park?

Question objected to as immaterial.

A. I think that so much of the record as is printed is a fair statement, though it does not give several lamps that burnt an exceptionally long time. For example, one on the lamp post at the corner of Mr. Thornall's barn, which burnt from 1,400 to 1,500 hours. I recol- this lamp distinctly as giving a bright light. I recollect examining it to see if the number was on it. I have a tabular statement of the life of these lamps which I will endeavor to find and put in evidence.

24 Q. Did all these lamps about which you have just testified have carbon conductors made from paper?

A. Yes.

25 Q. Have you continued the manufacture of such lamps since?

A. Yes.

26 Q. What do you know of the sale to and use by other parties of such lamps—I mean electric lamps with paper-carbon conductors?

A. The steamship Columbia was fitted out in May of 1880, I think, with about 150 of these lamps. An exhibition was given while the steamer was at the dock in New York, lighting the saloon and a number of state-rooms.

27 Q. Was any publication made by you about the last of December, 1879, or early part of January, 1880, about the state of perfection at that time of Mr. Edison's inventions in incandescent electric lamps? 3172

A. I wrote an article about that time which was published in "Scribner's Monthly" for February, 1880. This article is a full description of Mr. Edison's labors to that date.

Article produced, put in evidence, and marked Edison's Exhibit No. 10.

The exhibit is objected to on behalf of Sawyer and Man as incompetent, irrelevant and immaterial, and not legal evidence in any sense.

28 Q. Mr. Man, in his testimony in this interference, speaks of using "principally ordinary blotting paper" for incandescent conductors for electric lamps. Have you had any experience in the carbonization of ordinary blotting paper; if so, with what results?

A. I have had some experience. Carbons made from blotting paper are easily broken and not as durable as carbons made from compressed paper.

29 Q. Mr. Man further testifies in the same interference of "rubbing down and working out by hand the carbons." Have you had any experience in this kind of manipulation of paper carbons?

A. I have never tried the process mentioned. I should judge it to be extremely difficult.

30 Q. Referring to the answer to X Q. 67 on page 18 of the printed testimony of Albon Man, what office would be filled by the interior conductor coated in the manner described?

A. I should say that the paper loop is mostly useful for mechanically holding the solutions with which it is said to be treated, and that the larger portion of the current would be carried by the carbon from the substances with which the loop is treated, so that the greater portion of the light would be given by them. The looser and more porous the paper the less will it carry the current and give the light from itself.

3173 By consent, this testimony was postponed until Wednesday, June 29th, 1881, at 10 a.m., at same place.

WM. H. MEADOWCROFT,
Notary Public, New York County.

Pursuant to adjournment this testimony was continued June 29th, 1881, at same place, the same counsel being present.

31 Q. I call your attention to your answer to question 23, and ask if Edison's Exhibit No. 3 gives a correct statement of the life of the lamps therein recorded as not destroyed, and ask you to supplement the history of the lamps which were not destroyed, so as to show their full duration?

A. So far as it goes it is correct, but on examining the records I find that the lamps are continued in another book, for example, lamp No. 159 is continued in Book No. 74, copying the original record and carrying the record to January 30th, 1880. The lamp is shown to have a life of 683 hours and 45 minutes.

Lamp 223, which is copied on page 3, burned 367 hours and 17 minutes.

Lamp 155 is recorded as burning 562 hours 14 minutes. 201 is recorded as burning 638 hours. Lamp 164 is recorded as having burned 640 hours 14 minutes. Lamp 172 is recorded as burning 638 hours and 14 minutes. I find these memoranda on pages 1 and 2; page- 5, 7 and 8; 9 and 10; 11 and 12; pages 13 and 14, respectively.

Counsel for Edison tenders the above record book for examination to counsel for Sawyer and Man, and puts in evidence copies of the pages above named, the same being marked Edison's Exhibit No. 11.

3174 Counsel for Sawyer and Man objects to the exhibit as an incomplete copy of the record referred to, and as impertinent, the copy being no evidence unless the record itself is put in.

32 Q. Have you read the printed record of the testimony of Messrs. Sawyer and Man in this interference?

A. The larger portion of it.

33 Q. Where a paper-carbon conductor built up in the manner described by Sawyer and Man in their testimony is used in an electric lamp, what special function as regards incandescence is exerted by the paper-carbon portion of such conductor?

A. As a mechanical support for holding the solutions with which the carbon is built up.

34 Q. Would not materials other than paper carbon serve for such a support?

A. Yes; asbestos for instance, in the cases where they dip the loop into solutions; or fiber of any description.

35 Q. I wish you would examine the answer of William E. Sawyer to the 18th question, and the statement about candle power, duration of burners, fracture, &c., and state what results would follow from the various conditions named in his answer?

A. I should judge from the surface of the lamp in Sawyer's Exhibit No. 4, and from the thickness of the carbon, that it might be possible for a lamp to last, giving twenty-five candles, for the time mentioned. The surface, I should think, is twice as great as that in Exhibit Edison's Commercial Incandescence Electric Lamp.

Since the economy of a lamp is inversely as the surface, it would take more power to obtain the same light from the Sawyer as from the Edison. At the same time the thickness of the carbon is so great that it should also last much longer than the Edison carbon. The resistance of the carbon shown in the drawing must be in the
neighborhood of 1 ohm at the most. This, in my opinion,
3175 renders the lamp totally uncommercial owing to the enormous
mous loss there must be from conduction through the clamps.
For example, the Edison carbon having 100 ohms and the clamp 1 ohm, only $\frac{1}{100}$ of all the energy used by the lamp will be lost in the clamp, while in the lamp, Sawyer Exhibit No. 4, if the clamp has a resistance of 1 ohm, the same as in the Edison, one-half of the total energy used in the lamp will be lost in the clamps. Besides this the increase of the size of the carbon allows more heat to be conducted from it to the clamps. As a result, I should judge it would be impossible to seal the lamp unless some device were used to dissipate this heat, making the lamp very large and clumsy.

36 Q. Referring now to the description and sketches given in the printed record of Sawyer and Man's testimony of the perfected lamp made by them, state whether in your opinion such a lamp would be a practical lamp, and give your reasons?

A. I do not think that it is a practical lamp. The first objection is on account of its low resistance, as stated in the previous answer. Besides the heat at the clamps, owing to the large currents that would have to be employed to give out sufficient energy for light from a small resistance, there would be a great deal of trouble in making the clamp last, as the tendency for arcs to spring between the clamp and the carbon would be so greatly increased.

I do not consider it possible to make such a lamp and hermetically seal it in a glass case, preventing any air from reaching it. Unless this is done, a carbon lamp blackens the globe that surrounds it very quickly. Judging from my experience with nitogen placed in the globe around a lamp, it would be extremely difficult for a carbon to give the same light continuously for a number of hours. I tried for over a week at one time to make a carbon, composed of paper only, burn in an atmosphere of nitrogen, without success.

I took every precaution that Mr. Edison and his chemist,
3176 Dr. Moses, suggested to make the nitrogen pure. The ex-
periment was carried on in the bell jar of an air pump. The
air was exhausted from the bell jar, and nitrogen drawn in; then again exhausted, and nitrogen again drawn in. I made the nitrogen, holding it in large bags, then, before drawing it in, the bell jar was dried and passed over hot copper filings. With loops made of paper only, no light could be made. I should also say that the lamp, Sawyer's Exhibit No. 4, if filled with nitrogen would soon lose it if lighted many times. When lighted, the gas inside the globe will be expanded, thrusting out the nitrogen. When cold the outside air will be drawn in to replace the nitrogen. Judging from the style of the lamp, I should say that the gas would

be very much compressed when the lamp was lighted, owing to the great amount of heat evolved in a small chamber.

Counsel for Edison gives notice that he here closes his examination of this witness, and offers him to counsel for Sawyer and Man for cross-examination.

Cross-examination by AMOS BROADNAX, counsel for Sawyer and Man:

37 X Q. What is your name?

A. Francis R. Upton.

38 X Q. Have you fixed the exact date, by reference to your accounts, when you went into the employ of Mr. Edison?

A. November 15, 1878.

39 X Q. Have you been continually in his employ from that time to this?

A. Yes, to the first of January, 1881, when I became superintendent at the lamp factory of which he is chief owner.

40 X Q. Where is the lamp factory of which he is the chief owner, and what kind of lamps are manufactured there?

3177 A. The factory is situated at Menlo Park; and the lamps are those suitable for his system of electric lighting.

41 X Q. Are the lamps that are manufactured at that factory, substantially like the lamp, Exhibit Edison's Commercial Incandescent Electric Lamp?

A. Yes, with the exception that bamboo is used in a large number on account of the ease of manipulating it, instead of paper, for the illuminating conductor.

42 X Q. Which makes the best carbon for electric lighting by incandescence, paper or bamboo?

A. Bamboo.

43 X Q. How is bamboo superior to paper, for that purpose?

A. On account of the difficulty of procuring paper of even thickness, and because the fibres of bamboo are continuous in the direction in which the current flows.

44 X Q. How does the resistance of an illuminating conductor made of bamboo compare with the resistance of a similar conductor made of paper?

A. The resistance of the bamboo is slightly less than that of paper.

45 X Q. Is the difference in the resistance of the two carbons sufficient to affect the practical working of the lamp?

A. No.

46 X Q. Then, for all practical purposes, in this respect they are the same?

A. Yes, in so far as their illuminating properties are concerned.

47 X Q. What proportion of the lamps manufactured by you, are fitted with illuminating conductors made of carbonized paper?

A. One to two per cent., I should judge.

48 X Q. In preparing your carbons for electric lamps, do you treat them electrically in the presence of hydrocarbon gas?

A. No.

3178 49 X Q. What training have you had as an electrician?

A. A college course of electricity, the handling of electrical apparatus in the physical laboratory at Princeton, and one year's work at electrical measurements of various kinds at Berlin, before entering Mr. Edison's employ; since I have been with Mr. Edison I have made calculations concerning electrical matters, and assisted in a large number of electrical experiments.

50 X Q. Do you consider yourself an expert in the practical application of electricity in electric lighting?

A. So far as relates to the incandescent electric light, I do.

51 X Q. Before you went in the employ of Mr. Edison, were you acquainted with him?

A. I had met him once in a visit to his laboratory.

52 X Q. In answer to question 5 you say, when you went into the employ of Mr. Edison he was experimenting with the platinum spiral lamp with a thermal regulator, and was making an extended series of experiments to find the laws of magnetism, and was also studying publications relating to constructions of dynamo machines. How long did Mr. Edison continue on those experiments, and in studying publications referring to constructions of dynamo machines?

A. Up to the present time, I should say; of course with intermissions, giving time for his experiments to be carried out.

53 X Q. Does Mr. Edison still continue in his experiments upon the platinum spiral lamps with thermal regulators?

A. Yes; through his assistants.

54 X Q. I read your answer to question 6 of your examination-in-chief (counsel reads): Please to state when it was that he tested the thread of carbon made in his telephone experiments, for the purpose of ascertaining its resistance, referred to in the answer I read?

3179 A. My impression is that it was in August or September, 1879; that is the best of my recollection.

55 X Q. In answer to that question, you say: "I recollect when one of the first successful loops was made, Francis Jehl and I measured the resistance, cold, of the carbon." State, as nearly as you can recollect, when it was that you and Francis Jehl measured the resistance of the paper-carbon loop, referred to in that answer.

A. To the best of my recollection in November, 1879.

56 X Q. You say, in answer to the same question, that your attention was more particularly drawn to the vacuum pumps, and to the construction of dynamo machines. State, if you please, when it was that you succeeded in getting a pump by which you could obtain a satisfactory vacuum in the illuminating chamber of your lamps?

A. To the best of my recollection, in July, 1879.

57 X Q. In answer to that same question, you also say: "I remember that we all felt very much elated at the fact of the carbon not changing its resistance, for it showed that there was no wasting away of the carbon; we then felt that it was possible to make a system of electric lighting simply by adding to the life of the lamp,

which we have since done." State, if you please, in what way you have since added to the life of the lamp.

A. First, by making better clamps for the carbon, so as to hold the carbon firmly, and prevent arcing. Secondly, by making better carbons. Third, by improved methods of getting the vacuum, so as to be sure that all the lamps are well exhausted, even when the workman is not expert.

58 X Q. In answer to question 11 you say the first recollection you have of Mr. Edison turning his attention to improved means for producing a vacuum in electric lamps was when he sent you to Princeton to borrow a Geissler pump. Have you been able to fix the date exactly when that was?

3180 A. I have not. I looked last night but could find no record by which I could fix the date exactly.

59 X Q. Was it after you went to Princeton to borrow the pump that you came to New York to advertise for a glass-blower for Mr. Edison, as stated in answer to question 12?

A. I did not advertise; but it was after that that Mr. Edison advertised for a competent glass-blower.

60 X Q. State, if you recollect in what paper it was that that advertisement was inserted?

A. My impression is the Herald.

61 X Q. Give the date as near as you can recollect.

A. It was in the summer of 1879. I can't fix the date.

62 X Q. How often did Mr. Edison advertise for glass-blowers; and state whether all the advertisements were subsequent to the time that you borrowed the pump at Princeton?

A. My impression is twice. All the advertisements were subsequent.

63 X Q. This lamp referred to by you as being at the corner of Mr. Thornall's barn, as burning from 14 to 1,500 hours—what was the luminosity of that lamp in candle power?

A. I should judge from 12 to 16 candles.

64 X Q. How long would such a lamp last, in your judgment, yielding a luminosity of 25 candle power?

A. From 400 to 600 hours.

65 X Q. What, in your judgment, would be the average life of the lamps, referred to in the record, about which you have been testifying, yielding a luminosity of 25 candle power?

A. As the lamps were then made, when not very good, they would arc at high candle power, excepting these, I should say from 100 to 200 hours.

66 X Q. Do you mean to be understood as saying, if the plan of the lamp was skilfully carried out in its construction and organization, it would endure from one to two hundred hours at a
3181 luminosity of 25 candle power—referring, of course, to the lamps noted in the record?

A. I do.

66½ X Q. Have you ever tried any of your lamps, like Exhibit Edison's Commercial Incandescent Electric Lamp, raised to a luminosity of 25 candle power?

A. We never have at that point. We have tried above and below, and my judgment is as stated.

67 X Q. At what luminosity have you tested the candle power of the lamp referred to in my last question?

A. At 48 candles.

68 X Q. How long did the carbon endure at a luminosity of 48 candle power?

A. My impression is, somewhere in the neighborhood of 15 hours.

69 X Q. What size was the carbon?

A. Substantially the same as that in the Exhibit Edison's Commercial Incandescent Lamp.

70 X Q. In answer to question 27 you say that you wrote the article contained in "Scribner's Monthly," for February, 1880, marked Edison Exhibit No. 10; are the statements of facts contained in that article true, of your own knowledge?

A. So far as I was able to verify them they were.

71 X Q. At the head of that article I find the following statement: "Editor Scribner's Monthly, Dear Sir, I have read the paper by Mr. Francis Upton, and it is the first correct and authoritative account of my invention of the electric light. Yours truly, Thomas A. Edison, Menlo Park, N. J." Was that written by Mr. Edison?

A. It was, at the suggestion of the editors of "Scribner's Monthly." The fac-simile of the letter as written by Mr. Edison is published in the fore part of this book.

72 X Q. Did Mr. Edison revise this article before it was published?

A. He revised portions of it.

3182 73 X Q. Did he read the whole of it before it was published?

A. I cannot say. I think he did not read the historical part.

74 X Q. Which one of the patents granted to Sawyer and Man is "for a stick of carbon rendered incandescent in nitrogen"?

A. In answer to the question I refer to the patent 205,144.

75 X Q. Now please to point out the claim in that patent that is "for a stick of carbon rendered incandescent in nitrogen"?

A. Claim 16 is the one that I referred to more especially, which reads, "In the sealed globe of an electric lamp which contains an azotic or other atmosphere, an absorbent of carbonic acid gas," together with the following in the body of the specification, "To charge our lamp we prefer to employ nitrogen gas, and this we produce in the lamp by our improved process in a state of great purity."

76 X Q. Now, after reading the claim and the extract from the specification, don't you think your statement in your magazine article is too broad?

A. Not in a mere brief summary of the history of electric lighting as is purported to be given in the article.

77 X Q. Do you swear that the statement in the magazine article, of the Sawyer and Man patents, is an accurate statement of the facts as they appear in the patent?

A. The patent itself is the best evidence of what it contains. If what I stated is right it can be verified from the patent.

FRANCIS R. UPTON.

Postponed by consent to Thursday, June 30th, 1881, at same hour and place.

WM. H. MEADOWCROFT,
Notary Public, New York County.

3183

Edison's Electric Light.

By Francis R. Upton (Mr. Edison's mathematician).

Editor Scribner's Monthly.

Dear Sir: I have read the paper by Mr. Francis Upton, and it is the first correct and authoritative account of my invention of the electric light.

Yours truly, THOMAS A. EDISON.

Menlo Park, N. J.

The crowning discovery of Mr. Edison—the electric light for domestic use—is at last a scientific and practical success. A mistaken idea has been afloat that this new light was intended to be a rival of the sun, rather than what it really is,—a rival of gas. The contrivances of the new lamp are so absurdly simple as to seem almost an anticlimax to the laborious process of investigation by which they were reached. A small glass globe from which the air has been exhausted, two platinum wires, a bit of charred paper—and we have the lamp. The generator of the electricity is simpler than a gas-generator, and the wires for its distribution are more manageable than are gas mains and pipes. The light is equal to gas in brightness and whiter in color; it is inclosed and, consequently, perfectly steady; it gives off no appreciable heat; it consumes no oxygen; it yields up no noxious gases, and, finally, it costs less than gas. The difficulty of subdivision Mr. Edison has also overcome; in his method of illumination a number of separate lights can now be supplied from the same wire, and each one, being independent, can be lighted or extinguished without affecting those near it.

In order to a clear comprehension of the electric light, a few words upon the general subject are necessary. All illuminants are produced by the incandescence or white heat of matter. This matter may either be in a finely divided state—the particles widely separated—as in the flame of candles, lamps and gas jets, or an aggregation of particles, as in the calcium light. Both of these methods have been used in the various systems of electric lighting. Electricity flowing through a conductor generates a quantity of heat proportioned 1, to the amount passing through, and 2, to the friction, or resistance, of the medium. Ordinarily, the amount is hardly appreciable in a good conductor. When, however, a poor conductor forms part of the electric circuit, a heat is generated that, under certain conditions, rises steadily to whiteness, causing the substance

forming the imperfect conductor to become luminous. If the wire of an electric circuit be cut and the two ends, after being touched, are drawn slightly apart, the current leaps the chasm and a spark appears which vaporizes a small portion of the metal, and this forms a sufficient conductor to enable a constant electrical current to flow from end to end of the wire. When the two ends of the severed wire are properly tipped, a continuous and brilliant light may be produced. Carbon is found to be the best material for these tips, and so long as the current flows and the distance between the points is properly regulated, a storm of white-hot carbon particles is carried across the space, giving a brilliant illumination. This is the
voltaic arc, a light produced by the incandescence of finely
3184 divided matter. The broken circuit may be completed by
the interposition of some solid matter capable of sustaining a white heat without melting. Platinum and carbon were long thought to be the forms of matter which would best answer the purpose.

These methods of utilizing electricity presented so many difficulties that it was thought impossible to use either for domestic purposes. The objections to the voltaic arc were that the carbon did not offer sufficient resistance to the passage of the current, and that it wasted, the light therefore requiring either continual attention, or else some complicated mechanism, both troublesome and expensive, to keep the distance between the carbon points constant. (See Fig. 3.) The objections to platinum lay in its great cost and rarity, and the fact that its point of fusion is too low to ensure its successful use as the source of light. And finally the objection to all known methods was that the conductors necessary to the supply of any lamp then known would have been of such enormous cost and size as to be impracticable for general use.

In order to understand the difficulties of the problem presented to Mr. Edison, and the simple perfection of his lamp, a short summary of the history of the electric light will be necessary. The first method of illuminating by electricity was by the voltaic arc. About twenty years after the discovery of galvanism, or the modes of generating electricity by chemical decomposition, the voltaic arc was discovered by Sir Humphrey Davy. The battery of a single cell was succeeded by those of multiplied power. In 1812, by the use of a battery of 2,000 cells, Davy succeeded in producing an intensely brilliant arc measuring five inches. The experiment was, however, a very costly one, and had apparently no practical outcome; yet the effects produced by it were so brilliant that Professor Dumas, who repeated it in Paris, in 1834, predicted its final success as an illuminant, in spite of the enormous cost—six dollars a minute. For a number of years no improvement was made, the batteries then in existence being incapable of supplying a constant and steady flow of electricity. Daniell's invention in 1836 of a constant battery, used still in telegraphy, and Grove's improvement in 1839, of electrical generators, gave a new impulse to inventors. A constant and powerful current being supplied by these two inventions, the practical use of it was shortly afterward made in Morse's telegraph. In 1845, about the same time, we find that the first mechanisms for regulating the distance between the carbon points were independently invented by Staite and Foucault, who thus in another direction utilized the electrical power supplied by the batteries. Staite's patents show great inventive genius; in one of them there is a well-defined suggestion of the widely known Jablochkoff candles. In this field of research, as in so many others, the earlier investigators possessed a clearness of vision which enabled them to see further and more accurately than those who came after. Staite, before 1850, produced an electric light, which was exhibited in England, and was so favorably received that a company was organized and gas stock suffered a panic. Many other inventions were made, with a vast expenditure of time, ingenuity and patience, which, like those of Staite and Foucault, failed because of their great cost. It is not enough to invent a good light, nor even to perfect its mechanism; the cost of production must be small enough to enable it to compete with all existing methods of illuminating.

Electric lighting had now passed through three stages. It had been a brilliant laboratory experiment, it had been the subject of practical investigation, and it had been advanced to the precarious dignity of occasional use in the theaters and on great festal occasions. At the coronation of Alexander of Russia, the city of Moscow was lighted by numbers of electric lamps suspended in the old bell tower of the Kremlin, a thousand gilded domes glittering in the unearthly radiance, in happy contrast with the quaint arches of the old cathedral close at hand, while the river Moskva was transmuted into a stream of liquid silver.

The year 1860 saw improvements in generators. The force of steam was found to be convertible into electricity. In 1862 Faraday introduced the electric lamp into a British light-house. France and Brazil tried the same experiment, but even this failed to arouse public interest. The invention of the Gramme generator (though an instrument fully anticipating it had been lying for years in the cabinet of an Italian university) at last gave the impetus needed to set the inventors at work. This was soon followed by the Jablochkoff candles, the contrivance by which some streets in Paris are illuminated. So much for the history of illumination by the voltaic arc.

In 1845, to go back to the second method,—that of illuminating
by an incandescent solid,—an American named Starr, backed
3185 by George Peabody, went to England, and took out a patent
for the use of platinum, which had been already employed
in laboratory experiments, although it had never been used for
practical purposes. In the same year Grove speaks of reading by
an incandescent platinum spiral.

In 1847, Dr. Draper, of New York, made a number of experiments to test the qualities of highly heated platinum. He used a lever suspended by a straight wire, very much resembling a door latch held by a string. So marked was the illumination from, and the expansion of, the heated wire at the temperature required for the experiment that he wrote: "An ingenious artist would have very little difficulty, by taking advantage of the movement of the lever, in making a self-acting apparatus in which the platinum wire should be maintained at uniform temperature, notwithstanding any change taking place in the voltaic current." This suggestion, though so clear and practical, lay for twenty years unheeded, and would probably have done so much longer, but that Mr. Edison, with no knowledge of it, entirely independently made use of a similar device and proved himself to be the "ingenious artist," in his first electric light invention.

Fig. 1 shows the plan of the apparatus.* The current enters through the curled wire at the left, and flows from one post, P, to the other, P′, through a spiral and out at the right. It is carried to the top of the glass case, G, then through the straight wire, W, to the lever at A, then to the hinge, H, so that it escapes at the right. In passing through the straight piece of platinum wire, W, enclosed in the spiral the heat generated by the current causes the wire to expand. This expansion allows the lever, L, to fall until it touches the point, B. When this is done the electricity takes the short route through the lever and does not pass through the lamp. The wire, W, contracts and the process is repeated.

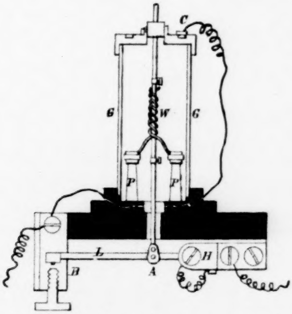


FIG. 1.—*Section of Edison's Expansion Regulator.*

Another method of accomplishing the same purpose is shown in Fig. 2. The current passes, in this case, through the wire, W. In

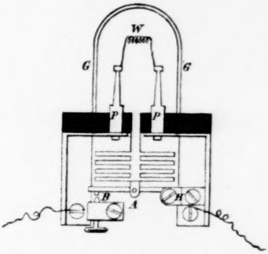


FIG. 2.—*Edison's Pneumatic Regulator.*

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* The portions marked black in the cuts are insulated.

so doing it heats the air in G. The air in expanding forces downward the small metal bellows which is connected with the chamber, until the lever attached below closes the break, B, and short circuits

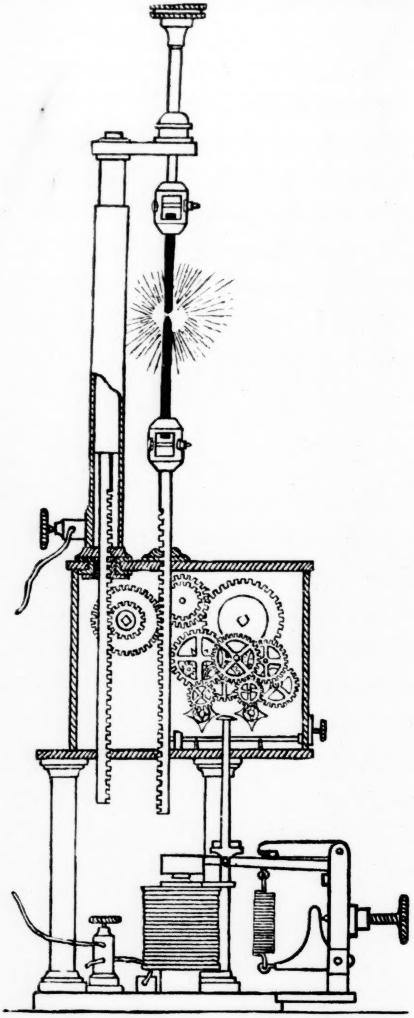


FIG. 3.—*Foucault's Regulator.*

the lamp, allowing the air to cool. These two inventions really belong to the infancy of electric lighting, though invented by Mr. Edison only a short time ago.

In 1849 Despretz describes a series of experiments on sticks of incandescent carbon which were sealed in a glass globe, the air being exhausted, or nitrogen substituted for it. He used several ingenious methods for holding the carbon—patented within the last few years.

So completely had the mode of lighting by an incandescent solid been forgotten, that in 1873 a medal was bestowed by the St. Petersburg Academy on Lodyguine for its supposed discovery, and letters patent were granted to Sawyer and Mann for a stick of carbon rendered incandescent in nitrogen. No successful light by incandescence had, however, been produced when Mr. Edison began his experiments.

In 1878 the lighting of Paris by the Jablochkoff candles was creating a great stir. It had been proved that electricity was really a rival of gas, and that, especially where great concentration was needed, it could take its place. The question now was whether light could be produced in such small amounts as to make it of general domestic use. The money value of an invention which could
compete with gas may be judged from the following items:
3186 The United States has $400,000,000 invested in gas, New
York and the vicinity owning about $35,000,000 of this; England has $500,000,000, $60,000,000 of which is in London. Paris has $40,000,000; Germany $50,000,000, etc. Capitalists, with these figures before them, and the further fact that notwithstanding the great depreciation in plant, the larger portion of this enormous capital was drawing ten per cent., were quick to see an opening for their money and enterprise. Several New York gentlemen, Mr. Grosvenor P. Lowrey and members of the eminent banking-house of Drexel, Morgan & Co. being the most prominent, placed $100,000 in cash at Mr. Edison's disposal, as the requisite means to make the research.

Mr. Edison came to the investigation unhampered by the blunders of his predecessors. He had never seen an electric light. He took hold of the subject in his usual clear-headed, practical way. Next to solving a problem, its intelligent statement is to an investigator the most important thing. Mr. Edison saw that permanence in the lamp and a subdivision of the light were the main things to be sought after. Of the two methods already described, he soon discarded the carbon arc. He perceived that from its nature this arc was inconstant, as its very existence depended upon the destruction of the carbon, and also that it presented greater difficulties in the way of subdivision. Even if he succeeded in conquering the latter difficulty, and was enabled to produce small lights, the carbon rods waste so rapidly that a system of such lamps would require an expert for every four or five houses to keep it in working order. The most effective apparatus then devised was Foucault's regulator, Fig. 3, which it will be seen is a very complicated piece of mechanism. The Jablochkoff candles, simple as they appear to be, require mechanical contrivances to light them and keep them burning, each candle lasting only a few hours, which makes the constant expense for new burners more than that of the electricity which they can utilize. Mr. Edison, therefore, concentrated his attention wholly upon the light from an incandescent solid.

The advantages of subdivision are twofold and may be explained in a few words. To show that a good gas jet or German student's lamp gives, near the source of light, all the illumination necessary for ordinary domestic purposes, a simple experiment may be tried. A printed page directly under the light, will be seen to be brightly illuminated. After carefully noting this, let another equally strong light be kindled. The room will be brighter, but the page will appear to be scarcely brighter. This is because beyond a certain limit the eye becomes insensible to light. One therefore gains nothing for ordinary use from a single intensely brilliant light. The object of such an illumination being of course to bring, by means of several moderate lights, all parts of the room up to that point where the eye, before it begins to be numb, can utilize the light. This explains the first advantage of subdivision;

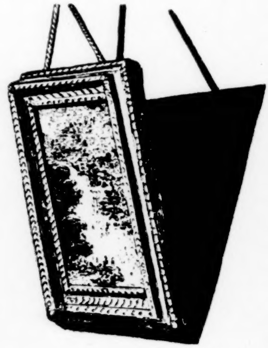


FIG. 4.—*Effect of Carbon Arc Illumination.*

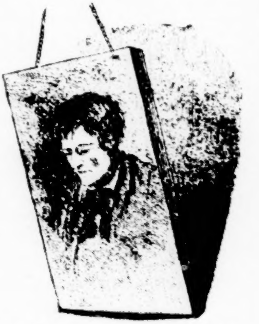


FIG. 5.—*Effect of General Illumination.*

3187 the second is of another kind. Every one familiar with the
electric light, as it has been exhibited, knows that the intense brilliancy of the light and the sharp definition of the shadows

as well as their depth, makes it most trying to the eyes. The same amount of light distributed among a number of burners would not give more illumination, but it would be of more practical value, the light would be more diffused, the contrast between light and shadow less sharp and startling. Fig. 4 shows the effect of a shadow from a single brilliant carbon light, and Fig. 5 the effect from several shaded lights; the advantage of the latter for practical and domestic use will be readily seen. This is equally true with other illuminators; though gas may be made to give out a brighter illumination per cubic foot when burned in a concentrated form, it is yet more grateful to the eye and less trying when burned as a number of small lights, so that sharp contrast shall be avoided. It is also found that the shape and size of flame, apart from the quantity of light emitted, makes a great difference in this respect—a large light softening the edges of the shadows. The shading of a light, although it obstructs illumination, is useful in diffusing it.

As has been said, Mr. Edison came to the subject unhampered. He saw that subdivision was his goal, and toward that he steadily worked. With a steadfast faith in the fullness of nature, a profound conviction that, if a new substance were demanded for the carrying out of some beneficial project, that substance need only be sought for, he set to work. Two examples of the reward of his faith may be mentioned. One of the great difficulties in the way of illuminating by an incandescent solid—a difficulty constantly urged as insuperable—was that platinum, though the most infusible metal which could be drawn out into a wire, still melted at a temperature too low to insure its successful use. Mr. Edison, by experimenting, found that by slowly raising a piece of platinum to a white heat in a vacuum, he could make a practically new metal, the fusing point was so greatly raised. Again, Mr. Preece, chief government electrician in England, declared, and was sustained by many others, that subdivision of the electric light was impossible, because of the enormous size of the conductors and the number of Faradic generators necessary. Edison simply introduced into his lamp an increase of friction or resistance to the electric flow, and the problem was solved.

Mr. Edison's idea in regard to the electric light was that, in all respects, it should take the place of gas. Following the analogy of water, the inventor conceived of a system which should resemble the Holly water works. As the water is pumped directly into pipes which convey it under pressure to the point where it is to be used, so the electricity is to be forced into the wires and delivered under pressure at its destination. In the case of water, after being used, it flows away by means of a sewer pipe, and is lost. But it is easy to imagine that the water used in working machinery, for instance, instead of being lost, might be returned to the pumps and used over and over again. With such a system as this, we should have perfect analogy to the Edison electric lighting system. The electricity, after being distributed under pressure and used, is returned to the central station. As the light results from no consumption of a material, but is mere transmutation of the energy exerted in the

pumping process, it is therefore seen that all which is es-
3188 sential to an electric lighting system is the generator (or pump),
the two lines of wire, one distributing the electricity, the other bringing it back, and a lamp which transmutes into light the energy carried by the electricity when it passes from one wire to the other, and in which the energy of the pressure expresses itself as the light. In Edison's invention the amount of electricity delivered in the lamp is determined by the size and resistance in the carbon, just as in water the amount of flow is determined by the size of the openings. As a great many small jets of water can be supplied from one pipe, so a great many lamps or small escapes for electricity can be furnished from one wire.

As in the case of water, the amount of work done by electricity—either as illuminant or motor—is dependent quite as much upon the pressure from which it escapes as upon the quantity passing through the wires. We might have a system of lamps which would give a certain amount of light from large quantities of electricity escaping under low pressure, or another system which could give an equal amount of light from a small quantity of electricity escaping under high pressure. As in either case the amount of electricity flowing through a wire is in proportion to the size of the wire, it will be readily seen that the application of pressure made by Mr. Edison obviates the main difficulty in the way of subdivision (*i. e.*, in the way of the domestic use of the electric light), namely, the enormous size and cost of conductors. The well-known principle of the effect of pressure upon the dynamic power of electricity had never been utilized because the proper lamp was still unknown. This lamp is Mr. Edison's main discovery. In order to utilize this, one of the plans devised by him was to make the flow of electricity intermittent. Enough was allowed to escape in a short time, say one-third, to keep the lamp all the time supplied. It of course would require a large wire to furnish the quantity of electricity needed, yet two-thirds of the time the wire would be inactive, during which period it could be used to supply two other lamps constructed on the same principle. According to the doctrine of probabilities, one-third of a large number of lamps would be in use all the time. Such being the case, the cost of a conductor would be divided among three lamps. The lamps were so constructed as to burn steadily all the while, although the electricity was passing through them only one-third of the time.

One form of apparatus for accomplishing this distribution among several lamps on the same electrical circuit is shown in Fig. 6. The current conducted by a single wire enters the wire, O, from the lower left-hand corner and flows through the spring, S, by way of B and B; upward through O′, around the magnets, M, M, and out through the lamp, B, B, are two points where the circuit can be broken if the spring, S, is depressed. Two points are made in order that the spark caused by the breaking of the circuit may be made less by division. The spring S is depressed by the arms, C, C, which are attached to the armature, A, by the rod, R. The action is as follows: The current renders the magnet active, it attracts the armature, A, and presses the spring, S, under, stopping the flow of electricity by breaking the circuit at B B. The magnet thus losing its power, the armature is drawn back by the spring to which it is attached and the apparatus is ready to work again. The period of this vibration may be regulated by means of a screw underneath, which can make the excursion of the armature more or less before it breaks the circuit, or can even act to break the circuit itself.

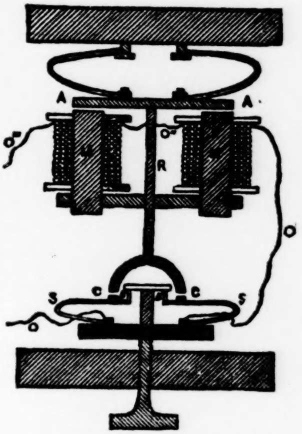


FIG. 6.—*Edison's Vibrating Regulator.*

In making an electric lamp which would be efficient without a
regulator (as is Mr. Edison's later invention), two things are essen-
tial, great resistance in the wire, and a small radiating surface. Mr.
Edison sought to combine these two essential conditions by using a
considerable quantity of insulated platinum wire wound like
3189 thread on a spool. This arrangement is shown in Fig. 7.
The spool was made of zircon, pressed extremely hard, and
was to be suspended in an exhausted glass bulb by two leading wires.
The platinum, as has been incidentally mentioned, was hardened
by alternate heating and cooling *in vacuo*, which is done by passing
electricity through it till white heat is reached and then cutting it
suddenly off. A theory is that the sudden cooling contracts the
metal and squeezes out the air contained in it.

One of Mr. Edison's greatest difficulties was to get a substance with which to insulate his wires that would not melt, and also become a conductor in the intense heat generated by the current,—in which case the electrical flow instead of traversing the whole length of the wire would flow across from layer to layer, or sidewise from wire to wire. This difficulty diverted his attention from platinum to carbon, which is infusible. He did not suspect, at first, that it could be made to offer sufficient resistance to the passage of the electric current, and that through it he was to reach a happy

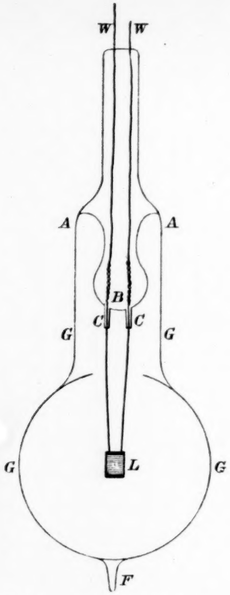

W
W
A
A
B
C
C
G
G
G
L
G
F

FIG. 7.—*Edison's Platinum Lamp. Half size.*

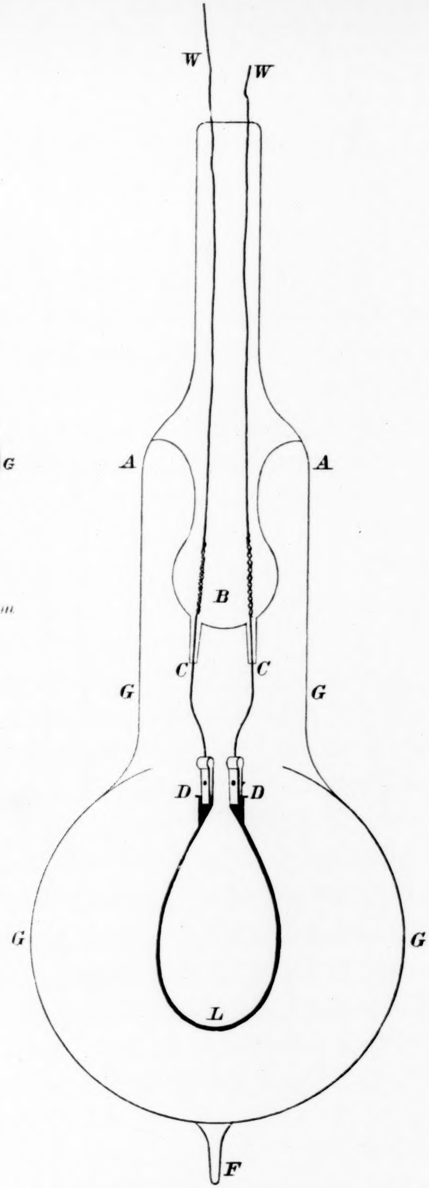

W
W
A
A
B
C
C
G
G
D
D
G
L
G
F

FIG. 8.—*Edison's Electric Lamp. Exact size.*

solution of the entire problem. A long time was spent, with a fair degree of success, in seeking to make a spiral of lamp-black tar in the form of a wire. To hold this together he used a bit of ordinary sewing cotton which was covered with lamp-black, and succeeded in producing from an inch and a half of this simple thread, bent into an arch, a light equal to an ordinary gas jet. The lamp-black, however, contained air, which greatly interfered with the success of the method. He then used a simple thread, which he found to answer the purpose, though it presented the objection of being fragile, uneven in texture, and unmanageable. This difficulty suggested the use of charred paper, cut into a thread-like form. The difficulties apparently so insuperable melted away. The electric lamp was com-

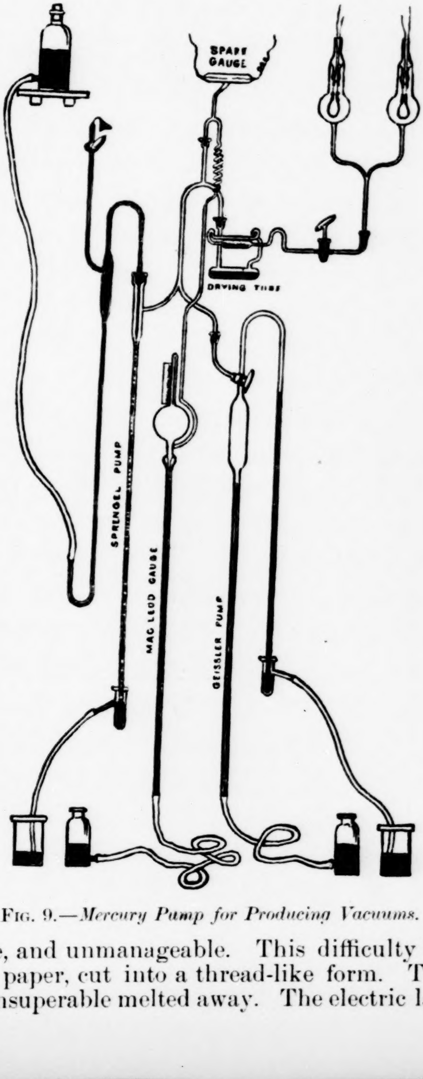


FIG. 9.—*Mercury Pump for Producing Vacuums.*

pleted. A piece of charred paper cut into horseshoe shape,
3190 so delicate that it looked like a fine wire, firmly clamped to
the two ends of the conducting and discharging wires, so as to form part of the electric circuit, proved to be the long-sought combination. From this a light, equal in power to twelve gas jets, may be obtained. Fig. 8.

The process by which the paper is rendered serviceable is also extremely simple and inexpensive. The horseshoe loops are cut from card-board and placed in layers, within an iron box, with tissue paper between; the box is hermetically sealed, and then raised to a red heat. Nothing remains but the carbon loops and the carbonized tissue paper. All other forms of carbon previously used had presented the difficulty of containing air or gas. The carbonized paper, however, is found to be perfectly homogeneous in structure, elastic, tough, and of an almost vitreous cleavage. It is strong enough to stand far more strain than will be put upon it in any ordinary use. If this paper were burned in air, or in a vacuum prepared by a common air pump, it would of course be almost instantly destroyed. In a high vacuum it burns, but is never consumed. The small glass globe which holds the simple apparatus is exhausted of air by means of nearly the same combination of the Sprengel and Geissler mercury pumps used by Crookes in making his radiometer, or "light mill," and in his wonderful discovery of the phenomena of radiant matter in high vacuums, recently brought before the Royal Society of England. Much attention has been bestowed of late on the question of securing good vacuums. An absolutely perfect one is unattainable. It is, however, found that, by the use of the mercury pumps and chemical appliances, where a nearly perfect vacuum is formed, the minute portion of air remaining shows some remarkable properties. When electricity under strong pressure passes through an Edison lamp, the whole bulb shines with a delicate blue light. So remarkable is the behavior of various substances in a vacuum prepared by means of mercury pumps, that physicists consider that a gas thus rarefied constitutes another state of matter, differing as much from that of an ordinary gas (either under atmospheric pressure or with the pressure removed by means of a common air pump) as a gas differs from a liquid, or a liquid from a solid. Mr. Edison's use of carbon in such a vacuum is entirely new.

The pumps are shown in Fig. 9; the Geissler pump is to the right and below. By raising a bottle which is connected with it, the air is forced out of a large glass bulb, and allowed to escape through the tube A. On lowering the bottle, the mercury flows back into it, leaving a vacuum in the bulb. The opening of a stop-cock allows some of the air which is left in the pump to flow into this bulb, when the air is again forced out as described; this is continued until the air is exhausted. The working principle of the Sprengel pump is the continuous dropping of mercury through a tube, each drop acting as a piston, carrying before it a small quantity of air. As
there is no return stroke, even by the aid of a small tube, the
3191 work of exhaustion goes on quite rapidly. The MacLeod

gauge in the center is so constructed that it will measure with exactness when less than one-millionth of the original air is left in the pump.

Another purpose besides that of preventing the destruction of the carbon is served by burning it in a vacuum. Almost all the electricity is converted into light, very little being dissipated by convection or conduction as heat. The little glass globe only an inch from this brilliant light remains cool enough to be handled, and does not scorch tissue paper wrapped closely around it.

Fig. 8 shows the lamp of its actual size. The current enters it by one of the wires, W. At B this copper wire is twisted and soldered to a platinum wire, which passes through the glass at C, and by means of a small platinum clamp into the horseshoe, L, from which, by as simple a route as it entered, it returns. L, the source of light, was made in the form of a horseshoe, in order to approximate to the shape of a gas jet, and is large enough to cause the edges of the shadows to be softened down, and so obviates the common objection to familiar forms of electric lighting. The carbon is sealed in a glass bulb, G G G G, the knob of glass, F, is the melted extremity of the tube by means of which the bulb was connected with the pumps. At the points, C, C, where the platinum wires are sealed into the bulb, some trouble was occasioned by the cracking of the glass, which allowed air to leak into the bulb. It will be noticed that the glass is now drawn up around the wire in a thin tube. This is found to heat and cool so rapidly that it is practically homogeneous with the wire, and even if the wire be heated red hot it will not break. Mr. Edison has tried putting a lamp alternately on and off the circuit for several hours by means of a telegraph key, without loosening the wire. This experiment was equivalent to using the lamp several thousand times.

Mr. Edison has thus succeeded in making a lamp of the simplest imaginable construction, and of materials whose expense is extremely small. The paper costs next to nothing, the glass globes very little, and the platinum tips of the wires are so small that, though the metal used is expensive, their cost is trifling. The test of the value of every invention is its simplicity, and this is the crowning characteristic of Mr. Edison's lamp, for it is really nothing more than a piece of wire looped into a glass globe.

The lamp being complete, let us consider the generator [Fig. 10], for which Mr. Edison has proposed the name Faradic, in honor of the great physicist.

The cylinder which is placed below, between the blocks of
3192 iron, F, on which the magnets, M, rest, is called the armature,
and is so arranged that it can be made to revolve rapidly by means of a belt. This armature consists of a small cylinder of wood, which is wound around with iron wire as thread is wound on a spool, the ends being made as in a spool, to hold the wire in place. Around the whole spool are a number of loops of copper wire, covered with cotton thread, running lengthwise of the armature. The ends of these loops may be seen as they are taken from the armature to the cylinder, C, which is an extension of the arma-

ture, by which the currents generated in the copper wire may be taken away from the machine. This cylinder, called the commutator, consists of blocks of copper that really represent the ends of the wire, which are placed side by side around the axis of the cylinder in such a manner that no current can pass from one to the other. Touching these as they revolve are brushes, R, made of copper wire, by means of which the electricity flows from the machine.

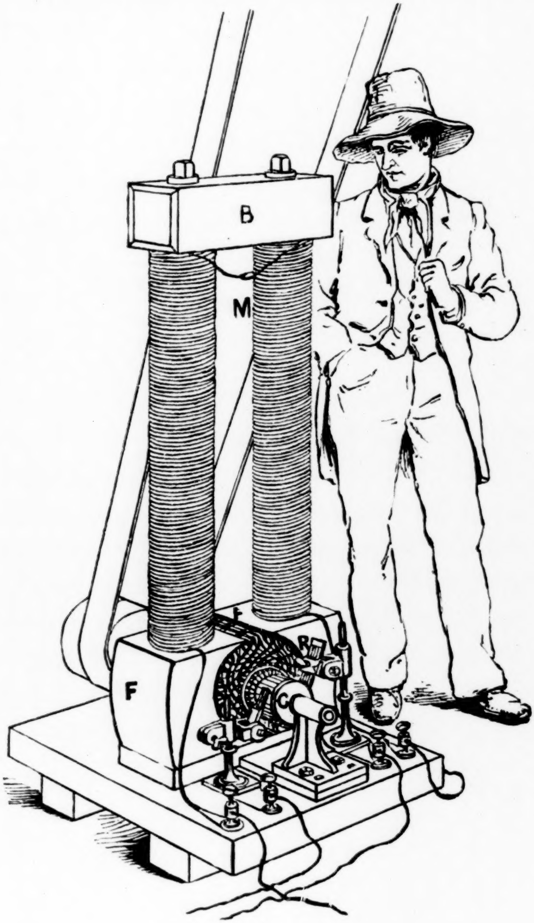


Fig. 10. *Faradic Generator.*

That the wire about the armature may be able to pump electricity into the line, it is needful that it be revolved immediately in front of magnets. The magnets are made of such large dimensions that the electricity, which is pumped through the machine, may meet with as little friction as possible in passing through the wire of the armature, since by means of the great strength of the magnets, very little wire can be made extremely powerful in forcing the electricity to a higher level or in putting it under pressure. It is exactly as in pumping water, if we have a poor pump (analogous to a machine with a poor magnet) the water may meet with an enormous friction in the pump itself, or require two or more, perhaps, to give it the required pressure, while in a good pump all the parts are so made that while great pressure is given to the water, it passes through it with the utmost freedom. The machine has such strength that it is intended to use only a small fraction of the power, which it could convert into electricity, and deliver outside.

It is proposed to mass a large number of such machines, as in Fig. 11, and have them all pump electricity up from one wire into a second. The two large wires, held on supports above the floor, are intended, the one to carry the electricity away, and the other to bring it back after it has been used. Two machines are placed at one side; these are for the purpose of rendering active the magnets of all the others.

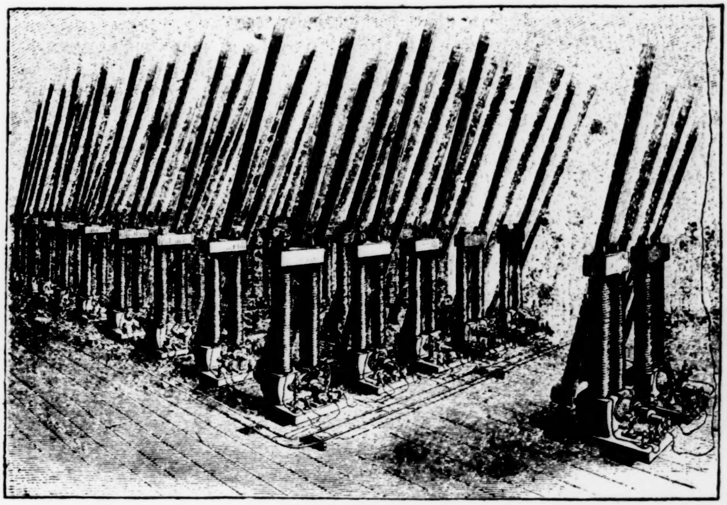


FIG. 11. *Proposed Central Station.*

3193 It is proposed to establish such stations in the course of a few months in the heart of several of our large cities. These will supply houses for quite a distance around them. 1,000 horse power is thought to be a sufficient amount for a unit, and the stations will be at such distances from one another that each district will require about this amount. The engines will be divided into four groups of 250 horse power each, with a spare one in each station of the same power.

The wires will be laid in fascines or bundles under the edge of the sidewalk in a tight box. The object of this is to make them easy of access and easy to place in position. Nor is there need of putting them out of the reach of the frost, for they are continuous and not liable to leak from change in position. Even more important is the fact that the colder the wires are the less is the waste of electricity, thus giving a decided advantage over gas in winter, when most light is needed.

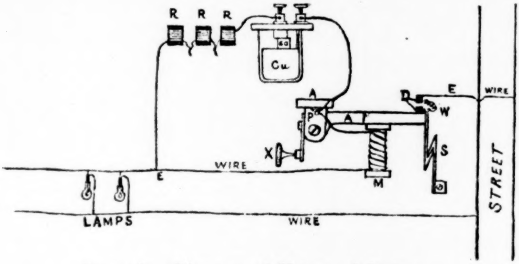


FIG. 12. *Diagram of Meter and System.*

The main wires may be either of iron or copper according to the market price of these metals; as quotations are to-day the preference is slightly in favor of copper wire. These lines of wire will start from the central station and send out branches in the same manner that gas or water pipes diverge, growing smaller the farther they are removed from the central station. Fig. 12 also shows the branch wires as they enter the house. It is proposed to color the distributing wires red and the waste wires green. These two distinct wires will be carried all through the house, and every lamp will be so placed that the electricity will flow through it from one wire to the other.

Before passing into the house, the electricity is carried through a sort of meter containing a safety-valve, by means of which it can be measured. The contrivances for doing this are shown in diagram, in Fig. 12, and in perspective in Fig. 13. The lettering is the same in both for identical parts. The current enters at E, passes through the two platinum points, D, then through the armature, A, to the dividing points, P P. The larger portion of the current then flows around the magnet, M. The armature above the magnet is held from it by means of the spring, X. The object of the device is to furnish a means of cutting out a house if too large a flow of electricity by any accident should occur. The magnet would then be capable of drawing down the armature which would separate the platinum points, D, and break the circuit.

The small wire, W, serves a double purpose and is a remarkably clever solution of a double problem. First: If the circuit were partly opened it would weaken the magnet, and the armature would recede, closing the circuit. It would thus form a vibrator resembling Fig. 6. The wire, W, allows enough electricity to pass to close the snap, S, so that the armature is firmly held in place, after which the wire, W, will melt off and completely break the flow of electricity. 3194 Secondly, the wire serves another purpose: If the points were drawn apart an arc would spring between them. The wire,

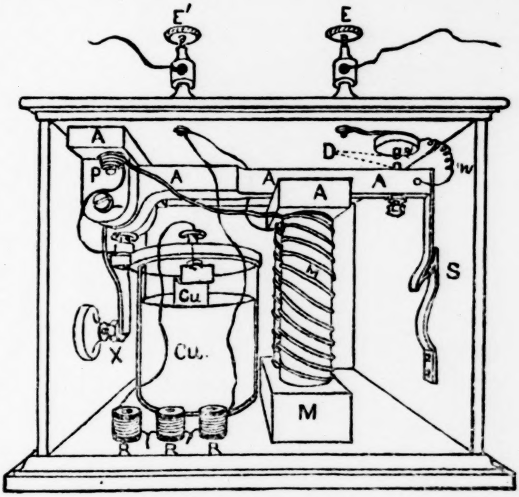


Fig. 13. *Edison's Electric Light Meter.*

W, conducts the electricity by a shorter route than that offered by an arc and so keeps the space between the two points free from the intensely heated vapors of the metal.

A small fraction of the current passes by another route to the lamps, from the point P. It first traverses a length of wire wound on small spools marked R. The amount placed here will regulate the flow through this line. The current next passes through from one copper plate marked C *u* to another, through a solution of copper salt. In thus flowing, for every unit of current a certain amount of copper is deposited on a thin sheet, the amount for a lamp being once determined by burning one for a number of hours. It must be remembered that only a small amount passes through the meter, but that which passes is proportionate to the whole. It is proposed to make a standard lamp, which shall give a light equal to that from a gas flame consuming five cubic feet each hour. From this it will be calculated how much copper will be deposited, and the amount will be said to represent five cubic feet. The bills for electricity will be made out in 1,000 feet, as in the case of gas. The inspector will take the strip on which the copper is deposited to the central station, in order to determine the amount of electricity used.

Besides giving light, the electricity supplies a convenient form of motor for domestic purposes. A small electrical engine placed beside a sewing machine for example, and connected with the distributing wire, may save all the fatigue of treading the machine, at an expense exactly equal to that of one jet burning for the same time. Elevators may be lifted, lathes turned, and instruments operated up to several horse power, by this same means. Fig. 14 shows the form adopted by Mr. Edison. It is substantially a small model of the large Faradic machine, the only change being in the fact that the armature, C, is placed lengthwise of the magnets, M M, instead of across them. At S is a switch by means of which the motor can be started or stopped. It is expected that the amount of power used in the daytime will largely pay for the expenses of generating—an additional advantage over gas.

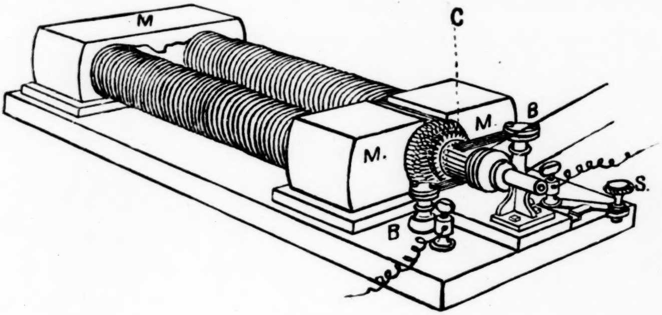


Fig. 14.—*Edison's Electric Motor.*

In order to use the lamp, it is brought into the circuit by turning a handle in a certain direction, or thrown out by reversing the motion, or by means of plugs, which are inserted in a socket. This may be done either in the chandelier or in any other convenient place in the house. Very simple arrangements may be made so that by touching a knob by the bedside the whole house may be brilliantly lighted for the reception or discovery of a suspected burglar. Of course, no matches have to be used; the light kindles itself by the turning of a handle, and so one fruitful source of destructive fires is avoided.

In order that the philosophical relations of the processes may be understood it is needful to trace the history of the energy as it is taken from the coal and conveyed over the wire to the lamp. A large portion of the heat produced by the combustion of the coal under the boiler is found in the steam as it flows to the engine. By means of the latter a small fraction, about ten per cent. of the original energy, is transformed into the motion of the wheels attached to the engine. It may be traced as it flows through the belt to the shaft, and again as it is carried from the shaft to any machine which it may drive. A belt exactly resembles, in carrying power, a man pulling a shaft around by means of a rope. The amount he is pulling can be measured by the strain on the belt, and the work he is doing by determining the speed with which he carries

the end of the rope. Mr. Edison has made a device, repre-
3195 sented by Fig. 15, to measure this strain. The belt starting
from the pulley over the main shaft, C, is carried under a
pulley, A, which is attached to a large box containing heavy
weights. This box is placed upon a platform scale. The belt then
runs over pulley, D, which it has to drive, and under a wheel, B,

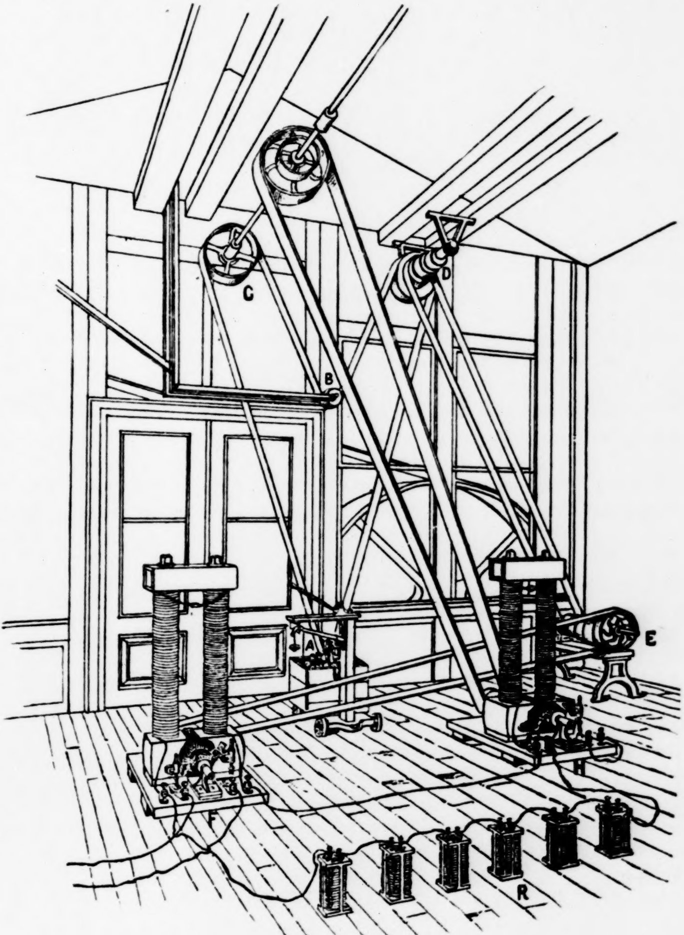


FIG. 15.—*Edison's Dynamometer, for Measuring the Force of an Electric Current.*

which rests heavily upon what would otherwise be the slack part of the belt, for the purpose of tightening it. The pulley, A, attached to the weight, will have a tendency to be drawn upward by any strain that may be put on the belt, just as the block of a tackle is drawn up when the rope is tightened which runs through it. The weight lifted may be measured by the diminution of weight on the scale, one-half of which gives the strain on the belt. Fig. 15 also shows the arrangement of machines as they were placed in order to be tested. The cones D and E were for the purpose of changing the speeds at which the machines were run. The machine, H, at the right, renders active the field of the other machine, F; the current may be regulated by passing through more or less of the resistance boxes, R. By means of this apparatus the exact amount of power carried by the belt can be reckoned when its speed is known. This latter measurement is made from the main shaft.

The energy which the belt carries is seemingly lost, as material motion, when it has turned the armature of the Faradic machine. Since this seems to be a point where the majority lose the track of the energy, in order to explain clearly allusion must be made to some fundamental experiments. Arago many years ago tried this experiment: a sheet of copper, which is not attracted by the magnet under ordinary conditions, was passed between the two poles of a powerful magnet, and it was found to be retarded in its motion. If the magnets are extremely strong, though the copper sheet to the eye passes through nothing but air, yet to the hand it seems
3196 as if it were cutting cheese, so strong is the drag put upon
the copper. This phenomenon Tyndall calls the apparent viscosity of the magnetic field. Faraday, a few years after this discovery, clearly explained the reason for seeming friction between the plate of copper and the invisible lines of magnetic force which he imagined to reach out from every magnet. He used wires and passed them in front of the magnet, and found that whenever they were made to cut these lines electricity was thrown into the wire. This grand discovery is at the basis of all that is now done in making strong currents, for it furnishes the method by which motion of mass may be transformed into the molecular motion called electricity.

As the energy appears in the wire, it is measured again by an electrical dynamometer, the main idea of which was that of Professor Trowbridge, of Harvard university.

By means of the two instruments, one is enabled to trace out the amount of energy absorbed and given back by the machine, and in many cases ninety per cent. of the original power applied is found converted into electricity. A system of electric lighting is nothing more than a gas system, where energy takes the place of vapors.

It is one of the laws of progress, that no sooner is a method for producing a certain result perfected than a practical use of it follows. This is attested by the history of many great inventions. Following out the laws of discovery, it has been for some time a speculation of the writer that the wonderful perfection to which vacuums had been brought, pointed historically toward some direct connection between them and the electric lamp. For the past few years no more striking result of scientific work has been effected than the startling phenomena shown in high vacuums; parallel with this, a growing want has been felt for a cheaper and more efficient mode of illuminating. Is this a mere coincidence? or may we believe that the demand and means of supply have been developing independently, but side by side; and that now in the electric light we find a practical application of what had been reached by purely theoretical research?

Besides the enormous practical value of the electric light, as domestic illuminant and motor, it furnishes a most striking and beautiful illustration of the convertibility of force. Mr. Edison's system of lighting gives a completed cycle of change. The sunlight poured upon the rank vegetation of the carboniferous forests, was gathered and stored up, and has been waiting through the ages to be converted again into light. The latent force accumulated during the primeval days, and garnered up in the coal beds, is converted, after passing in the steam engine through the phases of chemical, molecular and mechanical force, into electricity, which only waits the touch of the inventor's genius to flash out into a million domestic suns to illuminate a myriad homes.

3197 Pursuant to adjournment this testimony was continued June 30, 1881, at the same place, same counsel being present, and also Mr. Edison, one of the parties to this interference.

Mr. KRUESI recalled:

36 Q. I asked you in question 5 "What is the earliest date which you remember of Mr. Edison's experimenting with electric lights," to which you answered, "I am not sure whether it was the summer of '77 or summer of '78." Please state whether you have made such examination of memorandum books since giving the above answer, as will enable you to fix the time more definitely.

Objected to on the ground that it is a re-examination of the witness on a point about which he had already been examined.

JOHN KRUESI, a witness produced on behalf of Mr. Edison, testified on oath as follows, in answer to questions proposed by GEORGE W. DYER, counsel for Edison:

40 Q. Have you been previously examined in this case?
A. Yes.
41 Q. Since your former examination have you found a memorandum book which enables you to fix with certainty dates about which you were uncertain when you testified before?

Question objected to on the ground that it is intended to call out matter and facts about which the witness has been already examined.

A. Yes, sir.

42 Q. Refreshing your memory by such memorandum book,
3198 what is the earliest date you are able to fix in which Mr.
Edison was engaged in experimenting upon electric lights?

Objected to as immaterial.

A. January the 5th, 1877.

43 Q. If you have such memorandum book, please produce it and describe what the book is.

Objected to as immaterial and impertinent.

A. I do produce the book. The book is a memorandum book in which I put the time down for which I requested pay, showing how the time or in what the time was occupied.

44 Q. Is this book in your own handwriting?

A. Yes, sir.

45 Q. Were the entries made at the time marked in the book?

A. They were always made never later than the next following Saturday, and generally every day; sometimes even three or four times in one day.

46 Q. Please read from the book the items which bear upon experiments in electric lights by Mr. Edison giving the dates which appear in the book.

Objected to as incompetent to prove the contents of the book, unless the book is put in evidence.

A. "January 5th, 1877, electric lamp, 3 hours." "January 6th, 1877, electric lamp, 4 hours." "1877, January 20, air pump, 8 hours."

47 Q. For what purpose was the work done on this air pump under the date of January 20th?

A. To my best recollection for an electric light purpose.

Memorandum book referred to put in evidence and marked Edison's Exhibit No. 12.

Exhibit objected to as incompetent evidence upon any issue in the cause.

3199 Counsel for Edison gives notice that he here concludes his examination of this witness and offers him to counsel for Sawyer and Man for cross-examination.

Cross-examination by Amos Broadnax, counsel for Sawyer and Man:

48 X Q. Is this book in your handwriting—the whole of it?

A. Yes; I don't see anything that isn't my own handwriting.

49 X Q. In whose employ were you when you made this memorandum book?

A. In Mr. Thomas A. Edison's.

50 X Q. And does this book show the time you was at work on different kinds of work for Mr. Edison?

A. Yes, sir.

51 X Q. Where was you working from June the 13th, 1876, to January 2d, 1877?

A. I was working for Mr. Edison in Newark, N. J.

52 X Q. Are all the entries in this book made in lead pencil?

A. All except a few entries in the last four leaves of the book, and three entries in October, 1875.

53 X Q. Referring now to the entries in this book made on the page beginning with January 2d, 1877, do you swear that the entries on that page are all in your own handwriting, and that they were made by you on the day of the date set down in the left-hand column of the page?

A. Yes, I am positive that they are all in my own handwriting, and that they are put down not later than the next following Saturday to these respective dates, or on the same day that they are dated.

54 X Q. Does the column of figures on this page headed Particular Jobs represent the number of hours you were employed each day upon the job mentioned in the middle columns, in which the name of the job is given?

3200 A. Yes, sir.

55 X Q. Does this represent your own time, and not the time of somebody else?

A. It is only my own time.

53 X Q. By this book it appears that January 5th you worked three hours on electric lamps. What kind of electric lamp was you working on, and what was you doing to it during those three hours?

A. I do not remember the lamp, nor exactly what I did to it.

57 X Q. Is the same true as to the work it appears that you done on electric lamp on January 6th—four hours?

A. Yes, sir.

58 X Q. Is this your book?

A. Yes, sir.

59 X Q. Your own private property?

A. Yes, sir.

60 X Q. Has it been in your possession ever since it was made?

A. It has been in my possession ever since I made the entries.

61 X Q. Why didn't you refer to this book and produce it when you was previously examined in this case?

A. I was called to this examination from my place of business in the city of New York, and the book I kept in my house at Menlo Park, New Jersey. Therefore I did not have it at hand.

62 X Q. Have you got any more books bearing upon this subject?

A. Yes, sir. I have some more, but to my knowledge they do not bear upon this subject.

63 X Q. How does it happen that there are no entries in this book from June 13, '76, to January 2, '77?

A. The entries may be in another book, on account of the dissolving of partnership between Mr. Edison and Mr. Murray at that time. JOHN KRUESI.

3201 THOMAS A. EDISON resumes his testimony as follows, this 30th day of June, 1881:

375 Q. In your answer to question 374, you have not stated the nature of the duties of the assistants employed by you. Please do so now.

A. Francis Jehl was employed generally to assist in any kind of experiments; John Kruesi was foreman of the machine shop; Charles Clarke, mathematician and mechanician; Charles Batchelor, principal assistant on general experimenting; Wm. Hammer, assistant on vacuum pumps; Mr. Herrick, time-keeper for the lamps; Dr. Haid and Mr. Lawson, chemists; Martin Force, assistant on any experimenting; Dr. Moses, chemist and assistant on general experimenting; E. H. Johnson, assistant outside of laboratory generally.

376 Q. Have you been present this morning during the examination of J. Kruesi, and have you seen the memorandum book produced by Mr. Kruesi, and marked Edison's Exhibit No. 12?

A. Yes, sir; I have.

377 Q. In view of the testimony of Mr. Kruesi, and of your examination of his memorandum book, Exhibit 12, are you able to refresh your memory as to dates of early experiments with electric lamps?

A. I undoubtedly tried some experiment with an electric lamp about the time stated in the book, Edison's Exhibit No. 12, but I cannot remember the nature of the lamp or recall to memory the results of these experiments.

378 Q. Are you satisfied in your own mind that the repair of an air pump, noted in the memorandum book Exhibit No. 12, under date of January 29, 1877, had some connection with an electric lamp?

A. Yes, sir; my impression is strong that the pump was used in
connection with the electric lamp, as I cannot conceive what
3202 other use it could be used for about that time, and could con-
ceive that it could be used for an electric lamp.

379 Q. Since ceasing to give the testimony which you have now resumed, has search been prosecuted for exhibits relating to early experiments in electric lights, and if so, with what results?

A. Yes, sir; Mr. Batchelor has found two or three exhibits, one of which is in my handwriting, which I now produce.

Witness produces a paper which is put in evidence and marked Edison's Exhibit No. 13.

Exhibit objected to upon the ground that it is intended to prove the invention in controversy was made or conceived of previous to the time stated in the preliminary statement, and upon the further ground that it is immaterial to any issue in controversy.

380 Q. Please examine the paper, Edison's Exhibit No. 13, state when it was made, how you know that fact, and what it shows.

A. The sketch was made October 5th, 1877. It is signed by myself and is in my handwriting. It is witnessed by Charles Batchelor. It is headed electric light, and illustrates the principle for subdividing the electric light. The top figure represents a circuit in which there are resistances, around which are incandescent electric lamps, consisting of two electrodes with silicon between them. The second figure represents the same kind of electric lamps worked in multiple arc. The third represents them worked in series.

381 Q. Does this Exhibit No. 13 refresh your memory as to the

production of, and experiments with Edison's Exhibit First Incandescent Lamp, about which you have testified, and if so, how does it refresh your memory?

> Objected to, as going to show that the invention was made
> 3203 previous to the date alleged in the preliminary statement of Mr. Edison.

A. It does. It refreshes my memory as to the date that I tried the first incandescent lamp. Because I went from the carbon on to experiments with silicon, owing to the sensitiveness of the carbon to oxidation, and I know that the carbon experiment- were previous to the date of this exhibit, October 5th, 1877.

382 Q. Since you gave your testimony before in this case, have you been constantly absent from this office?

A. Yes, sir; I have.

Counsel gives notice that he here closes his re-examination of Mr. Edison, and offers him for recross-examination.

383 X Q. What qualities must paper carbon have to render it sufficient for an incandescent conductor in an electric lamp?

A. The paper should be free from adulterations and compact and well carbonized. It will then have a high resistance per unit length and thickness, and if cut as a filament the lamp in which it is used will have high resistance.

384 X Q. What qualities must any carbon have to render it sufficient for an incandescent conductor in an electric lamp substantially like Exhibit Edison's Commercial Incandescent Electric Lamp.

A. My impression is that all kinds of carbon, except, perhaps, the diamond, *and* the same, and their different appearances are due to their structural arrangement. I think that hard gas-retort carbon and paper carbon are the same kind of carbon, and the difference consists in their structural arrangements. Paper carbon, wood carbon, and, in fact, all carbon derived from vegetable organic matter of cellular formation when carbonized are very porous, hence the resistance to the passage of the current through a square millimeter section, and one inch long of paper carbon
3204 or wood carbon would be very much less than if the same
was made of hard retort carbon, and as a high resistance is a desirable thing to make a commercial incandescent lamp, then paper and other organic carbon has the desirable property owing to its cellular structure, of giving such high resistance. Almost any kind of carbon could be used under the conditions of the lamp, marked Edison's Commercial Incandescent Electric Lamp, and the same results could be obtained as to candle power and amount of energy. But the quality, or rather the aggregation of the carbon to form the incandescent conductor, should be such as to offer high resistance to the passage of the current to allow of commercial subdivision. And this quality organic carbon is possessed of.

Answer objected to by counsel for Sawyer and Man as irresponsive.

285 X Q. Question repeated and counsel disclaims any desire to induce the witness to reveal any new discovery he may have made in the treatment or quality of carbon, but asks him to state merely the qualities that he thinks the carbon should possess to make it suitable for an illuminating conductor in an incandescent electric lamp.

A. I do not think I can make my answer any plainer than I have already done.

386 X Q. Must it have the quality of hardness and uniformity of texture?

A. It must have uniformity of texture, but it is not essential that it should be hard, that is, the carbon as a whole.

387 X Q. Must the texture of the carbon be fine?

A. No, sir; it is not essential.

388 X Q. Must it be solid?

A. No, sir; I prefer to have it structural—formed of cells.

389 X Q. Must it be cellular, and must the cells be small or fine?

3205 A. It must be aggregated together in such a manner that the total weight of the carbon between the two electrodes shall, with a given radiating surface, be far less than if the carbon was perfectly dense, and the interstices may be large or small within the carbon.

390 X Q. Then as I understand you, it does not matter whether the interstices or cells be large or small provided the total weight of the carbon between the two electrodes shall, with a given radiating surface, be far less than if the carbon was perfectly dense?

A. No, sir; I speak within the limits of the ordinary size of organic vegetable cells.

391 X Q. Must the carbon have a high resistance?

A. The burner, as a whole, should have a high resistance, for reasons I have already stated.

392 X Q. When did you first discover that carbon made of paper would offer a high resistance to the passage of the current, to allow of commercial subdivision, so as to make it a suitable illuminating conductor for your lamp? I mean Edison's commercial incandescent electric lamp.

A. I knew that it had high resistance from my use of it in 1876 in rheostats, and in my telephonic experiments in 1877, and that it had a proper resistance to admit of subdivision in multiple arc. In my Exhibit No. 4, I have placed the boron, which is high resistance, in multiple arc and the silicon, which is low resistance, I was compelled to use in series, and I was perfectly aware when I made the Exhibit First Incandescent Lamp, that organic carbon was the proper kind to use, as with a small mass it had high electrical resistance.

Last part of the answer objected to by counsel for Sawyer and Man as irresponsive.

393 X Q. What was there in the experiments you made with Edison's Exhibit First Incandescent Lamp that enabled you to deter-

mine that carbon made of paper would offer a high resistance
3206 to the passage of the current so as to allow of commercial
subdivision, as you have stated?

A. I have already stated that I knew it beforehand.

394 X Q. Then there was nothing, as I understand you, in the experiment that added to your store of knowledge upon that point?

A. Not regarding the resistance of organic carbon, except confirmatory of what I already knew.

395 X Q. Then, as I understand you, when you made or caused to be made the lamp, Edison's Exhibit Commercial Incandescent Electric Lamp, you knew, not from any experiment upon the subject, but from your knowledge of the properties of paper carbon, that it would make a suitable illuminating conductor for your electric lamp, that it would offer a high resistance to the passage of the current, and would allow of commercial subdivision?

Question objected to upon the ground that it does not correctly state the testimony of the witness upon this subject, he having testified to experiments in 1876, which resulted in his knowledge of certain qualities pertaining to paper carbons.

A. I have already stated that I knew from my experiments in the use of carbonized paper in rheostats in 1876, in telephones in 1877, confirmed by the experiments in 1877, on the first incandescent lamp, and in 1878, also on paper carbons; that such carbon had such a high resistance as compared to its radiating surface, as to admit of commercial subdivision providing the incandescent conductor could be made small enough and be burned under proper conditions.

396 X Q. When did you ascertain whether or not the conductor could be made small enough and burned under the proper conditions?

A. I ascertained and obtained the proper conditions to
3207 allow of the conductor being made small enough, some time
in October, 1879. This was when it was placed in high
vacuum.

397 X Q. Without any reference to your experiments with your first incandescent lamp, did you know from your experiments with paper carbon in rheostats in 1876, and in telephones in 1877, that it would make a suitable illuminating conductor for an incandescent electric lamp?

Question objected to as obscure and misleading.

A. I knew upon the day that I tried the experiment on the first incandescent lamp, that such carbon would be suitable, which knowledge, as far as its resistance was concerned, was derived from experiments in measuring its resistance in 1876 and 1877, as I have stated.

398 X Q. Then, as I understand you, by your experiments with carbonized paper in rheostats in 1876, and in telephones in 1877, you had ascertained the resistance of carbon made of paper. Now, how did your experiments with Edison's first incandescent lamp

prove to you that carbonized paper would be suitable for an illuminating conductor in an incandescent electric lamp?

A. That experiment was not to prove the resistance of the paper carbon, but to ascertain if it could be made to stand at a high temperature.

399 X Q. Then, as I understand you, it was by that experiment that you determined the sufficiency of incandescent conductors for electric lamps, made of carbonized paper, as stated in answer to question 373 of your redirect examination?

A. I did not require any further experiments to ascertain whether paper carbon was applicable to incandescent lighting. I knew it was applicable if conditions could be obtained under which filements of it could be made stable at high incandescence.

3208 400 X Q. When did you first ascertain that carbon made of bamboo possessed the requisite qualities for an illuminating conductor in an incandescent electric lamp?

Question objected to by counsel for Edison as not being proper cross-examination, not pertaining to any matter brought out on direct examination, and not involved in this interference, and advises the witness not to answer the question.

A. I decline to answer.

401 X Q. Why do you decline to answer?

A. In the first place, I do not see as the counsel has any business to ask the question; second, it is not in controversy; third, my counsel advises me not to answer it; and fourth, that it would require hunting for exhibits, dates, and other data to give the proper answer, which I am not prepared to do.

Counsel for Sawyer and Man, in view of the witness' refusal to answer, declines to further cross-examine the witness, and requests the examiner to certify the question to the judges of the United States circuit court of the southern district of New York.

THOMAS A. EDISON.

By consent, the taking of further testimony was postponed to July 7th, 1881, at ten a. m., at the same place.

WM. H. MEADOWCROFT,
Notary Public, N. Y. Co.

3209 Pursuant to adjournment, this testimony was continued Thursday, July 7th, 1881, at 65 Fifth avenue, New York; the same counsel being present.

Charles Batchelor, a witness produced in behalf of Mr. Edison, testified on oath as follows, in answer to questions proposed to him by George W. Dyer, counsel for Edison:

1 Q. Please state your name, age, residence and occupation.

A. Name, Charles Batchelor; age, thirty-five; residence, Menlo Park, New Jersey; occupation, assistant to Mr. Edison.

2 Q. Please state how long you have been an assistant to Mr.

Edison, and what your particular labors and duties have been in that capacity.

A. I have been assistant to Mr. Edison for nearly eleven years; my occupation has been entirely during the last eight or nine years, the receiving of ideas and sketches, and afterwards carrying them out; making the necessary instruments myself, or with any help that I required; I have had general charge of all Mr. Edison's experiments during that time under himself.

3 Q. If you know of experiments of Mr. Edison's in 1876, in the carbonization of paper, please state about the same, somewhat in detail.

A. I remember some experiments in carbonization of paper in the summer or fall of 1876, in which paper carbon was made by him and myself for resistances; battery carbons, and other things that were to be sold by a company called the Novelty Company, I remember carbonizing strips of paper in pieces of gas tube, also sheets of paper in an old cast-iron box which we had lying around his laboratory. I do not remember what kinds of paper was used, with the exception that I remember carbonizing a number of sheets of tissue paper. The other papers were a variety of papers that were lying around the laboratory at the time. I also remem-
3210 ber that we carbonized there paper called bristol-board, besides a number of different kinds of wood.

4 Q. How extensive and long-continued were these experiments in the carbonization of paper?

A. They were not very long-continued. I believe the experiments lasted not longer than a fortnight, as far as the Novelty Company was concerned. My impression is that I carbonized paper later than those experiments for our own use in the laboratory.

5 Q. Had you proceeded before the end of 1876 in the carbonization of paper, so far that nothing more was needed in the way of information with regard to the proper carbonization, *per se*, of paper?

A. The experiments of 1876, of which I speak, answered their purpose as far as I am aware, the papers being properly carbonized. I believed we required to learn no more on carbonization for that purpose.

6 Q. During the time mentioned had you put such carbonized paper in electrical circuits?

A. Yes, sir; as some strips were intended for resistances. we had measured their resistance to see what variation there was in the carbonizing. I do not remember what resistance the carbon strips were, as we had no particular size for them.

7 Q. State, if you please, the next experiments you remember of as made under Mr. Edison's direction with carbonized paper?

A. The next experiment that I remember, was the use of carbonized paper in telephones. I have found a paper which refreshes my memory on that point, which is dated July 20th, 1877, and about that time we used carbonized paper in telephones for contact points and diaph-agms. The next experiment with carbonized paper that I can remember, is the cutting of strips of carbonized paper and

putting them into the lamp on the table here, marked Edison's Exhibit First Incandescent Lamp. I believe the strips were cut from carbonized paper that had been carbonized by us in 1876,
3211 and I believe I put them in the lamp about August or September, 1877.

Question and answer objected to in so far as it relates to the lamp marked Edison's Exhibit First Incandescent Lamp, or in so far as it has any reference to electric lighting by incandescence with paper carbons, as going to prove that the invention was made and used previous to the time alleged in Mr. Edison's preliminary statement.

Papers referred to in the previous answer is put in evidence, and marked Edison's Exhibit No 14.

(Here follows lithograph marked p. 3212.)

Exhibit objected to as immaterial.

8 Q. When did Mr. Edison first begin to experiment in lighting by electricity, to the best of your knowledge, recollection or belief?

Objected to as calling for the mere belief of the witness, which is not evidence.

A. I know Mr. Edison had frequently made experiments in electric lighting previous to the time I put the paper carbon in the lamp marked Edison's Exhibit First Incandescent Lamp, but I cannot tell just exactly what those experiments were. He had been experimenting for about a day on electric lighting previous to his telling me to put this paper carbon in the globe of this exhibit at that time. I find by a record book of Mr. Kruesi's, which is now in evidence, and marked Edison's Exhibit No. 12, which I believe to be true, that he did some work on an electric lamp in January, 1877. This, no doubt, was under my direction, but I have no memoranda to recall to my mind what the experiment was.

9 Q. What is the earliest experiment, to your knowledge, which Mr. Edison made with paper-carbon conductors in an incandescent electric lamp?

A. The earliest experiment that I remember is the one in
3213 which I put the paper carbons in the lamp marked Edison's Exhibit First Incandescent Lamp.

Answer objected to as intended to prove that the invention was made before the date stated in the preliminary statement.

10 Q. Please give in detail the history of the construction or fitting up of Edison's Exhibit First Incandescent Lamp so far as you know about it?

Objected to on the ground that it is intended to prove that the invention was made previous to the date stated in the preliminary statement.

A. The instrument marked Edison's Exhibit First Incandescent

No. 286.
C.E. Light Co.
v.
McK. Light Co. } p. 3212

30/

July 20 1877

1 – Hammered Aluminium
2 – Platina
3 – Silver
4 – Phosphor Bronze
5 – Zinc
6 – Lead
7 – French Steel
8 – Wrought Iron
9 – Nickel
10 – Russian leather
11 – White spruce shellaced
12 – Light Mahogany
13 – Box wood
14 – Brass
15 – Walnut wood
16 – paper of all kinds
17 – Celluloid
18 – Hard Rubber
19 – Vulcanized fibre
20 – Cardboard
21 – Carbon paper
22 – Copper foil
23 – Mica
24 – Bastie Glass
25 – Papier Maché
26 – Veneering of different woods
27 – Plaster of Paris
28 – Crocodile Skin
29 – Fish Skin near tail (Mackerel)
30 – Paper barrel stock
31 – Iridium foil
32 – Collodionised paper
33 – Gelatin
34 – Oil board such as used for copy press
35 – Soft rubber thick
36 – Gold foil
37 – Hair slate
38 – Oil cloth

Chas Batchelor
James Adams

(Edisons Exhibit No. 14) W.H.M.
notary public N.Y. Co.

Lamp was originally a philosophical instrument, bought by Mr. Edison for his laboratory, and is called, I believe, a Gassiot tube or cascade, and was intended to show the discharge of electricity *in vacuo.* It had been in the laboratory, I believe, since 1875. It was made into an incandescent lamp by myself, at the request of Mr. Edison in the summer or fall of 1877, he at that time wishing to try some experiments on incandescent carbon for lighting purposes. I put onto this instrument two binding posts, and also had made two clamps, which I put onto the ends of the rods inside the globe. At first Mr. Edison wanted a hard carbon piece put into the globe, but as I had great difficulty in making it small enough, and getting it in, he suggested that I should cut the carbon from carbonized paper, of which we had a quantity in the laboratory at the time. I did so, and succeeded in giving him a few of the carbons in the lamp. I do not believe the lamp has been used for any other experiments since that time.

11 Q. Please explain how you got the paper carbons into the lamp and held them in position there.

Same objection as before.

3214 A. It was a very difficult and tedious process to put the carbon in there, but I did it by unscrewing the ball from the top of the rod and also unscrewing the globe from the holder above the cock; also unscrewing the cock from the base, also unscrewing the packing cap. When these are all apart the top rod will drop out and the bottom rod can be left in the part having the cock. The carbon was now screwed to the clamp of the bottom rod whilst lying on the table. The other clamp was then screwed to the other end of the carbon, and all three together lifted and turned, so that the part having the cock would be topmost. The lamp also was turned upside down, and the rods and carbon carefully dropped through it. The top rod was then held until the packing and the packing cap were put on, when the whole was screwed together again and the ball replaced. The binding posts were put on the lamp to hold the connection wires from the battery.

12 Q. Please to state whether or not, after the carbon conductor was thus placed in position, the air was exhausted from the globe of the lamp, and if so, by what means?

Same objection as before.

A. After putting a carbon into the lamp the lamp was placed on the plate of an ordinary air pump, and the bulb exhausted as well as we could do it with that pump. The current of electricity was then applied to the carbon, and heated the same for some short time.

13 Q. Was the carbon brought up to a point of incandescence in the lamp?

Same objection as before.

A. Yes, the lamp did give light for a short time in each case.

14 Q. Please to state, if you remember, how numerous those experiments were.

Same objection.

3215 A. I cannot remember just the exact number I put in, but believe there were at least four.

15 Q. Do you remember from what kind of paper those paper carbons were made?

Same objection.

A. I cannot be sure what they were made from, as I did not make them at the time for the experiment. I remember I took a carbon sheet that was thin compared with others we had, but what kind of paper it was I do not know.

16 Q. Do you remember what was the size of the strips of carbon paper with which you experimented in that lamp?

Same objection.

A. I had no particular size given me by Mr. Edison, and I do not think I measured them, but should judge I made them three-quarters or an inch long, and about a sixteenth wide. The thickness of the paper, I believe, was about seven or eight thousandths.

17 Q. Did you give this lamp to Mr. Edison to be filed by him as an exhibit with his testimony in this case?

Same objection.

A. No, sir; I may have been the means of calling his attention to the lamp, because I told him I was sure that he had tried incandescent carbon paper previous to the boron and silicon experiments.

18 Q. Who found the lamp previous to its being put in as an exhibit in this case?

Same objection.

A. I do not know who brought the lamp in here. The lamp has never been lost, for it has been lying around the laboratory, generally in full view, ever since the experiment of putting the carbon in it.

3216 19 Q. Were there many other exhibits in the laboratory at the same time?

Objected to as immaterial.

A. There are and have been hundreds of such instruments in Edison's laboratory—relics of old experiments.

20 Q. How do know that this Exhibit First Incandescent Lamp was made and experimented with using paper-carbon conductors at the time you have testified?

Objected to as going to show that the invention was made previous to the date given in the preliminary statement.

A. I can only approximate the date of the putting in of the paper carbon from a paper in evidence marked Edison's Exhibit No. 13, which is dated October 5th, 1877, witnessed by me on or about that date, and in which silicon is used between two electrodes for incandescent lighting, and I know that the experiment on incandescent paper carbon, in the lamp marked Edison's Exhibit First Incandescent Lamp, was at least from one to three months before that.

21 Q. Is that recollection further strengthened by inspection of Edison's Exhibits Nos. 4 and 5?

Same objection.

A. It is; for I remember from them that we hoped at that time to get better and more stable results than we had previously got from paper.

22 Q. Referring to these Exhibits 4 and 5, state whether or not your signature upon the same is in your own handwriting, and if so, when was it made?

A. I recognize my signatures on both of these papers, and know that they were put on there by me, on or about the dates marked on the exhibits.

23 Q. After the experiments with paper-carbon conductors with
Edison's Exhibit First Incandescent Lamp, what was the
3217 reason of making experiments with boron and silicon, and
the other metals named in the Exhibits 4, 5 and 13?

Objected to as immaterial.

A. Mr. Edison hoped to get from them a more durable and unoxidizable substance than carbon for electric lighting.

24 Q. Referring again to Edison's Exhibit No. 13, please to explain what is shown and described in that exhibit.

Objected to as incompetent; that must appear by the exhibit itself.

A. Figure 1, on Edison's Exhibit No. 13, shows three incandescent electric lamps, in which the light-giving substance is silicon, each placed around resistances in the line, so that only a portion of the current goes through the silicon, and the whole fed with electricity from a magneto machine.

The figure directly under this No. 1, shows three incandescent electric lamps, similar to the three in No. 1, but placed in multiple arc, each one with its own resistance.

The bottom figure in this exhibit shows the same three lamps, I presume, although the word "silicon" is not there, and these three lamps are all placed in series; in all three cases the electricity is furnished by a magneto machine.

25 Q. Please make a similar explanation of Edison's Exhibit No. 4?

A. In Edison's Exhibit No. 4, figure 1 shows four of such lamps in multiple arc, and figure 2 shows three of such lamps in series, and an explanation is here made to show that other substances could be used besides silicon, as Mr. Edison has remarked on it that he has tried a number of other things, and suggests the better

method of working either boron or silicon; he also suggests
3218 on this mixtures of non-conductors and semi-conductors in
order to get a greater resistance when using low-resistance
materials.

26 Q. After the experiments described by you with Edison's Exhibit First Incandescent Lamp, what were Mr. Edison's next experiments with carbonized paper for electric lamps?

A. The next experiments that I remember in carbonizing paper for electric lamps were a series of experiments he had me make in order to get a good and light carbon for a lamp which was to be worked on a partial incandescence; I made a great many carbons about August and September, 1878, a great many of which were made from paper; some of these carbons, especially the smaller ones, were raised to incandescence in an exhausted bell jar of an air pump about that time; I believe I worked altogether, about that time, equal to about two months ordinary daily working.

Answer objected to upon the ground that it related to experiments made and carbonized paper burnt for electric lighting previous to the date alleged by Mr. Edison in his preliminary statement.

27 Q. What were the size and the form of the paper-carbon conductors used in these last-named experiments?

A. The thin ones were generally short—from two to three inches; the thick ones were sometimes as long as six inches; I believe I made as many as from fifty to seventy-five of the paper carbons, which ranged in diameter from three-sixteenths of an inch down to considerably below a thirty-second of an inch; it was difficult to get the small ones very long; the best method I found of making these carbons was to coat tissue paper, or very thin paper, with a mixture of tar and lamp-black, and then roll them up on a flat plate very tightly.

28 Q. Have you any recollection of applying these paper
3219 carbons to a lamp such as shown in Mr. Edison's patent No
224,329—if so, at about what time was that?

A. I do not remember a lamp similar to that shown in the patent referred to being made, except similar in principle; I made a lamp the same in principle as these, which I have found a portion of, in which one of these paper carbons was placed directly over six platinum points and guided in its descent by an upright arm, having a projection on it, with a hole through which the carbon could slip. I believe this lamp was used with three points and six points. The lamp was both an incandescent and an arc lamp—a slight arc forming between the points and the carbon. I cannot exactly tell the date of this lamp. I believe it was previous to Mr. Upton's coming with us in the laboratory, which I think was in November, 1878. I produce a portion of this lamp, showing the base and the six springs and holders screwed thereon, but the platina points have been taken out.

Portion of the lamp placed in testimony and marked Edison's Exhibit No. 15.

Answer and exhibit objected to as immaterial, and as referring to a lamp that is not an incandescent lamp, in the sense that that expression is used in the application for the patent in interference, but is an incandescent lamp in which the illuminating carbon, or electrode, is being continually consumed.

29 Q. Was this lamp, Edison's Exhibit No. 15, put in electric circuit and the paper carbon heated to incandescence?

A. Yes, sir.

30 Q. In this lamp, just referred to, was provision made to keep a constant electric continuity?

A. Yes, sir; the fact that the carbon conductor stood directly
3220 above the platinum or iridium points and was free to fall by gravity, kept it always in contact with the points.

31 Q. Were other experiments made at about this time by Mr. Edison, or under his direction, in connection with incandescent electric lights?

A. Yes, sir; at that time Mr. Edison was almost entirely occupied with incandescent electric lights. Mr. Edison about this time commenced the improvement of apparatus for getting a good vacuum. He was also experimenting at the time for the best dynamo-electric machine that could possibly be got. He was also endeavoring to get a lamp of high resistance from metals, such as platinum, nickel, iron and alloys of platinum-iridium. These experiments, on the perfection of vacuum apparatus, extended far into 1879.

32 Q. During that time also, namely, the latter portion of 1878, were not experiments going on on incandescent paper-carbon conductors *in vacuo*?

A. I have mentioned that we made experiments in August or September, wherein we placed paper carbons, made by myself, in a vacuum, and raised them to incandescence by the electric current in the bell receiver of the pump. To the best of my recollection, after these experiments were tried, Mr. Edison's attention was turned more particularly to the getting of this lamp of high resistance, which he required, from metals instead of carbon; this he succeeded in doing to a great state of perfection; but in doing so he had been able to get an apparatus for making a vacuum which was far superior to anything we had had before; and it occurred to him that, with such a vacuum, carbon however small, should be able to stand without oxidizing, which it had always done before.

By consent, this testimony was postponed to Friday, July 10, 1881, at 10 a. m., at same place.

WILLIAM H. MEADOWCROFT,
Notary Public, New York County.

3221 Pursuant to adjournment, the taking of testimony was resumed, July 8, 1881, at 10 a. m., at the same place, same counsel being present.

33 Q. Please examine Exhibit Edison's Commercial Incandescent

Electric Lamp, and state when lamps of that description were first made by Mr. Edison.

A. The lamp marked Edison's commercial incandescent electric lamp is one of a number of lamps made in October or November, 1879, and lamps of this description were first made about the middle of October, 1879.

34 Q. What kind of lamp is this exhibit you have just testified about?

A. It is composed of a hermetically sealed globe, wholly of glass, through which two platinum wires project on the inside, and to which is clamped a carbon conductor made of paper carbonized. This globe is exhausted of air.

35 Q. When did Mr. Edison first produce an incandescent electric lamp with a carbonized-paper conductor, in all respects complete and able to compete successfully with illuminating gas for light-giving purposes?

A. I believe about the middle of October, 1879, when he produced lamps similar to this lamp marked Edison's commercial incandescent electric lamp.

36 Q. At the date named, what progress had been made in generators, apparatus for producing vacuum, regulating apparatus, a system for lighting districts, and other matters and things essential for a commercial light for general use in cities and towns?

A. At this time everything was ready, to the best of my belief, and was only waiting for the perfection of the lamp to make the whole system a success, as directly we got the lamp we, in the shortest possible time, exhibited just such a system to the public, that being previous to Christmas day, 1879.

37 Q. Please to give a summary, in a connected way,
3222 mentioning dates, as far as possible, of the progress of the
invention of incandescent conductors for electric lights, made
of carbonized paper, from the beginning up to the completion of
the commercial lamp.

Question objected to in so far as it may be intended to bring out anything appertaining to the electric lighting by incandescence with the experiments on carbonized paper previous to the date of the invention alleged in the preliminary statement of Mr. Edison in this interference.

A. The history of electric lighting by incandescence with paper carbon by Mr. Edison, as far as I know it, is as follows: In the summer of 1877 he used strips of paper carbonized as an incandescent conductor *in vacuo*, and the lamp in which they were used is now in evidence and marked Exhibit Edison's First Incandescent Lamp. I should have said here that I remember Edison, within a day or two previous to this lamp being made, using carbonized paper as an incandescent conductor between two electrodes of a battery, but in the open air. The next experiment, or series of experiments, that I call to mind are the ones which I have before spoken of as being made in August or September, 1878. At this time my whole time and attention began to be devoted to development of his system of incandescent electric lighting. These paper carbons were made by coating thin papers with lamp-black and tar, and rolling up tightly into a rod, drying and carbonizing the same in a suitable furnace. Some of these paper carbons were put in between the two electrodes in an electric circuit, and raised to incandescence in a vacuum. At this time carbons made of paper were not the only things that we tried as incandescent conductors in a vacuum. We made many experiments with hard carbons, wood carbons, and some metals, such as platinum, nickel and iron. It had early been decided by Mr. Edison that the requisite 3223 material for his incandescent lamp should have a great resistance combined with the least possible surface, and I remember well that at this time and previous we used to expect that we should be able to get a substance for an incandescent conductor that would give us at least 500 ohms' resistance. The result of this latter series of experiments *in vacuo* had shown us that in order to get a high-resistance lamp from carbon in any form, it would have to be cut in an exceedingly fine filament. The paper carbons which we tried were larger than we should have to use if we wanted a higher resistance. With the vacuum we then got, and which we considered at that time to be good, the carbons lasted at the most from 10 to 15 minutes in a state of incandescence. The experiments on platinum led us to hope that it might be easier to get a high resistance from that metal than from carbon. From the date of the finishing of these experiments, which, I believe, was towards the latter end of October, '78, Mr. Edison turned his attention to lamps in which the incandescing conductors were formed of metals and alloys of metals. During the last part of the year '78, and up to October, 1879, I made, at Mr. Edison's request, a very large number of lamps having platinum and platinum-iridium composing the incandescent conductor. A great many of these lamps had their conductors coated with insulating material, in order to be able to wind them up close and get them into as small a space as possible in order to offer the least radiating surface. Mr. Edison very frequently sat down at my table and worked for hours helping me on these experiments. Our conversation frequently was directed to getting the highest resistance in the least possible space. I remember once or twice during these conversations, early in 1879, he remarked how easy it would be to get this resistance if carbon was only stable. During the time that I was experimenting on these lamps he had been busy experimenting to perfect the different apparatus composing his electric light-3224 ing system as a whole. I had also worked on these matters, but as our lamp was an exceedingly difficult job, the majority of my time, both night and day, with the exception of a week or two in which I devoted some time to telephones, was spent on the lamp. He had succeeded in making a more perfect dynamo machine. In testing the lamps with platinum conductors he had been continually improving the apparatus for exhausting the globes. In October, 1879, when he had got a very perfect vacuum for his lamps, he suggested the use again of carbonized paper as a conduc-

tor, and accordingly he had me cut a fine filament of paper, which we carbonized and put in a globe. This filament, I believe, was cut straight from paper, and bent round previous to putting in the carbonizing chamber. I do not remember what we did with this lamp afterwards; but within a day or so of that I cut a loop from paper similar in shape to the one now in Edison's commercial incandescent electric lamp. At the same time that these were being tried, I also made lamps of loops of carbonized thread, carbonized flax, fine filaments of lamp-black and tar rolled up and baked, and also threads which had been treated with lamp-black and tar previous to carbonization. All these things were used about the same time as incandescent conductors in electric lamps, and most satisfactory at the time being the carbonized-paper loop, which I had cut by hand. We immediately after this made a steel mould in which these loops could be cut quickly, and after a few experiments in the carbonization of them, in order to get their resistance as near as possible alike after carbonization, we made a number or these filaments and used them at an exhibition in Mr. Edison's house, about the 2d or 3d of December, 1879. When the first lamp was made which had a fine filamentary carbonized-paper conductor, from which the light was given, which was about October 22d, 1879, then, I believe, we had a system of electric lighting that was complete and could
3225 compete with gas, and we proceeded as expeditiously as possible
to exhibit as such.

38 Q. Did you start a record of the life of the early lamps put in position at Menlo Park, and if so, is Edison's Exhibit No. 3 a transcript of the first fifteen pages of that record?

A. I started a record about January 2d, but at that time a number of the lamps had been burning on exhibition for some time, and I remember, on looking at book 67, that as I did not know the exact time at which these lamps were put up, I allowed as near as possible for the time they had burnt. This is shown on page 1, where lamp 142 is recorded by me on January 2d, 1880, and after marking its resistance I remarked that it has burned at least 200 hours. I have compared the exhibit referred to with the book and see no variation.

39 Q. Please examine note book No. 74. State whether you commenced said record and had it continued under your charge. State whether or not Edison's Exhibit No. 11 is a correct transcript from said note book.

A. I have examined book 74, and I find it is a continuation of the record of lamps commenced by me on January 2d, 1880, and was continued under my direction through book 74. The Exhibit No. 11, as far as I can see, is a correct copy of the pages mentioned in the exhibit.

40 Q. Please state whether or not such records state the facts correctly.

(Here follow diagrams marked pp. 3226, 3227, 3228, & 3229.)

Impt in Electric lamps and in carbons or incandescing conductors therefor and in methods for and means of manufacturing the same No. 11968.

References.

A. Fibre. Fig 1 2 3.
B. Clamp.
C. Platinum wire
a. Supporting neck

4 5 6.
A. Base.
a. Supports.
a "
B block.
b Knife
C Stock.
D screw.
d "
E disc.
e screw
H Clamp
J "

O Slot
S clip
w offset
h
i screws

Fig 9.10.
A D W
a cutting edge
B bed plate
D Recess
E Horse shoe.
C Veneer.
e end of E.

Fig 14.15.16.
A Block of wood
B
c
D clamp.
E
F surface
C lines of separation
a holes.
e screws.

Fig 11 & 12.
A web of the block
E End " " "

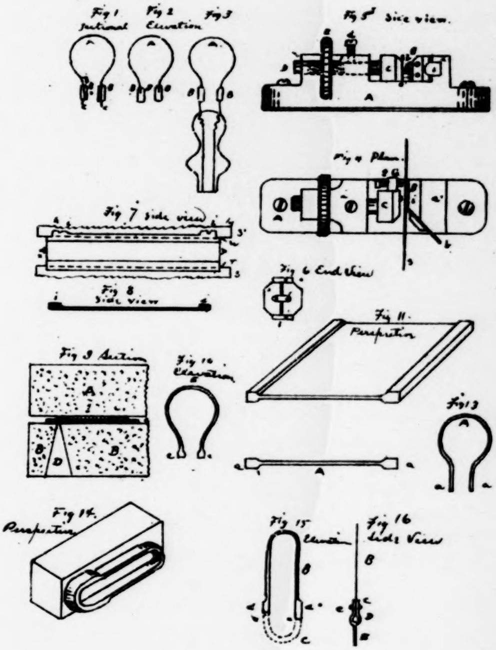


Fig 1
Sectional
Fig 2
Elevation
Fig 3
A
B
C
a
Fig 5 Side view
Fig 4 Plan
Fig 6 End view
Fig 7 side view
Fig 8
Side view
Fig 9 Section
A
B
D
Fig 10
Elevation
Fig 11.
Perspective
Fig 13
A
a
Fig 14.
Perspective
Fig 15
Elevation
Fig 16
Side View
B
C
D

No. 286.
C.E. Light Co. v. McK Light Co. } p. 3226.

Improvements in electric lamps and in carbons or incandescing conductors therefor and in means for and methods of manufacturing the same. No 11968.

References.
Fig 17, 18, 19, 20, 21.
22, 23, 24, 25, 26, 27.

A. Nickel plate.
a Groove.
B Band
b Chamber
C Plate.
c Enlarged Ends.
D Flask
E Groove.
e Pin.
F Cover.
F' Lid.
f Wedge
g Washer
o Washer
S Filament
H. } Current of concentration
H' } " " filament
d Clamp
a Chamber.

Fig 29 & 30

A Carbonizing Plate.
B Bars.
b Lug.
D Oven.
E Cover
e Exit
G Pipe Gas supply.
g Branch pipes.
H Pipe air supply
h Branch pipes
C Cover
F Cover

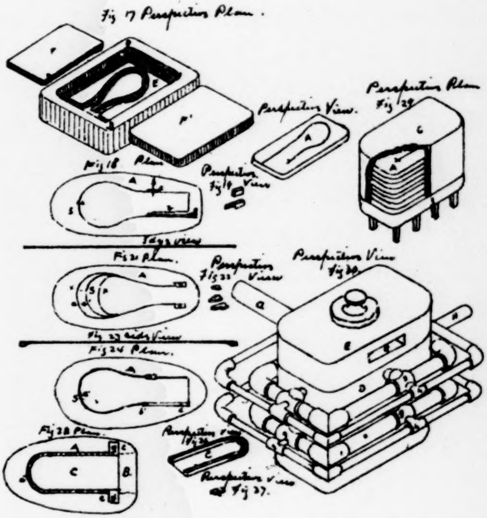


Fig 17 Perspective Plan.
F
E
F'
Perspective Plan Fig 29
C
A
Perspective View.
A
Fig 18 Plan
A
S
Perspective Fig 19 View
Fig 22 Side View
Fig 21 Plan.
A
Perspective Fig 23 View
Perspective View Fig 30
a
H
E
D
Fig 25 Side View
Fig 24 Plan.
S
Fig 28 Plan.
A
C
B
Perspective View Fig 26
C
Perspective View of Fig 27.

No. 286.
C.E. Light Co. } p. 3227
v.
McK Light Co.

Improvements in electric lamps and in carbons or incandecing conductors therefor, and in means for and methods of manufacturing the same. No 11968.

REFERENCES Fig 31, 32, 33.
a Lamp.
c Conductor.
c' " " "
B Lamp
a circuit breaker.
b " " "
1 multiple arc.
2 " "
F Holder.
D screw
E " Apertures.
C Conducting Plates
c' " "
d " "
d' " "
h seat
e metal block.

REFERENCES Fig 34.
a Base.
A Bulb.
b Clamps.
B Horse shoe.
c'c glass tubes.
1'1 conductors.
D'D Compartment.
E insulating top.
E' Base.
F Standards.
F' " "
S S' screw connection
l l' line of opening.
m Junction of c c'
x Height of mercury.
1 Conductor
4 "
N Projections
2.3 Wires

Diagram Fig 31.

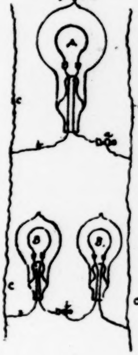


Fig 32 Elevation

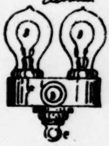
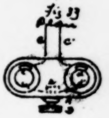
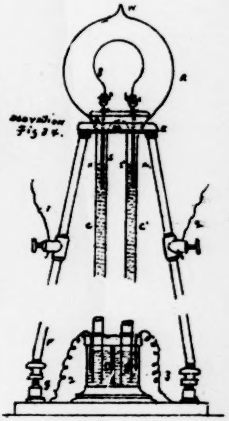


Fig 33 Plan





No. 281.
C.E. Light Co. v McK Light Co. } p 3228

Improvement in electric lamps and in carbons or incandescing conductors therefor and in means for and method of manufacturing the same.

No 11 962

REFERENCES.

Fig 35
A Carbon
B Rubber cork
b tube
C lamp globe.
e tube.
d mercury reservoir
E " seal
n tube.
s support.
r point of sealing
x stop cock.

Fig 36.
A Globe.
ab point of sealing A.B.
B support neck.
D Clamp
d "
d' "
E Key
c carbon
g carbon.
b anvil
x "
z "
1234 contacts
5.6.7.8.9 Wires.

Fig 37
A Globe.
B "
b tube.
C' support neck.
c c' places of sealing wires 1
s s' " " " " 2
x places of sealing tube a
z " " " tube b.
1 wire
2 "
a tube.

Fig 35
A Globe.
B carbon.
D soft Rubber plug
a places of sealing a
c tube
E Washer.
F cup
H Mercury
1 conductors
2 "
places of sealing wires 1, 2
B b clamps
A' neck.

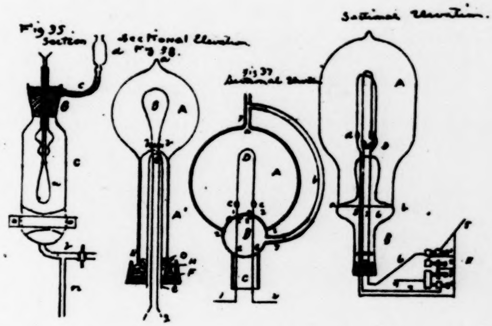


Fig 35.
Section
Sectional Elevation of Fig 38.
Fig 37
Sectional Elevation
Sectional Elevation.
A
B
C
D

No. 286
E. Light Co.
v.
McK. Light Co.
} p. 3229

A. They do. I was always very particular to have this attended to in a proper manner. It was the duty of Mr. Herrick to enter in these books their time, as they burnt, daily, and I believe that he did so. I was also very particular to have him mark down in the book the cause of their ceasing to burn; and if at any time he was not present when a lamp ceased to burn, it was generally made a note of by any one in the laboratory present, and put on Mr. 3230 Herrick's desk, so that he could go, take out the lamp and examine it, noting its defects.

41 Q. Have you read the testimony of Sawyer and Man in this interference, and if so, have you carbonized paper in the various modes described by them?

A. I have read the testimony and have made some samples of carbonized blotting paper in the same manner that is described in their testimony.

42 Q. Please produce such specimens, describing what each one is.

A. I here produce specimens of ordinary blotting paper carbonized, which were carbonized in a square iron box, filled with powdered charcoal. This carbonization was done in an ordinary fire.

Specimens referred to put in evidence and marked Edison's Exhibit No. 16.

I also produce a piece of carbonized blotting paper, the paper having been pressed before carbonization, as stated in answer to question 22 in Albon Man's testimony.

Said specimen is put in evidence and marked Edison's Exhibit No. 17.

I also produce a specimen—two sheets of ordinary blotting paper cemented and pressed together, as also stated in answer to question 22 of Albon Man's examination-in-chief.

Specimen put in evidence and marked Edison Exhibit No. 18.

I also produce a specimen of several sheets of blotting paper cemented together without pressure and carbonized, which may be meant in answer 22 in Albon Man's examination-in-chief. All these specimens were carbonized in an iron box, packed in powdered charcoal and heated in ordinary fire.

Specimen referred to put in evidence and marked Edison's Exhibit No. 19.

3231 I also produce a number of sheets of blotting paper in which two or more are cemented together and carbonized, the cement being different in this case from the former ones.

Specimen put in evidence and marked Edison's Exhibit No. 20.

43 Q. Have you also carbonized paper in the manner described in your testimony as having been done by Mr. Edison, and under his direction, in the earlier experiments?

A. I have carbonized also some samples of tissue paper similar to the experiments on carbonization of paper that I have testified to as being in 1876, and here produce the same.

Carbons put in evidence and marked Edison's Exhibit No. 21.

I have also carbonized some samples of strips of bristol-board, which I also remember are like the ones carbonized in gas-pipe tubes in the experiments of 1876.

Samples put in evidence and marked Edison's Exhibit No. 22.

44 Q. Where a paper-carbon conductor has been recarbonized and treated with the electrical current in a hydrocarbon bath, as testified to by Albon Man in answer to 67th cross-question, if such a conductor is heated to incandescence in an electric lamp, what part of the conductor produces the light?

A. As the light from an incandescent conductor is all given off at its surface, and as the experiments which my experience has tried have shown that the treatment of an incandescent conductor in a hydrocarbon bath deposits carbon from the hydrocarbon 3232 on its surface and in the interstices, I believe that all the light would be radiated from the deposited carbon.

Counsel for Edison rests his examination of this witness here, and offers him for cross-examination.

Cross-examination by AMOS BROADNAX, Esq., counsel for Sawyer and Man:

45 X Q. The papers you say you carbonized in pieces of gas tube in the summer of 1876; please to state in detail just how you carbonized the paper in the gas tubes?

A. A piece of tube was taken, such as is for gas pipes. To the best of my recollection from five to six inches long, and having about three-quarters to an inch hole in it. A thread was cut on each end of this and a screw-cap fitted on each end. One end of this tube was completely closed by the cap being fitted tight on it. The other screwed on and off easily. The strips of paper that were carbonized in this tube were cut into lengths, and put lengthwise in the tube, in which some powdered charcoal had been placed and the tube was then packed full of powdered charcoal. In screwing the cap onto this we generally put a little moist clay on the thread to make it air tight. There was more than one tube made for this purpose. I remember one smaller than this. I cannot give the exact size of the smaller one, but believe it was a piece of three-eighths pipe.

46 X Q. How many pieces of your piping did you have fitted in that way for carbonizing paper?

A. I can only call to mind at present the two mentioned.

47 X Q. What kinds of paper did you carbonize in these tubes?

A. Principally stiff papers, such as bristol-board. We also carbonized other kinds of papers, but I do not know that they were carbonized in these tubes.

3233 48 X Q. How much paper did you carbonize in these tubes?

A. I cannot say how much paper was carbonized in these tubes, as all the work that I did on this carbonizing was generally done at night. Mr. Edison and Mr. Adams being there in the daytime also carbonized, I presume, with the same tubes.

49 X Q. How did you heat the tubes?

A. We put them into a common fire and heated them red hot, and allowed them to cool again before taking the carbons out.

50 X Q. How long did you keep them red hot before taking them out of the fire?

A. I cannot say just how long; sometimes two or three hours. In some of my experiments I took them out of the fire red hot, and covered them up with ashes, so that they would take a long time to cool off.

51 X Q. These paper carbons that were made in the gas tubes, how long were they, how wide, and how thick after being carbonized?

A. I do not remember that we cut them any particular size. The ones that I carbonized were generally about 3½ to 4 inches long, about ⅜ of an inch wide, and the thickness of ordinary bristol-board. I do not believe that I ever measured this bristol-board for thickness, but believe it was about the thickness of an ordinary visiting card. This was the size, as near as I can recollect, when they were put in.

52 X Q. How many pieces of paper did you put in at one time?

A. I put in no specified number each time, but I believe I sometimes had as many as six in the large one.

53 X Q. What were these paper carbons used for?

A. As far as I was concerned, they were specimens of carbonizing. Mr. Edison and Mr. Adams, I believe, tested them for resistance, and used them as such. I do not remember making any instrument myself in which these were used as resistances.

3234 54 X Q. Did you see Mr. Edison use them as resistances in any instrument, and if so, what instrument?

A. I had seen Mr. Edison testing their resistance with a Bradley galvanometer. Previous to this I had made for Mr. Edison resistances of powdered carbon, also resistances of plumbago on wood. At the time of these carbonizing experiments the majority of my time was taken up in New York, and the experimenting that I did on this was at night.

55 X Q. I asked you if you had seen Mr. Edison use any of the carbons carbonized in the gas tube as resistances in any instrument, and if so, what instrument?

A. I simply saw him measure one or two of these carbons, and in those cases they were resistances in an instrument when being measured.

56 X Q. Well, what instrument were they used in?

A. The Bradley galvanometer.

57 X Q. Did you see them used in any other machine; if so, what?

A. I do not remember seeing him use them as special resistances for other experiments, but know that they were carbonized with a view towards getting carbons for resistances, as I believe that was one of the things we proposed to give to the Novelty Company.

58 X Q. Was any practical use made of these carbons, and if so, what? I am referring to the carbons made in the gas tubes, all the time.

A. I do not remember that there was any practical use made of these special carbons, as the experiments were never carried far enough to make an instrument from them suitable for the Novelty Company to sell.

59 X Q. Did you undertake these experiments in carbonizing paper in the gas tubes upon the request of Mr. Edison?

A. I did, although I was not working at them all my time. I believe*d* Mr. Adams carbonized and carried on the experiments more than I did.

3235 60 X Q. But you initiated the experiments, as I understand you?

A. No, sir. Mr. Edison commenced the experiments, and we simply helped to carry them out. If I remember right, the stoppage of the Novelty Company for want of funds stopped these experiments for them.

61 X Q. When you undertook these experiments, or commenced to assist Mr. Edison in making them, did he explain to you his object in carbonizing paper?

A. I believe I remember that in conversation with myself and Adams, on the things that should be given to the Novelty Company, when he mentioned the different articles to be made from carbon, he then said that we could get any resistance we wanted from paper carbonized. We had been using previous to that, resistances for cable work which had been made of carbon, but which did not keep their resistances well, as they were made from powdered carbon packed in tubes. A cheap and high-resistance carbon was a desideratum for cable experiments, if it could be made constant. This, I believe, was Mr. Edison's idea when he proposed to have the Novelty Company sell resistances which were made of carbonized paper.

62 X Q. These paper carbons which you say you made with a gas tube, were any of them considered commercially salable for the purposes you have mentioned?

A. As the experiments were never carried to such an extent that we had a standard instrument made of these carbonized-paper strips, I do not consider that they were a commercially salable article.

63 X Q. Can you produce any of the carbonized paper made by you in the gas tubes in the experiments about which you have testified?

A. I cannot; to my knowledge for a year or so after these carbonizing experiments, I believe, there were some of these strips carbonized in gas tubes lying around the laboratory, but I cannot say whether there are any there now.

3236 64 X Q. Have you, upon your examination-in-chief, produced any specimens of carbonized paper made in a gas tube similar to those about which you have testified?

A. I have produced and put in evidence strips of carbon paper which have been carbonized in substantially the same manner as those described as being carbonized in a gas tube. These strips, however, were carbonized in a small iron box with the cover luted on, and not screwed on as in the tube experiments. This was heated in a boiler fire. This method is substantially the same as the gas-tube experiments.

65 X Q. Which one of the exhibits contains the carbons referred to in your last answer?

A. That marked Edison's Exhibit No. 22.

66 X Q. What kind of papers are these carbons made of—Exhibit 22?

A. These paper carbons are made from what is known as bristol-board.

67 X Q. And they were made in an iron box and not in a section of gas tube, as I understand you?

A. Yes, as I had not a section of the gas tube. A section of the gas tube would probably have made me a more perfect carbon, as the screwing of the cover on is less likely to allow air into the chamber than the mere luting of it up.

68 X Q. How big was the box in which you made the carbons, Exhibit 22?

A. The box was somewhere about five inches long, about two inches wide, but about four inches deep. The box was filled to within an inch of the top with powdered charcoal previous to my putting these card-board strips in. I used thisbox simply because I had it. If I had had to make a box, I should have preferred the gas tube, in order to make the experiment the same as in 1876.

69 X Q. How many paper slips did you put into the box when you made this Exhibit 22.

3237 A. I did not count the number of paper carbons in the exhibit, but I think they are all there that I put in, in the form of paper.

70 X Q. Then these were all made at once, as I understand you?

A. Yes.

71 X Q. After you had the strips of paper put in the box on the pulverized carbon, did you cover the strips with pulverized carbon also?

A. Yes, sir; pressing down the carbon so as to get in as much as possible and as tight as possible.

72 X Q. Did the lid of the box screw down on it, or how was it fastened on?

A. The box lid had a projection on its under surface that extended into the box about an eighth of an inch. We took moistened clay and plastered all around the projection, and then pressed it to its place carefully. The moistened clay filled the crevice all around the box. It was not screwed or otherwise fastened down.

73 X Q. Was the lid of the box held simply by the clay?

A. The lid of the box does not depend on the clay to be held, as we kept it in one position, and it stayed there by its own weight.

74 X Q. Then as I understand you, the only pressure there was upon the powdered charcoal and the strips of paper in the box was that due to the weight of the lid of the box.

A. Yes.

75 X Q. In making these carbons, Exhibit 22, was it your intention to show just the quality of paper carbons you made in the gas tubes in the summer of 1876?

A. My intention was to show paper carbons made in a similar manner, and with the same material, as those we made in the summer of 1876 in the gas tube.

76 X Q. Why didn't you make them in exactly the same way that you did in 1876?

A. I should have done so if I had time.

3238 77 X Q. When did you make these, Exhibit 22?

A. Early this morning, between half-past twelve and three o'clock.

78 X Q. For the purpose of this examination?

A. Yes, sir.

79 X Q. How do these carbons, Exhibit 22, compare in quality with those you made in the gas tube in the summer of 1876?

A. I can only tell from their appearance. As near as I can recollect, they are very similar in appearance.

80 X Q. Were those you made in the gas tube as entirely unbroken as these are?

A. As far as I can remember, they were as unbroken as these.

81 X Q. Now, that we have got through with the carbons made in the gas tube, and the carbons of Exhibit 22, I call your attention to the sheets of paper carbon you made in an old cast-iron box that was laying around the laboratory in 1876. Please to give the several dimensions of that box, as near as you can recollect them.

A. As near as I can recollect, the size of the box named was about five inches in diameter, and about two inches deep; the box was circular; there was no regular cover to this box, but we used a piece of sheet iron.

82 X Q. How large were the sheets of paper that you carbonized in that box, and what kind of paper was it?

A. I remember only two kinds of paper that I ever carbonized in that box myself, and they were tissue paper and card-board. I believe many other kinds were carbonized, but do not remember doing it myself. The size of the sheets, I should judge, was not more than about three inches by two, or thereabouts.

83 X Q. What you believe is not evidence. Please to confine yourself to what you know and what you remember, and
3239 state, if you please, how you charged the box, and how much
paper you put in in each charge, and how often you charged it.

A. It is impossible for me to remember at this late date, without anything to refresh my memory, exactly how many times I charged the box, or how many papers I put in each box, or in what way I charged each box. I can only say that the experiments I tried for Mr. Edison with this particular box were those in which he required me to get a flat paper carbon after carbonization. The box sometimes had the bottom covered with powdered charcoal, and then a paper sheet. Afterward another layer of powdered charcoal, and then another paper sheet. This was continued for a number of sheets in some experiments. In other experiments fewer sheets were put in and a weight of iron placed on the top to keep them straight.

I tried a number of devices and finally succeeded in bringing out flat carbons by putting a heavy weight on top of the successive layers of card-board and powdered charcoal.

84 X Q. Having the box thus charged, and forced down by a weight, in what kind of furnace did you heat it?

A. Sometimes it was heated in a stove; at other times in a small boiler furnace.

85 X Q. Were the carbons thus made straight flat sheets, or were they more or less crooked.

A. The carbons in some of the experiments were exceedingly crooked. The problem was, with me, how to make them come out straight. I succeeded in this by putting heavy weights on them, and leaving the weights on until they were cold.

86 X Q. And then were the carbon sheets whole, or were they more or less fractured?

A. There was no difficulty, that I remember, with the breaking of the carbons. Sometimes some would be broken in taking them out.

3240 87 X Q. What proportion of all the carbons which you made in this box were straight and perfect?

A. Only a small proportion of the carbons that I made myself in this box were straight and unbroken, but when I left off experimenting with that box I could bring out almost all the papers I put in as straight and perfect carbons.

88 X Q. And was this perfection of the carbons referred to by you, in your last answer, due, in your opinion, to a sufficient weight upon them, and to uniform heating and cooling of them?

A. When I spoke of the perfection of the carbon in that last answer, I meant its perfection of form and shape unbroken. There was no effort at uniformity on my part at that time to get uniform heating other than from an ordinary fire, but I frequently endeavored to get uniformity of cooling by covering it over with the ashes of the grate.

89 X Q. These sheets of paper carbon that you at last succeeded in getting straight and whole, of what kind of paper were they made?

A. I believe principally of ordinary card-board.

90 X Q. Card-board is of various thicknesses. State about how thick the card-board was that you used to make these carbons, as near as you can recollect.

A. About the thickness of an ordinary visiting card.

91 X Q. What use did Mr. Edison make of these sheets of carbon you made in this box in 1876?

A. I do not remember any use that they were put to, as well as I can remember, the flatness of the carbons was requisite for making carbons for batteries, and in order to make the generality of battery carbons we should have to have larger molds and larger sheets; the experiments I remember, resulted merely in getting flat sheets of carbon from paper.

92 X Q. Can you produce any specimens of the carbons made in this box in 1876?

A. I cannot; I have looked in Edison's laboratory
3241 & 3242 for some specimens of these paper carbons, but although I can find plenty of carbonized paper, I could not bring any here that I could swear was carbonized by us in 1876.

93 X Q. Have you produced here to-day any specimen of carbonized paper intended to show the quality of the carbonized paper you made in that box in 1876, other than these contained in Exhibit 22?

A. Yes, sir; I have put in evidence here some carbonized tissue sheets which are marked Edison's Exhibit 21, which are substantially similar to some tissue sheets that I carbonized in the iron box in 1876.

By consent the taking of further testimony was postponed to Saturday, July 9, 1881, at 10 o'clock a. m.

WM. H. MEADOWCROFT,
Notary Public, New York County.

Pursuant to adjournment this examination was continued on Saturday, July 9th, 1881, at 10 o'clock a. m., same counsel being present.

94 X Q. Are these carbons of Exhibit 21 carbonized in the same box that the carbons of Exhibit 22 were carbonized in, and in the same way and at the same time?

A. They were carbonized in the same box but not at the same time; they were carbonized in the same manner, between eleven o'clock the night of July 7th, and three o'clock the morning of July 8th, 1881.

95 X Q. Are these carbons of Exhibit 21 suitable carbons out of which to make illuminating conductors for Mr. Edison's incandescent lamp?

A. No, sir.

96 X Q. The same question as to the carbons of Exhibit 22?

A. I cannot say, as I have not tried them.

97 X Q. What is your opinion about it?

3243 A. My opinion is that the carbons in Exhibit 22, if used as incandescent conductors in an electric lamp, would answer that purpose, as the carbonizing we do now for Edison's electric lamps is no different in principal from the way in which we carbonized the strips in 1876.

98 X Q. What time in the year 1876 did you commence these experiments of carbonizing paper, about which you have been testifying?

A. I cannot give the exact date, as I have no memoranda to refresh my memory; the particular year 1876, I remember, as during that year I spent a great part of my time in New York selling and perfecting the manufacture of Edison's electric pen; it was about the time of the organization of the Novelty Company.

99 X Q. At the time these experiments were made, what reference did they have to electric lighting?

A. I know of none.

100 X Q. Referring now to the exhibit marked Edison's First Incandescent Lamp, please to state whether the lamp is now in same condition it was when you made the experiment in it about which you have testified?

A. As far as I can see, it is in the same condition as when I put the paper carbons in for Mr. Edison.

101 X Q. These experiments, as I understand you, with this lamp, were undertaken by you at the request of Mr. Edison in the latter part of the summer or the early part of the fall of 1877?

A. Yes, sir.

102 X Q. When Mr. Edison requested you to undertake these experiments, what did he say to you?

A. As near as I can recollect, his words were, "Batch., put me a piece of carbon in this," and I believe he brought the globe to me at the time.

103 X Q. Is that all he said to you upon the subject of the experiment at the time—did he say nothing about the object of the experiment?

A. At that particular time that was all that I remember; 3244 but when I had finished the instrument, and was making a thin carbon to put in, and he saw the difficulty I had to get it thin enough, he suggested to me to cut the carbon from some of the carbonized paper that was lying around. I do not remember that he said anything to me at that time about the object of the experiment. It was quite apparent to me what he wanted to do.

104 X Q. When did he first say anything to you about the object of the experiment?

A. I cannot call to mind the first time he spoke of the object of this experiment.

105 X Q. State the first time you recollect of his speaking to you about it, and state what he said?

A. I cannot give any particular time when he spoke of the object of this experiment. At the time this experiment was made my time was not wholly devoted to experimenting on electric lighting, and the experiment only occupied my mind for a short time, as I had to make it for him. It was a frequent occurrence for me to break off experimenting on one thing to make an instrument to illustrate some idea of Mr. Edison's.

106 X Q. After you succeeded in getting the carbon in this lamp, to what degree of illuminosity did you succeed in raising it?

A. I cannot tell the exact degree; I remember Mr. Edison and Adams made the experiment with it, and I remember that they all came to incandescence before oxidizing or bursting.

107 X Q. How long were they maintained in a state of incandescence before they were destroyed?

A. I cannot say, but they lasted a very short time.

108 X Q. Well, about how long?

A. None of them, I believe, lasted more than from ten to fifteen minutes.

109 X Q. Did you see these experiments yourself?

A. I was present and saw them, but did not direct the ex-
3245 periments, Mr. Edison doing that himself, as my mind was
not on that. I was simply curious to see the result, and
did see it.

110 X Q. Then you can tell me whether the carbon was raised to a red heat, to a yellowish heat, or to a white heat. Give me, as near *at* you can, the degree of luminosity or color of the carbon that was obtained in those experiments.

A. In those experiments the carbons were raised through the red and yellow to a white heat, and generally before bursting gave a very brilliant light. The degree of luminosity I cannot say.

111 X Q. How many carbons were put in this experimental lamp?

A. I cannot say the exact number, but am sure there were more than two. I could not swear to there being more than six or seven.

112 X Q. All that was put in, as I understand you, you put in?

A. Yes, sir; as far as I know.

113 X Q. How large were the carbons—give their several dimensions, as near as you can recollect?

A. I cannot give their dimensions exactly, but I remember the first one was the widest; their lengths, as near as I remember, were about alike, and their thickness. I do not believe that any of these carbons were more than an inch long or less than ¾ of an inch. Their width was not more than ¼ of an inch nor less than $\frac{1}{32}$ of an inch, and their thickness, as near as I can judge, without anything to refresh my memory, would be in the neighborhood of from seven to ten thousandths of an inch. As I did not carbonize these especially for the purpose, but cut them from already carbonized sheets, this measurement is as near as I can get.

114 X Q. What degree of vacuum did you obtain in the glass chamber or globe of this lamp in which you illuminated a carbon?

A. That I cannot tell; but I know that the vacuum pump, on
the platen of which this was exhausted, will not, under any
3246 circumstances, give a state of exhaustion which I should call
a good vacuum now. At that time, I believe t*k*ey pumped
until they could see no diminution in the column of mercury, and
then stopped.

115 X Q. When Mr. Edison saw the carbons illuminated in this

experimental lamp, and saw them go out, or destroyed by the current, as you have stated, what did he say?

A. I cannot remember what he said, with the exception theat he wanted another one in, and I proceeded immediately to put one in. My attention was taken with this, and I cannot remember what he said at the time, or whether he said anything further than expressing a wish to have another put in.

116 X Q. After he saw the last one burn and go out what did he say?

A. I cannot remember at this time that he said anything in particular.

117 X Q. Didn't make any remarks about the experiments at all?

A. I cannot remember that he made any at all at that time.

118 X Q. Why did he undertake the experiments?

A. Because his mind was running on experimenting with electric light as one of the after things of the telephone; for many months during our experimenting with that telephone, and before my time was devoted entirely to the light.

119 X Q. What did he undertake to prove by these particular experiments?

A. He did not undertake to prove anything to me about them. I knew from these experiments that he had me try what his object was to do; they needed no explanation.

120 X Q. How did you know what his object was?

A. I knew that he thought some on electric lighting. I saw him
for a day or two working at a table near my table experimenting
with a battery and pieces of material in between the electrodes,
and I knew, without being told, that he was experimenting
3247 in electric lighting. Paper carbons were part of the same
series of experiments, and he gave them to me because I was
more used to doing work of that kind than he was, or at least I suppose so. My principal time, and almost all my energy at that time, was on telephones.

121 X Q. Then, as I understand you, you ascertained what Mr. Edison's object was in making the experiments with this exhibit, Edison's First Incandescent Lamp, by what you saw him do, and not by what you heard him say?

A. Yes, sir; by what I saw him do, and what he had me do.

122 X Q. Now, what did you see him do, and what did he have you do, that showed you the object of his experiments?

A. As I said before, I saw him experimenting on electric lighting. He had me put paper carbons in the lamp marked Edison's First In*d*candescent Lamp, and I saw from that, that in this case, he wanted to make an incandescent electric lamp, in which the incandescent material was carbonized paper *in vacuo*.

123 X Q. And that, as I understand you, is all that you saw him do and all that you done, that led you to that conclusion?

A. Yes, sir; that was all that was needed to lead me to that conclusion. I afterwards saw him raise these carbons to incandescence in a vacuum proving to me that such was the case.

124 X Q. When did you see him raise the carbons to incandes-

cence in the vacuum afterwards; was it at the time of these experiments or afterward?

A. Immediately on my giving him the lamp with each paper carbon fixed in place.

125 X Q. Then, from the facts and circumstances which you have related, you inferred, as I understand you, that Mr. Edison's object was to make an incandescent lamp, in which the illuminating conductor should be of carbonized paper?

A. Yes, sir.

3248 126 X Q. How well did Mr. Edison accomplish this object at that time?

A. The lamp was complete, and gave light for a short time. It was not a commercial success. As a lamp for a few minutes it was a success.

127 X Q. If that was Mr. Edison's object in making those experiments why did he tell you first to put hard carbon in the lamp, and then when he saw how much trouble it was to get in the hard carbon, direct you to put in strips of paper carbon?

A. I do not know why he told me to put in the paper carbon, except that I knew he did so.

128 X Q. Now, in putting this carbon in this lamp, I understand you to say that you screwed the glass globe off of the pedestal, in which the cock is placed below the globe?

A. Yes, sir.

129 X Q. That you screwed the ball off of the top of the stem?

A. Yes, sir.

130 X Q. And the gland off of the stuffing box?

A. Yes, sir.

131 X Q. And took the packing out of the stuffing box?

A. Yes.

132 X Q. And made the clamps on the end of the rod that forms the conductor in the chamber of the lamp?

A. Yes, sir.

133 X Q. That you took the piece of carbon and fastened it in the clamps?

A. Yes.

134 X Q. That you then screwed the lower end of the conductor in the top of the pedestal in which the cock is placed under the globe of the lamp?

A. I either screwed it in there or fastened it in tightly.

3249 135 X Q. You then passed the whole conductor up through the bottom of the globe, the upper end of the conductor passing up through the stuffing box, the globe being turned right upside down.

A. Yes.

136 X Q. You then, while the globe of the lamp was in an inverted position, screwed the pedestal in which the cock is placed in the bottom of the globe?

A. Yes.

137 X Q. Then put the packing in and screwed in the gland?

A. Yes, sir.

138 X Q. Now, after you had got the carbon in the lamp, and the lamp together in that way, how did you exhaust the air out of the globe?

A. This was done by an ordinary air pump; the base of this lamp, being true, was placed right over the exhausting hole on the platen, and the air drawn out of the lamp; this, I believe was done by Adams.

139 X Q. How could the air be drawn out of the globe of the lamp unless there was an open passage between the air pump and the globe of the lamp?

A. You will find that there is such a passage in the inside of the lamp, I believe where the screw is driven in.

140 X Q. On an examination of the lamp I do not find any such passage; please to point it out.

A. You will find there are two small grooves, one on each side of the rod of brass, through which, if the grease was cleaned out of the lamp, you would be able to suck air.

141 X Q. When were these experiments with the Exhibit Edison's First Incandescent Lamp concluded?

A. They only lasted a few days altogether with this particular lamp, in the end of the summer or beginning of the fall of 1877.

142 X Q. Did you experiment with any other lamps at that time?

A. I do not recall to my mind making any more lamps for Mr. Edison about that time.

3250 143 X Q. I read to you your answer in examination-in-chief to question 26.

(Counsel reads question and answer.)

Were all the carbons that were then illuminated—I mean at the time referred to in your answer which I have just read—illuminated in the bell receiver of the air pump, or did you then have at that time, in the fall of 1878, a lamp made having a glass chamber from which the air was exhausted, and into which you put these carbons to illuminate them?

A. As far as I remember, they were all illuminated in one of the bell jars belonging to the pump.

144 X Q. What was the shape of these carbons?

A. They were as near as we could get them to short, straight sticks.

145 X Q. Did you experiment with other carbons besides paper carbons at the same time?

A. Yes, sir; during the same series of experiments.

146 X Q. How long did that series of experiments last, and when was it concluded, as near as you can recollect?

A. I cannot say just what time I gave over experimenting myself on these; probably about the end of September, 1878.

147 X Q. After you concluded your experiments in the fall of 1878 with the carbonized paper in the bell jar of the air pump, when did you next use carbonized paper for illuminating in an electric lamp?

A. Shortly after the experiments referred to, Mr. Edison used some of these carbons in the electric lamp Exhibit No. 15.

148 X Q. Was that a sealed lamp in which the carbons burned *in vacuo* or in an inert gas?

A. No, sir; the carbons burnt in the atmosphere.

149 X Q. When did you next use carbonized paper for illuminating in a sealed electric lamp, out of which the air had been 3251 exhausted, after you had completed your experiments in the fall of 1878—I mean the experiments in the bell jar of the air pump.

A. About the middle of October, 1879, within a day or so of the time that the first of the style of lamp of which Edison's Exhibit Commercial Incandescent Lamp is one, was made.

150 X Q. In that case, as I understand you, the carbon was substantially of the form of that shown in the Exhibit Edison's Commercial Incandescent Electric Lamp, and the lamp was made for the purpose of burning an incandescent conductor of carbonized paper, or something substantially the same as carbonized paper?

A. It was substantially the same with this exception, that, I remember, the first loop that was cut, was cut straight and bent round when put into the carbonizing chamber. The lamp was made for the purpose of a lamp; with the exception that I have mentioned the lamp was similar to this exhibit.

151 X Q. When did you first cut the paper of the form substantially shown in the Exhibit Edison's Commercial Incandescent Lamp before carbonizing?

A. I believe I cut them during October, 1879. My impression is between the 20th and 25th. I think I could find the record somewhere amongst our books, to that effect.

152 X Q. Then, as I understand you, the first sealed incandescent electric lamp or lamps that Mr. Edison made or caused to be made, as a lamp, in which he used carbonized paper for the illuminating conductor, was made in October, 1879?

A. With the exception of the Exhibit Edison's First Incandescent Lamp, and the experiments I have mentioned in the bell jar of an air pump, the lamp made in October, 1879, was the first lamp which answers the conditions of your question.

153 X Q. Referring now to Exhibit No. 16, please to describe exactly how you carbonized that paper, and what kind of blotting paper you used?

3252 A. The Exhibit 16 is ordinary blotting paper similar to that which I now put in the box with Exhibit 16 and mark in ink with my initials. These sheets were carbonized in the same box that I have spoken of as being one in which Exhibits 21 and 22 were made. The paper was put in the box, tightly packed with powdered charcoal between each sheet. They were made to show what kind of carbon ordinary blotting paper makes when carbonized, substantially the same as is spoken of in Mr. Man's testimony.

154 X Q. How did you fasten the lid down on the box in this case, the same as in the other case?

A. I did not fasten the lid down by wire, as spoken of in one of Mr. Man's statements, as the lid of my box has a projection going inside the box.

155 X Q. Was there any pressure upon the paper during the operation of carbonization?

A. None except the weight of the lid.

156 X Q. Was the full weight of the lid upon the paper?

A. No, sir; the lid rested on the tightly packed powdered carbon. The papers were some distance from the surface.

157 X Q. Did you saturate the paper with any carbonaceous material, put it in a hydraulic press and press it hard before carbonizing?

A. I did not saturate this exhibit with anything, nor did I press it. I however, pressed a piece of the botting paper under a powerful screw-press, and carbonized that. I did not, however, saturate this with anything. I have produced this and it is here, marked Edison's Exhibit No. 17. I made these to show the kind of carbon that blotting paper made, whether pressed or in its ordinary state.

158 X Q. What experience, if any, have you had in treating paper carbons electrically, in the presence of hydrocarbon gas?

Question objected to as being new matter, not brought out upon examination-in-chief.

3253 A. I have had considerable experience in treating carbonized paper used as an incandescent conductor in hydrocarbon vapor in connection with the paper-carbon loops of Edison's electric lamp.

159 X Q. What effect does such treatment have upon the paper-carbon burner?

A. It deposits carbon from the hydrocarbon on the surface of the incandescent conductor.

160 X Q. Doesn't it fill up the interstices and consolidate the carbon—making it finer and more compact?

A. It probably does fill up the little interstices on the surface, but I do not think it makes the paper carbon any more compact. It adds to that by coating on the surface. I have frequently broken these conductors that have been treated in the vapor of the hydrocarbon, and, under a powerful microscope, have found that the fracture of the paper carbon showed no greater density, and the deposited carbon sticking to it in the shape of small needles stuck endwise on it.

161 X Q. In the presence of what kind of hydrocarbon gas did you treat the carbon; how high did you raise its temperature or luminosity?

A. In our experiments we have generally used the vapor gasoline, benzine and such vapors. The carbons were raised to different temperatures, but were always raised to brilliant incandescence when we were depositing this carbon.

162 X Q. Under what pressure of the gas did you treat the carbon?

A. I do not know what pressure we had. The chambers that I had made for our experiments in the experiments I speak of, always had a small outlet, so that the vapor could escape, and we made it while the experiment was going on. We did not create an artificial pressure for the purpose of treating carbon under pressure. If there was any pressure at all, it was an incidental pressure, while we were making the gas.

163 X Q. How large were the carbons you treated?

3254 A. Some of the carbons were the same as the one in Exhibit Edison's Commercial Incandescent Electric Lamp. The other carbons were about the same size, but made from different fibres.

Redirect examination by GEORGE W. DYER, counsel for Edison:

164 Q. Do you wish to explain your testimony in regard to first putting carbons into the lamp, Exhibit Edison's First Incandescent Lamp, if so, please make your explanation.

A. Yes; in my direct testimony I testified that Edison wanted a hard carbon put in that lamp, so that it reads as if he requested that it should be specially hard carbon. I could not swear that he especially wanted a hard carbon, but that he told me, as I have afterwards stated, to put a carbon in the lamp, and I proceeded at that time to put a hard carbon in, supposing that was what he wanted.

165 Q. Referring to your answer in cross-examination about the Exhibit First Incandescent Lamp, state, if you remember, how long before the experiments with the lamp was the lamp made, as a lamp?

Question objected to, and all testimony appertaining to the alleged lamp—Edison's first incandescent lamp—as tending to prove that the invention was made before the date alleged in the preliminary statement; because the question assumes that the so-called lamp was ever made for a lamp.

A. The lamp was used as a lamp within a day of its being made as a lamp.

166 Q. At the time of these experiments with this exhibit, do you wish to be understood that the only conversation Mr. Edison had with you in regard to electric lighting by incandescence was the direction to put a carbon in that lamp?

3255 A. Previous to that time, and after that time, Mr. Edison had frequently spoken of electric lighting for domestic purposes as a big field for experiment when we had the telephone and some other things off our hands. He frequently tried experiments himself whilst we were working on these other things. He knew that I was conversant with the experiments and the end they tended towards, and therefore his order to me to put the carbon in—that needed no further explanation from him as to what he proposed to do.

CHAS. BATCHELOR.

3256 By consent, the taking of testimony was postponed to Wednesday, July 13th, 1881, at same place, at ten o'clock a. m.

WM. H. MEADOWCROFT.
Notary Public, N. Y. Co.

Parties met, pursuant to adjournment, on Wednesday, July 13th, 1881, and adjourned by consent to Saturday, July 16th, 1881, at 10 o'clock a m., at same place.

WM. H. MEADOWCROFT,
Notary Public, N. Y. Co.

Parties met, pursuant to adjournment, on Saturday, July 16th, 1881, and adjourned by consent to Wednesday, July 20th, 1881, at 10 a. m., at same place.

WM. H. MEADOWCROFF,
Notary Public, N. Y. Co.

3257 Pursuant to adjournment, this testimony was continued Wednesday, July 20th, 1881, at 10 a. m., same counsel being present.

STEPHEN D. FIELD, a witness produced in behalf of Mr. Edison, being duly sworn, testified as follows, in answer to questions proposed to him by GEORGE W. DYER, counsel for Edison:

1 Q. Please state your name, age, residence and occupation.

A. Stephen Dudley Field; 35 years old; residence, New York; occupation, electrical engineer.

2 Q. Please state whether or not you visited Mr. Edison at Menlo Park, in 1877, and if so, at what time during that year?

A. I visited Mr. Edison's place during the summer of 1877. To the best of my recollection it was the middle or latter part of the month of August.

3 Q. When at Menlo Park, at the time named, did you see Mr. Edison perform any experiments in incandescent electric lighting, and if so, please state what the experiments were?

Question objected to as going to prove that the invention was made before the date alleged in the preliminary statement of Mr. Edison and notice of motion to strike it out at the hearing.

A. I went there at Mr. Edison's invitation to witness experiments in incandescent lighting. The experiment consisted in the heating, by means of a bichromate battery of small crystals, of what Mr. Edison called silicon, said crystals being supported between carbon clamps.

4 Q. Please examine exhibits marked Edison's Exhibit No. 4 and No. 13, already in testimony in this case, and state whether 3258 or not these exhibits indicate substantially the character of the experiments which you then witnessed?

Objected to as immaterial and incompetent. Notice of motion to strike out.

A. The experiments which I witnessed are indicated in figures 1 and 2 of Exhibit 4, and the middle and lower figures of Exhibit No. 13. The exception being that the source of power in the experiments was a bichromate battery in place of magneto machines, as shown in the exhibit.

5 Q. During that visit to Mr. Edison, did he explain to you what he had previously done in incandescent electric lighting, and if so, what explanation or information did he give?

Same objection and same notice.

A. My recollection is that he stated that this use of silicon he hoped would give him an inexidizable agent for a burner, and thereby greatly simplify the problem of incandescent lighting. Beyond that I have no recollection of any conversation between us, except he referred to a note book which he showed me, wherein he had first discovered the incandescent properties of silicon.

6 Q. Do you recollect whether or not Mr. Edison spoke of materials for incandescent conductors, which had been previously tried by him and found to be oxidizable?

Same objection and same notice.

A. My recollection is that we had a general conversation on the subject, the details of which have, however, almost entirely escaped my memory.

7 Q. Who was present during these experiments you have mentioned, besides yourself and Mr. Edison?

Same objections.

3259 A. Dr. Cornelius Herz, now in Paris, and Mr. Batchelor, I believe, and one or two of Mr. Edison's assistants.

Counsel for Edison gives notice that he here closes his examination of this witness, and offers him for cross-examination.

No cross-examination.

STEPHEN D. FIELD.

3260 THOMAS B. STILLMAN, a witness produced in behalf of Mr. Edison, being duly sworn, testifies as follows in answer to questions proposed by GEORGE W. DYER, counsel for Edison:

1 Q. Please state your name, age, residence and occupation.

A. Thomas B. Stillman; 29 years old; residence, Plainfield, N. J.; occupation, analytical chemist and assayer.

2 Q. Please state whether or not you are acquainted with William E. Sawyer, the electrician.

A. I am.

3 Q. Please examine the paper I now show you, marked Edison's Exhibit No. 8, and state whether or not you read the same soon after its publication in the newspapers.

Objected to as immaterial.

A. I have examined the paper shown me; I read it; it might have been one month, but not later than three months after its publication.

4 Q. Did you ever hear William E. Sawyer speak of the authorship of that article marked Edison's Exhibit No. 8.

Same objection.

A. I have.

5 Q. How often have you heard him so speak?

A. Once, certainly and I think twice.

6 Q. Repeat what he said as nearly as you can remember it.

Objected to as incompetent and immaterial.

A. I can't state what he said; he called my attention to the article, and asked me if I had read it. I said, "No." I then read it.

7 Q. How did he speak of it—as his article?

Objected to as leading.

3261 A. I can't say that he did. My impression is he said "my challenge."

8 Q. Do you remember what he said when he asked you to read the article?

A. I don't recollect any more than what I have said, positively.

9 Q. Have you heard the article referred to in his presence as his article?

Objected to as incompetent.

A. Not in those words as coming from him, but the impression derived from what he said led me to think he wrote the article.

10 Q. Have you heard the article referred to in his presence as his challenge, or as Sawyer's challenge to Edison?

Objected to as incompetent.

A. Not by other parties, but when Mr. Sawyer drew my attention to it as his challenge.

11 Q. Are you acquainted with Mr. William E. Sawyer's signature?

A. Yes, sir.

12 Q. Please examine the paper now shown you; state whether or not the signature, W. E. Sawyer, is in the handwriting of William E. Sawyer.

Objected to as incompetent.

A. I think it is—yes, sir.

13 Q. Have you any papers in your possession in the handwriting of William E. Sawyer, containing his signature?

Objected to as incompetent and immaterial.

A. I have.

14 [illegible] Please produce the same.

Same objection.

3265 A. I produce a note sent to me by William E. Sawyer.

The paper first mentioned is put in evidence and is marked Edison's Exhibit No. 23.

(Here follows lithograph marked pp. 3262 & 3263.)

Exhibit 23 objected to as not being shown to be in the handwriting of Mr. Sawyer, or caused to have been written by him, and as not being produced by the person to whom it is addressed; and as incompetent, irrelevant and immaterial.

Second paper referred to, being a note to the witness, is put in evidence and marked, Edison's Exhibit No. 24.

(Here follows lithograph marked p. 3264.)

Objected to as incompetent, irrelevant and immaterial.

15 Q. Please state if you find the newspaper article put in evidence, and marked Edison's Exhibit No. 23, published in the New York Sun of January 5, 1880?

Objected to as incompetent, irrelevant and immaterial; and upon the further ground that there is no proof that the paper put in evidence was January 5, 1880.

A. I find it published in the paper dated on that date, January 5, 1880.

16 Q. Also, is the paper now shown you the same extract cut out of the newspaper?

A. Yes.

Extract referred to put in evidence, and marked Edison's Exhibit No. 25.

Object- to as incompetent and no proof of anything except its own existence.

17 Q. Were you subpœnaed as a witness in this case for Mr. Edison?

A. I was.

3266 Counsel for Edison her- closes his examination of this witness and offers him for cross-examination.

Cross-examination by Amos Broadnax, Esq., counsel for Sawyer and Man:

1 X Q. When was the paper marked Exhibit 24 written?

A. I can't give the date of it.

2 X Q. How do you know this paper is in the handwriting of Mr. Sawyer?

A. It is the same handwriting I have always seen him use.

3 X Q. How often have you seen him write, if at all?

A. A number of times; I can't state exactly how many.

4 X Q. About how many?

No. 286
C. E. Light Co
v.
McK Light Co } 17. 32 62

Mr. Edison Challenged by Mr Sawyer Offer

(Ap. — Dec 6)

To the Editor of the Sun — Sir:

Edison's Exhibit
No ~~[illegible]~~ 23 W.H.M. Notary public N.Y. Co.

~~Editor Sun~~

~~78 Walker St.~~
~~New York Jan 4 1880~~

Notwithstanding the assertion that one of Mr Edison's electric lamps has been running for 240 hours I still assert, and am prepared to back up my assertion, that Mr Edison cannot run one of his lamps up to the light of a single gas-jet (to be more definite, let us call it 12 candle power) for more than three hours. To be still more definite I offer to Mr Edison, at 226 W. 54th St. in this city, an opportunity to prove what he says. From the private residence in that street, wires are run a circuit of 800 feet. Mr Edison shall have every facility; he shall use w/ Lit my wires: he shall have any dynamo machine or other generator of electricity he may prefer; and all I ask is that the power of his light shall be measured by a photometer: that, once in place, it shall not be interfered with; and that a committee of gentlemen, preferably nominated by the editors of the N.Y. press

No. 286
E. Light Co
v.
McK. Light Co } p. 3263

agate 8K

shall be present and certify to the facts of the test

Furthermore, I will place one of my lamps side by side with Mr Edison's; it shall be run at a power of 25 candles; (it shall outlast the entire 40 lamps at Menlo Park run at the power of 25 candles;) my lamp to stand as it is put up, and Mr Edison to put up a fresh lamp as fast as the preceding lamp shall have burned out.

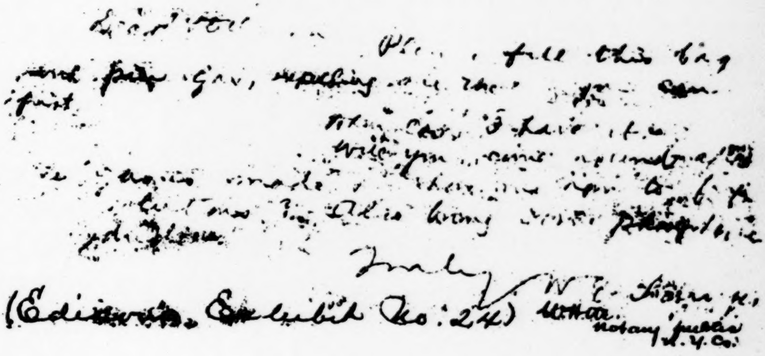
¶ I am anxious for this test; and if Mr Edison has really run one of his ~~lamp~~ horse shoe lamps 240 hours he will not refuse to accept my offer. for he will be treated with the utmost courtesy and shall have everything his own way.

I adhere in every particular to my original challenge to Mr Edison.

Respectfully
W. E. Sawyer

78 Walker Street New York Jan 4

111



Dear [illegible] — Please fill this bag
with pure gas, expelling all the [illegible] com-
pint.

[illegible] can I have it [illegible]
Will you [illegible] [illegible]
[illegible] [illegible] made [illegible] [illegible] [illegible] to [illegible]
[illegible] [illegible] this being [illegible] [illegible]
[illegible]

Truly

(Edison's Exhibit No. 24) W. C. [illegible]
[illegible]
notary public
N. Y. Co.

No. 286.
E. Light Co.
v.
McK. Light Co.
} p. 3264

A. I couldn't state about how many; I have been connected with him nearly three years.

5 X Q. Can you swear that you saw Mr. Sawyer write ten times in these three years?

A. Yes, sir.

6 Q. And use the same handwriting every time?

A. Yes, sir; with one exception when he couldn't see.

7 X Q. Did you see him write when he couldn't see?

A. I did not. He had injured his eyes by an explosion. I had a note written from him when his eyes were in that condition, where he stated that fact. That note was in a different handwriting.

8 X Q. In whose handwriting is this paper, Edison Exhibit 23?

A. I don't know; it looks like Sawyer's uncle's—Leonard Sawyer.

9 X Q. Did you see Mr. Sawyer sign this paper?

A. No, sir.

10 X Q. It's not in the handwriting of Mr. Sawyer, is it?

3267 A. No, sir.

11 X Q. Do you know whether Mr. Sawyer read it or heard it read after it was written?

A. I do not.

12 X Q. Do you know whether he dictated it?

A. I do not.

13 X Q. Is this the paper Mr. Sawyer referred to as his challenge to Mr. Edison?

A. No, sir; the paper he referred to as his challenge to Mr. Edison is Edison's Exhibit No. 8.

14 X Q. Do you know who wrote this paper Exhibit No. 8?

A. No, sir.

THOS. B. STILLMAN.

3268 William Sawyer, a witness produced in behalf of Mr. Edison, being duly sworn, testifies as follows, in answer to questions proposed to him by George W. Dyer, counsel for Edison:

1 Q. Please state your name, age, residence, and occupation.

A. Name, William Sawyer; age, 59; present location, Earle's hotel; occupation, gentleman, as near as I can act one.

2 Q. Are you the father of William E. Sawyer, the electrician?

A. Yes.

3 Q. Please examine the paper now shown you which is marked Edison's Exhibit No. 8, and state whether you read the same soon after the date of its publication?

Objected to as incompetent, irrelevant and immaterial.

A. I think I read that about the time of its publication. I couldn't swear positively that this is the same thing, but think it is virtually the same. It was a challenge.

4 Q. Did you ever hear your son, William E. Sawyer, deny being the author of this challenge?

A. No, sir; nor I never heard him acknowledge it.

Latter part of the answer objected to by counsel for Edison as not responsive.

4 Q. Have you not stated within a week that your son, William E. Sawyer, wrote this challenge before referred to?

Objected to as incompetent.

A. I may have made that remark. I couldn't say that I did not. I have no recollection of making that remark; neither will I say that this is the challenge shown me that he wrote.

3269 6 Q. Have not you stated, within a week, that you went into a certain place and found your son dictating this challenge to a messenger boy?

Objected to as also being incompetent.

A. Emphatically, no. I may have stated that I understood that he did dictate to a messenger boy and the messenger boy wrote it down as it came from his lips, but not from my personal knowledge. It was hearsay.

7 Q. From whom did you understand that William E. Sawyer dictated that challenge to a messenger boy?

A. I couldn't tell; not within my recollection.

8 Q. Did you ever hear this challenge talked over in the presence of William E. Sawyer?

A. No, sir; to the best of my recollection, I never heard the subject-matter talked over in his presence, either with myself or any other parties.

9 Q. Have you not stated within a week that you advised your son, William E. Sawyer, that he ought not to have published the challenge referred to, or so advised him at the time the challenge was being dictated?

Objected to as leading and immaterial.

A. I do not recollect of doing so.

10 Q. At what place did you understand this challenge, so called, was dictated?

A. According to the best of my recollection, he was boarding at 200 West Forty-second street at the time of this publication.

11 Q. I do not ask where he was boarding, but where, as you understand it, he was when this challenge was dictated.

Question objected to as calling for hearsay evidence, and upon the further ground that the witness has not stated that he understood the challenge to be dictated at all.

3270 A. I have answered this question before. He may, however, have been boarding at 267 instead of 200 West Forty-second street. My present impression is that it was dictated either at 200 or 267 West Forty-second street. I would not state positively to either place, as I have no means of fixing it.

12 Q. Have you not stated within a week that that challenge was dictated at the corner of Walker and Elm streets?

Objected to as grossly leading and immaterial.

A. I have no recollection of it.

13 Q. Have you any recollection of talking with any one whatever about this challenge within a week?

A. I have no recollection of it.

14 Q. You stated conversationally, a moment ago, did you not, that you were very much annoyed when you read this challenge in the newspapers?

Objected to as leading and immaterial.

A. I did so state confidentially to Mr. Dyer.

15 Q. Had you any doubt at the time of reading this challenge that it proceeded from your son, William E. Sawyer?

Objected to as leading and immaterial as to what his opinion was, or doubts upon the subject.

A. Of course, I took it for granted, as all others would, the communication being over his signature.

16 Q. Were you subpœnaed as a witness in this interference?

A. Yes.

Counsel for Edison closes his examination of this witness, and turns him over for cross-examination.

3271 Cross-examination by AMOS BROADNAX, Esq., counsel for Sawyer and Man:

17 X Q. Do you know of your own knowledge, whether your son, William E. Sawyer, wrote or dictated this article, cut from a newspaper, and marked Edison's Exhibit No. 8?

A. No.

WM. SAWYER.

3272 JAMES A. RUSSELL, a witness produced in behalf of Mr. Edison, being duly sworn, testifies as follows in answer to questions proposed to him by GEORGE W. DYER, counsel for Edison:

1 Q. Please state your name, age, residence and occupation.

A. Residence, 347 West Thirty-sixth street, New York; I am a canvasser for the Edison Electric Light Company. My name is James A. Russell, and I am 44 years of age.

2 Q. State whether or not you know Mr. William Sawyer, who has just testified as a witness in this case and in this room.

Objected to as immaterial.

A. Yes, I know him.

3 Q. State whether or not you have heard Mr. William Sawyer lately make any statements regarding the authorship of a newspaper challenge published in the New York Sun, December 22d, 1879, marked Edison's Exhibit No. 8, and if so, when and where were such statements made, and what was the statement?

Objected to as calling for mere hearsay testimony, at second or third hand, and after the witness, William Sawyer, has testified that he really didn't know anything about it.

A. On Sunday last at Earle's hotel, talking with Mr. Potter. Mr. Potter had a conversation with him about a man named William Sharpe, who had formerly said he would like to hire him as he was an expert mechanic. He said he wanted to hire him for a gentleman friend of his in Reading, Pennsylvania. This man wanted him to do some very fine work. That was his object in calling on Mr. Sawyer.

3273 Mr. Sawyer said, "Do you know how that article was written?" He said, "Ed. was drunk, and it was written by a district telegraph boy at his dictation, and he told Ed. he had made a mistake," and Ed. says, "I've done it, I've done it. They can't answer it." I don't know that he said he was drunk, but that he was a little off.

4 Q. What article was referred to in the last part of your answer?

A. The challenge, Edison's Exhibit No. 8. I want to add to my last answer that Mr. Sawyer said, "Ed. slings a nasty pen, and talks too much."

Counsel for Edison closes his examination of this witness and offers him for cross-examination.

Cross-examination by Amos Broadnax, Esq., counsel for Sawyer and Man:

5 X Q. At the time you overheard this conversation which you have related in your examination-in-chief, did Mr. Potter show Mr. Sawyer this exhibit?

A. No.

6 X Q. How did he identify the article?

A. He mentioned the fact that the article was written in the Sun just before Christmas.

7 X Q. Did he say that he saw his son dictate the article?

A. Yes.

8 X Q. How did you come to go there?

A. I went to H. Dralle, 93 Walker street, and he told me that Wm. Sawyer, Sr., could give me all the information.

9 X Q. What did you want of Mr. Sharpe?

A. I wanted some excuse to have an interview with Mr. Sawyer.

10 X Q. And the object of your interview, as I understand you, was to see what you could suck out of him about this matter?

A. Not to suck out of him, but to obtain anything I could that would benefit my employers.

JAMES A. RUSSELL.

3274 James D. Potter, a witness produced in behalf of Mr. Edison, testifies as follows, in answer to questions proposed to him by George W. Dyer, counsel for Edison:

1 Q. Please state your name, age, residence and occupation.

A. James D. Potter; age, 57; residence, 390 Manhattan avenue, Brooklyn; I am engaged in mining.

2 Q. Are you acquainted with Wm. Sawyer, who has just testified in this case and in this room?

A. I am acquainted with the gentleman who calls himself William Sawyer. I have just come in this building and did not see Mr. Sawyer here.

3 Q. Have you had a conversation with William Sawyer lately about the authorship of an article called a challenge, published in the New York Sun, December 22d, 1879, marked Edison's Exhibit No. 8, and if so, when and where did you have this conversation, and if anybody was present besides yourself and Mr. Sawyer state who was present?

Question objected to as calling for mere hearsay testimony, as contradicting the statement made by one of Mr. Edison's own witnessess.

A. It was on Sunday, July 17th, at 2 o'clock, at Earle's hotel; Mr. James A. Russell was present.

4 Q. Please state what Mr. Sawyer said in regard to the authorship of the article referred to in the former question.

A. We had a conversation in regard to a man named William Sharpe, desiring to know his locality, as I wished to hire him for a gentleman in Reading. He informed me where Sharpe could be found; said he was at Ansonia, Connecticut, employed by the Wallace Manufacturing Company. Then the conversation drifted off to electricity. He said, "Ed. was one of the best electricians in 3275 the United States." I told him I had read many articles of his son's about electricity, electric light, etc. He said, "Did you read that challenge in December, '79?" I said, "Yes, sir;" and also said "that never was answered." He replied, "He couldn't answer it." He then said, "Do you know how that was written—under what circumstances?" I said, "No, I do not." He said, "I'll tell you. Ed. got a telegraph boy to write it." He said, "He was pretty full," or "he was drunk;" one or both expressions. While he was dictating it he would fall asleep or doze off. He would wake up and ask "Where did I leave off? What did I say last?" The boy wrote the article, and that was the way he wrote it. He was writing the article when Sawyer came in. He said to him, "Ed., do you think *your* doing right?" He said, "Yes, I've done it, I've done it. They can't answer it."

JAMES D. POTTER.

Examination ended. No cross-examination.

3276 James E. O'Keeffe, a witness produced in behalf of Mr. Edison, testifies as follows in answer to questions proposed by George W. Dyer, counsel for Edison:

1 Q. Please state your name, age, residence and occupation.

A. James E. O'Keeffe of 65 Monroe street, New York; office boy to the Aldine Publishing Company; age 15.

2 Q. What were you doing before you went in the office of the Aldine Publishing Company?

A. Working in E. Daly's boat shop.

3 Q. Where before that?

A. With Matthew, Leach & Co.'s wholesale and retail tea store.

4 Q. Were you ever in the employ of the American District Telegraph Company? If so when and where?

A. In the 15th district, from May, 1879, until February, 1880.

5 Q. Look at this newspaper article I show you, which is marked Edison's Exhibit No. 8, and state what you know, if anything, about that article.

A. I remember hearing him speak about a challenge, and there was words in it that I couldn't spell and he told me how to spell them—big words.

6 Q. Did you write that article from anybody's dictation?

A. Yes, sir.

7 Q. When was it; and where was it?

A. In Dralle's lager-beer saloon, corner of Elm and Walker streets, in December, 1879, on Sunday morning.

8 Q. What did you do with the article after you wrote it from dictation?

A. I handed it back to Mr. Sawyer.

9 Q. Then what did you do with it?

A. He put it in an envelope, and I went up to the Sun office.

10 Q. Did you leave the paper at the Sun office?

3277 A. Yes, sir, and I brought back an answer.

Counsel for Edison closes his examination-in-chief of this witness, and gives him over for cross-examination.

Cross-examination by AMOS BROADNAX, counsel for Sawyer and Man:

11 X Q. Was the article you wrote from Mr. Sawyer's dictation printed in the Sun?

A. I don't know; I didn't see it.

12 X Q. Can you produce the paper that you wrote from Mr. Sawyer's dictation?

A. No, sir.

13 X Q. When did you read that paper—Edison's Exhibit 8?

A. To-day.

14 X Q. Is that the first — you read it since you wrote it from Mr. Sawyer's dictation?

A. Yes, sir.

15 X Q. Now, can you swear that this paper, Exhibit 8, is a copy of the paper that Mr. Sawyer dictated to you, as you have stated?

A. I can't say that it's all, but I know some of it is.

16 X Q. After the paper was printed, did you compare the printed paper with the paper you say you wrote from Mr. Sawyer's dictation?

A. No, sir.

17 X Q. Have you ever seen the paper that you wrote from Mr.

Sawyer's dictation, and that you took to the Sun office since you took it to the Sun office?

A. No, sir.

18 X Q. What was the answer that you brought back from the Sun office?

A. I don't know; Mr. Sawyer didn't receive the answer, but the man behind the bar. Mr. Sawyer was upstairs.

3278 19 X Q. Was Mr. Sawyer drunk when he dictated the paper to you?

A. He acted like it.

Redirect examination by GEORGE W. DYER, counsel for Edison:

20 Q. Have you ever written any other paper from dictation for anybody else?

A. Yes, sir; once before; for a man down in New street.

JAMES E. O'KEEFFE.

Counsel for Edison gives notice that the testimony in behalf of Edison closes here.

WM. H. MEADOWCROFT,
Notary Public, New York County.

3279 STATE OF NEW YORK,
City and County of New York, } *ss:*

I, William H. Meadowcroft, a notary public, within and for the city and county of New York, and State of New York, do hereby certify that the foregoing depositions of Thomas A. Edison, Martin N. Force, Edward H. Johnson, John Kruesi, Francis R. Upton, Charles Batchelor, Stephen D. Field, Thomas B. Stillman, William Sawyer, James A. Russell, James D. Potter and James E. O'Keeffe, were taken on behalf of Thomas A. Edison, in pursuance of the notice hereunto annexed, before me, at No. 65 Fifth avenue, in the city of New York, on the 10th, 11th, 13th, 14th, 15th, 16th, 17th, 18th, 27th, 28th, 29th and 30th days of June, 1881, and the 7th, 8th, 9th, 13th, 16th and 20th days of July, 1881; that each of said witnesses was by me duly sworn before the commencement of his testimony; that the testimony of the said witnesses was written out by Henry W. Seely and Richard N. Dyer, they having been, by me, duly sworn to record the same faithfully; that Amos Broadnax, Esq., representing the opposing parties, Messrs. Sawyer and Man, was present during the taking of said testimony; that said testimony was taken at No. 65 Fifth avenue, in the city of New York, and was commenced at 11 o'clock a. m. at 65 Fifth avenue aforesaid, on the 10th day of June, 1881, and was continued, pursuant to adjournment, on the 11th, 13th, 14th, 15th, 16th, 17th, 18th, 27th, 28th, 29th and 30th days of June, 1881, and the 7th, 8th, 9th, 13th, 16th and 20th days of July, 1881; and was concluded on the last-mentioned day; and that I am not connected by blood or marriage with either of said parties, nor interested directly or indirectly in the matter in controversy.

[L. S.] In testimony whereof, I have hereto set my hand and affixed my official seal at No. 65 Fifth avenue, in the said county of New York, this 21st day of July, A. D. 1881.

WM. H. MEADOWCROFT,
Notary Public, New York County.

3280 EDISON'S EXHIBIT No. 11. W. H. M., NOTARY PUBLIC, N. Y. Co.

From Note Book No. 74, pages 1, 2, 5, 7, 8, 9, 10, 11, 12, 13 and 14.

Record of Lamps.

No. 159. Hung on leading wires over pumps, first over pumps nearest to chandelier. Place.

Res., 153 ohms. } Jan. 2, 1880,
Has burnt 200 h. } noon.

Jan	2.	200.		
"	3.	19.30		
"	4.	9.58.		
"	5.	20.50.		
"	6.	20.26.		
"	7.	12.15.		
"	8.	22.00.		
"	9.	15.50.	Res. the same. Total h., 310.12.	
"	10.	19.15.		
"	11.	7.00.		
"	12.	20.30.	Total hours burned, 381.57.	
"	13.	22.30.		
"	14.	22.30.		
"	15.	11.30.	" " "	437.
"	16.	23.00.		
"	17.	11.	" " "	571.
"	17.	8.		
"	18.	2.	" " "	489.
"	19.	8.		
"	19.	11.		
"	20.	11.		509—over.
Jan.	20, up to 509.			
"	20.	11.		
	21.	9.15.		
	22.	15.45.		
	23.	8.00.	Total, 553.10.	
	23.	5.00.		
	24.	18.30.		
	25.	6.00.		

3281

26.	10.00.	"	592.40.

Jan. 26.	10.40.	Total, 614.20.
27.	11.00.	
27.	10.25.	H'rs, 614.20.
28.	11.00.	635.40.
28.	10.00.	
29.	11.00.	656.45.
29.	11.00.	
30.	16.00.	
	27.00.	

Bu-sted at eight o'clock. Total hours, 683.45.

3282 223. Third chandelier, top room in laboratory:

Res., 140. } Jan. 2, 1880,
Burnt 13 hours. } noon. Place.

Jan. 3.	32.30.		
4.	9.58.		
5.	23.47.		
6.	20.26.		
7.	12.15.		
8.	22.00.		
9.	15.50.	Total time burned,	173.12.
10.	19.15.		
11.	7.00.	" " "	217.17, noon.
12.	20.00.		
13.	22.30.	" " "	237.47 "
14.	22.30.		
15.	11.30.	" " "	294.17 "
15.	11.00.		
16.	22.00.		
17.	11.00.		
18.	18.	" " "	339.17 "
18.	2.		
19.	8.	" " "	367.17 total time.

One clamp red hot; poor vacuum.
Bu-sted at —.

3283 155. Over Carman's desk, office:

Res., 126 ohms. } Jan. 2, 1880. Place 31.
Burnt 50 hours. } Noon.

Jan. 2.	50.
3.	69.58.
4.	9.50.
5.	23.47.
6.	20.26.
6.	12.15.
8.	22.00.

Jan. 9.	15.50.	Total time burned, 173.12.
10.	19.15.	
11.	7.00.	" " " 217.17, noon.
12.	20.00.	
13.	22.30.	" " " 237.47 "
14.	22.30.	
15.	11.30.	" " " 271.47 "
15.	11.00.	
16.	22.00.	
17.	19.00.	" " " 389.17 "
18.	8.00.	
18.	2.00.	
19.	19.00.	
20.	11.00.	" " " 377.17 "
20.	11.00.	
21.	9.15.	
22.	15.45.	
23.	8.00.	" " " 416.17 "
24.	5.00.	
24.	18.30.	
25.	6.00.	
26.	10.30.	" " " 450.17 "
26.	10.40.	
27.	11.00.	" " " 471.57—over.
Jan. 27.	10.25.	
28.	11.00.	Total, 547.00—noon.

3284

28.	10.00.	
29.	11.00.	Total, 538.14.
30.	12.00.	
31.	11.00.	

Bu-sted at clamp or pos. 1. 562.14.

3285 201. Over Carman's desk, office:

Res., 147. } Jan. 2, 1880. Place, 30.
Burnt 50 hours. } Noon.

Jan. 3.	19.30.
4.	9.58.
5.	23.47.
6.	20.26.
7.	12.15.
8.	22.00.
9.	15.50.
10.	19.15.
11.	7.00.
12.	20.00.
13.	22.30.
14.	22.30.

Jan. 15.	11.30.	Total hours burned, 322.13, noon.
15.	11.00.	
16.	22.00.	
17.	11.00.	“ “ “ 372.10 “
17.	8.00.	
18.	2.00.	
19.	19.00.	
20.	11.00.	“ “ “ 412.13 “
20.	11.00.	
21.	9.00.	
22.	15.45.	
23.	8.00.	“ “ “ 456.13 “
23.	5.00.	
24.	18.30.	
25.	6.00.	
26.	10.30.	“ “ “ 496.13 “
26.	10.40.	
27.	11.00.	“ “ “ 517.53 “ over.
27.	10.50.	
28.	11.00.	538.14, noon.
29.	22.00.	
30.	22.00.	
31.	22.00.	

3286

Feb. 1.	6.00.	
2.	9.00.	Total, 608.14 hours.
3.	11.00.	619.00 “
3.	10.00.	
4.	9.00.	638. “

Bu-sted March 21.

3287 164. Office chandelier, near door:

Res., 182. } Jan. 2, 1880. Place, 28.
Burnt 50 hours. } Noon.

Jan. 3.	19.30.	
4.	9.50.	
5.	20.47.	
6.	20.26.	
7.	10.15.	
8.	22.00.	
9.	15.00.	
10.	19.15.	
11.	7.00.	
12.	20.00.	
13.	22.30.	
14.	22.30.	
15.	11.30.	Hours burnt, 322.13, noon.
15.	12.00.	
16.	11.00.	“ “ 367.13 “

Jan. 17. 11.00.
17. 8.00.
18. 21.00.
19. 19.00.
20. 11.00. Hours burnt, 418.13, noon
20. 11.00.
21. 9.15.
22. 15.45.
23. 8.00.
23. 5.00.
24. 18.30.
25. 6.00.
26. 10.40.
26. 10.40. " " 502. "
27. 11.00. " " 523.43
27. 10.25.
Jan. 28. 11.00. Total, over 537.14, 5 P.
28. 10.00.
29. 11.00. 538.14.

3288

29. 11.00.
30. 22.00.
31. 22.00.
Feb. 1. 6.00.
2. 9.00.
2. 9.00. " 610.14.
3. 11.00.
3. 10.00.
4. 9.00. " 640.14, noon.

3289 172. Chandelier over Griff's desk :

Res., 135. }
Burnt 50. } Jan. 2, 1880.

Jan. 3. 19.30.
4. 9.58.
5. 23.47.
6. 20.26.
7. 12.15.
8. 22.00.
9. 15.50.
10. 19.15.
11. 7.00.
12. 20.00.
13. 22.30.
14. 22.30.
15. 11.30. Total hours burned, 322.13, noon.
15. 11.00.
16. 22.00.
17. 11.00.

Jan. 17.	8.00.	Total hours burned,	367.13,	noon
18.	2.00.			
19.	19.00.			
20.	11.00.	“ “ “	418.13	“
20.	11.00.			
21.	9.15.			
22.	15.45.			
23.	8.00.	“ “ “	462.13	“
23.	5.00.			
24.	18.30.			
25.	6.00.			
26.	10.30.	“ “ “	502.13	“
26.	10.40.			
27.	11.00.	“ “ “	523.43.	
27.	10.25.			
Jan. 28.	11.00.	“ “ “	544.15.	
28.	10.00.			
29.	11.00.	“ “ “	538.15.	
29.	11.00.			

3290

30.	22.00.	
31.	22.00.	
Feb. 1.	6.00.	
2.	9.00.	610.15.
2.	9.00.	619.15.
3.	10.00.	638.15.
4.	9.00.	

Taken to Edison's parlor.

158.

3291 Edison's Exhibit No. 25, W. H. M., Notary Public, N. Y. Co.

Mr. Edison challenged by Mr. Sawyer.

To the Editor of the Sun.

Sir: Notwithstanding the assertion that one of Mr. Edison's electric lamps has been running for 240 hours, I still assert, and am prepared to back up my assertion, that Mr. Edison cannot run one of his lamps up to the light of a single gas jet (to be more definite, let us call it twelve-candle power) for more than three hours. To be still more definite, I offer to Mr. Edison, at 226 West Fifty-fourth street, in this city, an opportunity to prove what he says. From the private residence in that street wires are run a circuit of 1,000 feet. Mr. Edison shall have every facility; he shall use my wires; he shall have any dynamo machine or other generator of electricity he may prefer; and all I ask is that the power of his light shall be measured by a photometre; that, once in place, it shall not be interfered with; and that a committee of gentlemen, preferably nominated by the editors of the New York press, shall be present and certify to the facts of the test.

Furthermore, I will place one of my lamps side by side with Mr. Edison's; it shall be run at the power of twenty-five candles; it shall outlast the entire forty lamps at Menlo Park, run at the power of twenty-five candles; my lamp to stand as it is put up, and Mr. Edison to put up a fresh lamp as fast as the preceding lamp shall have burned out.

I am anxious for this test; and if Mr. Edison has really run one of his horseshoe lamps 240 hours he will not refuse to accept my offer, for he will be treated with the utmost courtesy, and shall have everything his own way.

I adhere in every particular to my original challenge to Mr. Edison.

W. E. SAWYER.

78 Walker street, New York, Jan. 4.

The Sun, Monday, January 5, 1880.

3292 Copies sent.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Jan.* 19, 1882.

In Re Interference SAWYER AND MAN *v.* EDISON. } Before the Examiner of Interferences.

Subject-matter: Electric lamps or lights.

Sawyer and Man, care A. Broadnax, 57 Broadway, N. Y. city;
T. A. Edison, care Dyer & Wilber, Washington, D. C.:

The motion is granted.

Limit of appeal five days.

J. B. CHURCH,
Examiner of Interferences.

(Endorsement: 7768; 43; office to Sawyer and Man and Edison, intf. Motion granted Jan. 19, 1892.)

3293 Copies sent.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Jan.* 20, 1882.

In Re Interference SAWYER AND MAN *vs.* EDISON. } Before the Examiner of Interferences.

Subject-matter: Electric lamps or lights.

Sawyer and Man, care A. Broadnax, 57 Broadway, N. Y. city;
T. A. Edison, care Dyer & Wilber, Washington, D. C.:

Please find below a communication from the examiner in charge of interferences in regard to the above-cited case.

An appeal may be taken from the decision of the examiner within twenty days (see section 4904 Revised Statutes).

Very respectfully,
E. M. MARBLE,
Commissioner of Patents.

Room No. 1.

In the matter of the interference above referred to, upon 3294 which hearing was appointed for the 10th day of December, 1881, the question of priority of invention has been d*i*cided in favor of Sawyer and Man.

J. B. CHURCH,
Examiner of Interferences.

(Copies of the decision will be furnished by the office at the usual rates.)

(Endorsement: 7768; 45; office to Sawyer and Man and Edison, intf. Decided in favor of Sawyer and Man, Jan. 20, 1882.)

3295 In the U. S. Patent Office.

SAWYER AND MAN *vs.* EDISON. } Before the Examiner of Interferences.

Application of Sawyer and Man filed Jan. 9, 1880.

Application of Edison filed Dec. 11, 1879.

The invention involved in this controversy is:

"The incandescent conductor for an electric lamp formed of carbonized paper."

It appears from the testimony on both sides that carbonized paper has certain qualities which are generally considered very desirable, if not indispens*i*ble, for an incandescent conductor; but it also has defects which, if not cured, cause its destruction in such a brief period as to render it of no practical value in the system of electric lighting. It is found that carbonized paper, if used as a conductor in the open air, or in such a vacuum as can be obtained by ordinary apparatus, has a life of only a few minutes. The two parties to this interference have discovered methods of using this paper so as to make use of its desirable qualities and lengthen its life to such an extent as to make a practical operative incandescent electric lamp, instead of obtaining mere momentary flashes of light as were given in their first experiments. For those reasons we do not regard the use of paper carbon abstractly as within the issue which must be construed to be paper carbon embodied in an operative combination. Though the methods employed for producing this effect are dissimilar in some respects yet the paper carbon is the basis of the system, and the party who first invented 3296 some manner of practically applying the paper carbon so as to adapt it to use is entitled to an award upon the issue involved herein.

Sawyer and Man made experiments in March, 1878, in which paper carbons were used and, perceiving the difficulties, numerous methods of obviating them were resorted to. During that spring the resistance of the paper carbon was made more uniform by treating it with powdered plumbago and with a hydrocarbon vapor or liquid, and oxygen was excluded from the chamber containing the incandescent conductor, either by creating a partial vacuum therein, or by filling the chamber with a gas (preferably nitrogen).

It is shown that this treatment resulted in a successful lamp, if not that spring, yet certainly in the autumn of the same year.

It is urged by the opposing party that Sawyer and Man no longer employed a paper carbon, but that it was so modified by the treatment as to become a different composition, and so be removed from this controversy. To this it may be replied that the paper carbon still exhibited its desirable qualities, while its defects were modified to such an extent as to render it a success in electric lighting. The principle was the same, though the improvements, from a failure, brought success. A product may receive additions which remove certain of its defects, and yet retain the valuable properties and capacities of the original, and then, because it is an improvement, it is none the less within the scope of the basic product. (See Goodyear Dental Vulcanite Company *vs.* Evans, 3 Fisher, page 390.) If Sawyer and Man first discovered a manner of practically applying a paper carbon as an incandescent conductor, they would seem to be entitled to prevail in this proceeding. It must be held that they reduced the invention to practice as early as the autumn of 1878.

3297 The testimony in behalf of Edison shows that carbon from paper was made by him in 1876, but it was for other purposes than electric lighting. He, however, seems to have been then aware of its quality of high resistance for small surfaces.

Experiments were made by Edison and his assistants relating to incandescent electric lamps in the autumns of 1877 and 1878, and amongst the almost innumerable materials tested, it appears that carbonized paper was included. It was the uniform opinion of Edison, and the other witnesses testifying in relation to these experiments with carbonized-paper conductors that they were unsuccessful, and these opinions were expressed in no ambiguous language. The result was that paper carbons were abandoned, and attention directed to platinum and other metals for incandescent conductors. In the autumn of 1879, while experimenting in this line with platinum, a more perfect vacuum was obtained by means of a new appliance for that purpose, and it then occurred to Edison that as the paper carbon had been formerly destroyed by reason of the amount of oxygen with which it came in contact, it could, with the improved vacuum, be made to operate successfully.

This idea being followed up, it resulted in a successful reduction to practice during the same autumn. The autumn of 1879 is the earliest date of invention which can be accorded Edison, and, as this is a year later than that heretofore given his opponent, judgment of priority of invention must be rendered in favor of Sawyer and Man.

J. B. CHURCH,
Examiner of Interferences.
FRANK BROWN,
Ass't Exam'r.

Jan. 20, 1882.

(Endorsed: 7768; 44; Sawyer and Man *vs.* Edison; decision; Rec. vo. 13, p. 343; Jan. 20, 1882.)

3298 Copies sent.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Feb.* 9, 1882.

In Re Interference SAWYER AND MAN *vs.* EDISON. } Before the Examiner of Interferences.

Subject-matter: Electric lamps or lights.

Sawyer and Man, care A. Broadnax, New York city:

T. A. Edison, having vested sole power of attorney in Z. F. Wilber, of 65 Fifth avenue, New York city, all notices in this case will henceforth be sent to him instead of to Dyer & Wilber, of Washington, D. C., as formerly.

J. B. CHURCH,
Examiner of Interferences.

(Endorsed: 7768; 46; Office to Sawyer and Man; Feb. 9, 1882.)

3299 COMPLAINANT'S EXHIBIT PATENT OFFICE RECORD NO. 6.

COMPLAINANT'S EXHIBIT NO. 6.

Edison's Motion to Reopen. May 11, 1885. T. G., Ex.

CONSOLIDATED ELECTRIC LIGHT CO. *vs.* EDISON ELECTRIC LIGHT COMPANY. } G, 3553.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the files of this office of the motion papers and affidavits filed in behalf of Edison, on motion to reopen the case in the matter of the interference Sawyer and Man *vs.* Edison, for improvement in carbon for electric lamps.

In testimony whereof I, M. V. Montgomery, Commissioner of Patents, have caused the seal of the Patent Office to be affixed this

19th day of June, in the year of our Lord one thousand eight hundred and eighty-five, and the Independence of the United States the one hundred and ninth.

M. V. MONTGOMERY,
Commissioner.

3300 In the United States Patent Office.

In Re Interference SAWYER AND MAN
v.
EDISON.

"Paper carbons for incandescent electric lamps."

Messrs. Sawyer and Man, care Amos Broadnax, their attorney:

Please take notice that on the 20th day of March, 1882, at 11 o'clock a. m., I shall move before the proper tribunal in the United States Patent Office, for the setting aside of the decision of the examiner of interferences heretofore made in this case, and for other relief, as fully set forth in the motion and accompanying affidavits and papers, copies of which are hereunto appended.

Z. F. WILBER,
Of Counsel for T. A. Edison and the Edison Electric Light Co.

Received above notice and copies this the 15th day of March, 1882.

AMOS BROADNAX,
Attorney for Sawyer and Man.

3301 In the United States Patent Office.

In Re Interference SAWYER AND MAN
vs.
EDISON.

"Paper carbon for incandescent electric lamps."

Hon. Commissioner of Patents:

The accompanying motion in this case, made in the name of Thomas A. Edison, as a party of record thereto, is made by and with the consent and knowledge of and in behalf of the Edison Electric Light Company as sole assignee of the invention and application involved in this interference. And it is made in his name for the reason that in the record, as made up in the Patent Office, his name has been used, and not that of the company assignee.

Given under the seal of said company, this 14th day of March, 1882.

S. B. EATON,
Vice-president Edison Electric Light Co.

[L. S.]

Attest: C. GODDARD, *Secretary.*

3302 In the United States Patent Office.

In Re Interference SAWYER AND MAN
vs.
EDISON.

"Paper carbons for incandescent electric lamps."

Hon. Commissioner of Patents.

SIR: And now comes Thomas A. Edison, one of the parties to the above-entitled interferences, by his counsel, and moves that the decision of the examiner of interferences in this case, rendered January 20, 1882, be set aside, that the case be reopened, and that he, Edison, be allowed to take, and to introduce into the case certain new testimony.

This new testimony is as follows: Three letters of William E. Sawyer, one of the parties hereto, to the New York Herald, and published in such paper, on the dates December 24, 1879; January 5, 1880, and January 6, 1880, copies of which are attached hereto, and marked "Exhibit A," "Exhibit B," and "Exhibit C," respectively, and such testimony as may be necessary to show the office conclusively that said Sawyer wrote and caused to be pulished said letters, and to show just what said Sawyer refers to and means in said letters.

A certain book entitled "Electric Lighting by Incandescence and its Application to Interior Illumination," "by William Edward Sawyer," published by D. Van Nostrand, in New York city, in the year 1881, and such testimony as may be necessary to show that said Sawyer wrote and caused to be published said book.

3303 An affidavit made by said William E. Sawyer upon the 21st day of December, 1881, before Walter L. Clarkson, a notary public, in and for the county of New York, State of New York, and such testimony as may be necessary to corroborate the statements of said Sawyer therein as to this controversy. Affidavits are attached hereunto, showing that due and reasonable care and diligence were used in searching for and procuring the testimony in behalf of Edison in this case; that it is newly discovered testimony, the existence thereof having been unknown to any one interested in this case in Edison's behalf prior to decision thereon; that the motion has been made without unreasonable delay, and in the interests of justice.

The testimony is relevant and material in that it will establish three facts, either one of which is fatal to the claims of Sawyer and Man in this controversy, as follows:

1st. That Sawyer and Man were not, and are not joint inventors in the eyes of the law.

2d. That whatever either or both did jointly or severally, in respect of the invention in controversy, prior to the filing of their application, amounted only to unsuccessful and abandoned experiments.

3d. That Sawyer himself, in an enduring and solemn manner, has given Edison credit for the invention of the matter here in issue, taking credit to himself, or to himself and Man only for carbon manufactured from hydrocarbon liquids, and for live "willow-twig carbon."

Wherefore, an order of your honor, for the things moved for is prayed.

Z. F. WILBER,
Of Counsel for Thomas A. Edison.

3304 STATE OF NEW YORK,
County of New York, } *ss:*

Z. F. Wilber, being duly sworn, deposes and says that he has been and is of the attorneys of record in the matter of the application for a patent of Thomas A. Edison, now pending in the United States Patent Office for a carbon for incandescent electric lamps made of paper, and in the interference thereon with an application filed by Sawyer and Man, and likewise pending in the United States Patent Office.

That prior to the taking of testimony therein, he made diligent inquiry and search for all testimony and evidence which might seem relevant to the case and have bearing upon any phase thereof to that end, going over a large mass of records and memoranda and a large number of scrap books containing clippings from the current periodical literature of the day, and communicated the results of such enquiry and search to Col. Geo. W. Dyer, who had charge of the taking of the testimony in behalf of Edison.

That in such search and enquiry he came across only the newspaper extracts already introduced in evidence, nor did Mr. Edison or any one connected with the case, or any one of whom affiant made enquiry, seem to know of the letters, whose introduction into the case is in part the object of this proceeding.

The first knowledge or intimation of the existence of said letters, or either of them, was obtained by affiant from a gentleman, who remembered to have read them at the time, but who had no connection whatever or knowledge of these proceedings, and was absent from the country during the time in which the interference was being carried on, and who, as he informed affiant, obtained the first knowledge that there had been such an interference from learning of the decision thereon. Upon receiving this intimation, affiant again instituted enquiries amongst all the persons connected with Mr. Edison, and was unable to find any person who had
3305 known of the publication of said letters or either of them.

Mr. Edison was personally questioned again and requested to recall, if possible, any knowledge that he had at any time possessed of said letters, or either of them, but was unable to remember them. From thorough enquiries affiant is entirely convinced, and therefore affirms, that the existence of said letters was not known to any person having any connection whatever with said interference proceedings, or from whom he could have obtained that knowledge by any enquiry which he could have made prior to the decision in this case.

Affiant also made and caused to be made, search through the scraps and other books and records of Mr. Edison, and found that copies of such letters were not in the possession of Mr. Edison, or of the Edison Electric Light Co., or of any one connected with him or it.

The letters were published in a daily paper, and it could not have been expected that any of the parties in interest would have known of all that might have been published relative to possible contests. In order to obtain definate knowledge of these letters affiant was compelled to make search through the files of the New York Herald, and having found them, to make manuscript copies for use, having been unable, even by the offer of a large price therefor, to buy or procure printed copies.

Due diligence was used in searching for and gathering up testimony in the case. Knowledge of the testimony in Mr. Sawyer's letters to the New York Herald and in his book was nor had until after decision in the case, and it was of a kind that might easily elude diligent search.

The affidavit of William E. Sawyer reached the Edison Electric Light Company early in this year, but after the case had been closed and the hearing thereon had. Testimony of the facts therein set forth was not, and could not have been in possession of Mr. Edison or the Edison Electric Light Co.

3306 The affidavit itself was the first intimation of the matters it recites, and affiant believes from enquiries made by him that of a certainty the matters therein set forth can be fully substantiated.

Affiant has prepared the motion to which this is appended with all reasonable haste, there having been no greater delay than that occasioned by necessary and proper investigation of the matters set out and consultation with counsel. And the motion is made honestly and in good faith and solely in the interest of justice.

Z. F. WILBER.

Sworn to and subscribed before me, this 14th day of March, 1882.

WILLIAM H. ALDEN, Jr.,
Notary Public, N. Y. Co. (75).

3307 City of Washington,
District of Columbia, } *ss:*

George W. Dyer, being duly sworn, deposes and says, that as one of the counsel of Thomas A. Edison and the Edison Electric Light Co., he had charge of the taking of testimony in behalf of Edison in the interference case "Sawyer and Man *vs.* Edison," on paper carbons for incandescent electric lamps; that in the taking of such testimony and in the preparation therefor diligence was used in searching for and making enquiry for any testimony, verbal, printed or record, which would be relevant to the case.

That in this he was assisted by Mr. Wilber; that he had frequent interviews in relation thereto with Mr. Edison, Mr. Wilber and others, and that in no way whatever was any knowledge of the letters of Mr. Sawyer, in the New York Herald, copies of which are attached to this motion, one of such letters dated January 5, 1880, being a copy of the same letter in the Sun previously put in evidence, or any knowledge of any utterances of Mr. Sawyer in his published book, communicated to him. That he has had no knowledge of any such matters until it was communicated to him within a few days, and this notwithstanding every effort to obtain knowledge of and a purpose to put into the case, all testimony bearing upon any phase thereof. That in his search for testimony he personally examined the scrap books of Mr. Edison, and had assistants of Mr. Edison make search among them and among other files for letters of Mr. William E. Sawyer, and such search by himself and by others failed to elicit the letters, copies of which are attached to the deposition of Z. F. Wilber, now shown to me.

GEO. W. DYER.

Subscribed to and sworn to before me, this 13th day of March, 1882.

[SEAL.] G. E. HARRIS, *J. P.*

3308 EXHIBIT A.

(From the Herald of December 24, 1879.)

Sawyer on Edison and the Herald.

To the editor of the Herald:

Your interesting editorial of to-day advises me not to try conclusions with the Wizard of Menlo Park. I am quite anxious to try them, and am not remarkably easy to alarm, and shall not at present accept you advice, however well intentioned. The Herald is at perfect liberty to advocate Mr. Edison's claims, and I am at perfect liberty to advocate my own.

If you care to settle the question of priority of invention upon the horseshoe lamp as between Mr Edison and myself, you may inspect one of those lamps which broke down at No. 94 Walker street about a year ago, and after many experiments was so far condemned that Mr. Man and I concluded we would not waste enough money on it to pay for a patent. The lamp is at present just exactly as it was removed from the bracket, hermetically sealed in a glass globe, filled with nitrogen gas, and in just exactly the same condition it was in a year ago.

To avoid any question, I placed said abandoned institution in the hands of Messrs. Arnoux & Hochhausen, No. 2 Howard street, yesterday (Monday) morning at 9 o'clock. So far as I am concerned, the Wizard is welcome to patent it. I fail to see what difference it can make to the Herald whether Mr. Edison or somebody else invents the successful electric lamp. Mr. Edison, over a year ago, began this controversy by an attack upon me. He has received one in return, and evidently does not like it. I expect he will have something to say himself in return for that, and I am prepared to meet him half way on any point whatever that he may bring up.

There is no occasion for personalities on the part of the 3309 Herald that I can understand, or for threats. Next week I shall show my system of electric household illumination in this city in practical operation, and if I do not prove it superior to anything else I am much mistaked; and if I do show to those interested that it is superior, all the personalities in the Herald, or by Mr. Edison will not prevent capital putting it where it will do the most good.

W. E. SAWYER.

3310 EXHIBIT B.

(From the Herald of January 5, 1880.)

No. 78 WALKER STREET, NEW YORK, *January* 4, 1880.

To the editor of the Herald:

Notwithstanding the assertion that one of Mr. Edison's electric lamps has been running for 240 hours, I still assert, and am prepared to back up my assertion, that Mr. Edison cannot run one of his lamps up to the light of a single gas jet (to be more definite, let us call it 12 candle power), for more than three hours. To be still more definite, I offer to Mr. Edison, at No. 226 W. 54th street, in this city, an opportunity to prove what he says.

From the private residence in that street wires are run a circuit of a thousand feet. Mr. Edison shall have every facility, he shall use my wires; he shall have my dynamo machine or other generator of electricity he may prefer, and all I ask is that the power of his light shall be measured by a photometer; that once in place it shall not be interfered with; and that a committee of gentlemen, preferably nominated by the editors of the New York press, shall be present to certify to the facts of the test.

Furthermore, I will place one of my lamps side by side with Mr. Edison's; it shall run at a power of 25 candles; it shall outlast the entire forty lamps at Menlo Park, run at the power of 25 candles; my lamp to stand as it is put up, and Mr. Edison to put up a further lamp as fast as the preceding lamp shall have burned out. I am anxious for this test, and if Mr. Edison has really run one of his horseshoe lamps 240 hours he will not refuse to accept my offer, for he will be treated with the utmost courtesy, and shall have everything his own way. I adhere in every particular to my original challenge to Mr. Edison.

Respectfully, W. E. SAWYER.

3311 EXHIBIT C.

(From the Herald of January 6, 1880.)

Mr. Sawyer's Exhibitorium.

To the editor of the Herald:

Your remarks this morning were both interesting and to the point. A great newspaper as the Herald undoubtedly is, should be impartial. I don't know much about the newspaper business, but I know that much. In all the time I have been working at this problem of electric lighting, I have been working simply and solely with a view to a genuine scientific success. I have made no money out of it. Instead of selling out I have increased my original interest by $19,000; have bought my own stock from those to whom I made a gift of it, at 50 per cent. of its par value. I think I know enough about this business not to make a very great mistake, and am not risking my reputation by any wild challenges.

The Herald is in error in implying that this is my residence, and that in consequence, this is a kind of a family matter. I hunted New York over to find some one who would permit me to use his house for a public exhibition. As may be imagined, it was not an easy thing to do. Allow me to correct. My residence is No. 261 W. 42nd street; my office is No. 78 Walker street, my shop is No. 141 Elm street, the exhibitorium is No. 226 W. 54th street.

W. E. SAWYER.

STATE OF NEW YORK, } ss:
County of New York, }

3312 Thomas Johnston, being duly sworn, deposes and says that the foregoing copies of three letters purporting to have been signed by W. E. Sawyer, and copied from the New York Herald, a daily newspaper published in the city of New York, are exact copies of such letters as there published, and that the copies were made by him from the files of the said newspaper, in the library-room of said newspaper, and from papers dated as set forth at the head of each of the three letters.

THOMAS JOHNSTON.

Sworn to and subscribed before me, this — day of March, 1882.

WM. H. MEADOWCROFT,
[NOTARIAL SEAL.] *Notary Public, New York Co.*

3313 EXHIBIT D.

STATE OF NEW YORK, } ss:
City and County of New York, }

William E. Sawyer, of New York, being duly sworn, deposes and says that his testimony given in certain interference suits before the Commissioner of Patents, in which it inferentially appeared that Albon Man was joint inventor of certain inventions not specified, was made upon the erroneous belief that such statement was true; that since such time this deponent has been advised that he was in error, and that such acts of the said Al*h*on Man, did not in law, make him a joint inventor with this deponent.

WILLIAM E. SAWYER.

Sworn to before me, this 21st day of December, 1881.

WALTER L. CLARKSON,
Notary Public, New York City and County.

(Endorsement: 9; 19023; 9; Dec. 21, 1881; William E. Sawyer; deposition that Man is not a co-inventor with him.)

STATE OF NEW YORK, } *ss:*
County of New York, }

Anthony Arnoux, being duly sworn, deposes and says that he is the Arnoux referred to in a certain letter of Wm. E. Sawyer, published in the New York Herald, December 24th, 1879, and that he knows that said letter was written by said Sawyer, that 3314 he, said Arnoux, heard the same read, and himself read a part at least thereof prior to its publication.

And further that he had the lamp therein referred to in his possession at the time said letter was written.

ANTHONY ARNOUX.

Sworn to and subscribed before me, this 9th day of March, 1882.

WM. H. ALDEN, JR.,
Notary Public (75), *N. Y. Co.*

Ex.: J. A. W. McE.

(Endorsement: U. S. Patent Office, March 17, 1882; Sawyer and Man *vs.* Edison; motion by Edison to reopen case.)

3315 Copy.

Room No. 4.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *March* 21, 1882.

In the Matter of the Interference between SAWYER AND MAN and T. A. EDISON. } Motion by Edison.

You are informed that the hearing on the above motion is continued per stipulation to Monday, March 27, 1882, at 11 o'clock, a. m.

Respectfully,
(Signed) M. GARDNER,
Acting Chief Clerk for Commissioner.

Sawyer and Man, care Amos Broadnax, 57 Broadway, New York city; T. A. Edison, care Z. F. Wilber, 65 Fifth avenue, New York city.

(Endorsement: 27; office to Sawyer and Man and Edison; notice of postponement; March 21, 1882.)

3316 COMPLAINANT'S EXHIBIT PATENT OFFICE PROCEEDINGS NO. 7.

Affidavits of Sawyer, Street, *et al.*, May 11, 1886. T. G., Ex'r.

CONSOLIDATED ELECTRIC LIGHT CO.
vs.
EDISON ELECTRIC LIGHT CO. *et al.*
} H, 3553.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the files of this office of the affidavits of W. E. Sawyer, Robert Street, *et al.*, filed April 3, 1882, in the matter of the interference Sawyer and Man *vs.* Edison.

In testimony whereof, I, E. M. Marble, Commissioner of Patents, have caused the seal of the Patent Office to be affixed this [L. S.] 5th day of April, in the year of our Lord one thousand eight hundred and eighty-two, and of the Independence of the United States the one hundred and sixth.

E. M. MARBLE,
Commissioner.

STATE OF NEW YORK,
City and County of New York. }

William E. Sawyer, residing at Hotel Brighton, corner of 42d St., and Broadway, in the city of New York, being duly 3317 sworn, deposes and says that on or about November 5th, 1881, while doing business at 111 Liberty St. in said city, deponent's partner, Rob't Street, residing at 130 Eldridge St. in said city, came to deponent and said that he had an important matter to communicate, to wit, that one S. Bergmann, a friend of his, doing business for T. A. Edison, in Wooster St., in said city, had offered him, Street, the sum of one thousand dollars for the purpose of inducing deponent to throw over the side of Sawyer and Man, and Thos. A. Edison for what is known as the carbon filament electric incandescent lamp; that deponent was busy and said no more about the matter than to remark it was very singular the Edison people were getting so hard pushed as to have to resort to bribery to secure their patents.

And deponent further states that on or about November 7th, 1881, said Street came to deponent and handed him twenty gold coins of the denomination of five dollars each, saying, "That shows the Edison crowd means business; Bergmann says you will get the rest as soon as you testify for them." Deponent said he did not want the money but its payment might some day be of use and he would receive it, and deponent gave two of the coins to said Street, and the remainder he gave away to various persons, immediately thereafter.

WM. E. SAWYER.

Sworn to and subscribed before me this 10th day of March, A. D. 1882.

SAMUEL GOODWIN,
Notary Public, Kings County.

Certificate filed in the N. Y. Co.

Ex'd: A. N.

(Endorsed: U. S. Patent Office; April 3, 1882.)

3318 CITY AND COUNTY OF NEW YORK, } *ss:*
State of New York, }

Robert Street, residing at Eldridge street, in the city of New York, being duly sworn, deposes and says that he has read the foregoing affidavit; that the 20 gold coins of $5 each mentioned therein were paid to him for the purpose specified; and furthermore that the other statements contained in the foregoing affidavit are true.

ROB'T STREET.

Sworn to and subscribed before me this 10th day of March, A. D. 1882.

SAMUEL GOODWIN,
Notary Public, Kings County.

Certificate filed in N. Y. Co.

Ex'd: A. N.

(Endorsement: U. S. Patent Office, April 3, 1882.)

3319 STATE OF NEW YORK, } *ss:*
City and County of New York, }

William E. Sawyer, residing at the Hotel Brighton, corner of 42d street and Broadway, in the city of New York, being duly sworn, deposes and says: That on or about March 7, 1882, while deponent was about leaving the Hotel St. Stephens, 11th street, in the city of New York, where deponent then resided, to go down town to work, a waiter handed deponent the card of Z. F. Wilber, whom deponent knows as one of the patent counsel of Thomas A. Edison, saying that said Wilber desired to see deponent; deponent said he had no time, but would meet said Wilber at the door; deponent then rode down the elevator and passed out to his coupé; there he met said Wilber, who held a roll of papers and said he was very anxious to have a talk with deponent; deponent replied that he could not stop, but that said Wilber might jump into the coupé if he was going down town, and we could talk there, which said Wilber did.

And further deponent states, that the said Wilber rode down to deponent's office, at No. 103 Fulton street, and entered the same, all the time urging upon deponent the importance of helping the Edison Company to reopen the interference suit between W. E. Sawyer and Albon Man on the one side and Thomas A. Edison on the other, and offering deponent the sum of two thousand five hundred dollars if deponent would reply as an unwilling witness to certain questions which the Edison side would ask, and which, properly answered, would result in giving the patent to Edison; that deponent declined to converse upon the subject, or to answer any questions unless the same were put in writing; and while said Wilber was in deponent's office deponent obtained from said Wilber, a promise to submit the same in writing by four o'clock the 3320 same afternoon, and the said Wilber then retired and went directly to the Edison headquarters, at No. 65 5th avenue, in the city of New York.

WILLIAM E. SAWYER.

Sworn to and subscribed before me this 11th day of March, A. D. 1882.

SAMUEL GOODWIN,
Notary Public, Kings Co.

Certificate filed in N. Y. Co.

E'd: A. N.

(Endorsed: Affidavit of Wm. E. Sawyer; U. S. Patent Office; April 3, 1882.)

3321 STATE OF NEW YORK, *City and County of New York,* } *ss:*

We, Robert Street, of 130 Eldridge street, New York city, and E. S. Whitmore, of Whitestone, Long island, being duly sworn, depose and say: That on or about the 7th day of March, 1882, at about half past ten o'clock, a. m., a person pointed out to us as Z. F. Wilber, attorney for Edison, came into the office of W. E. Sawyer, at 103 Fulton street, accompanied by said Sawyer; that after examining several models of said Sawyer, said Wilber appeared to be trying to induce said Sawyer to sign some paper, or make some statement, the purport of which we did not understand; that as said Wilber arose to depart said Sawyer remarked that he wanted everything clear, and that while he might possibly be able to answer the questions that had been put to him he must insist upon their first being reduced to writing; that said Wil*d*er then said he would have the questions written out and would be back by four o'clock the same day.

ROBERT STREET.
E. S. WHITMORE.

Sworn to and subscribed before me this 11th day of March, A. D. —.

SAMUEL GOODWIN,
Notary Public, Kings County.

Cert. filed in N. Y. Co.

Ex'd: A. N.

(Endorsed: U. S. Patent Office; April 3, 1882.)

3322 CITY AND COUNTY OF NEW YORK, }
State of New York. }

Galen C. Thatcher, residing at No. 216 West 33rd street, in the city of New York, being duly sworn deposes and says, that on or about March 7th, 1882, he was with W. E. Sawyer at the Hotel St. Stephens when card of Z. F. Wilber was brought to said Sawyer; that at a later hour, as deponent was entering said Sawyer's office, at 103 Fulton street, he met said Wilber coming out of the office, and was told by said Sawyer that said Wilber was trying hard to get something out of said Sawyer, and would be back again at four o'clock.

G. C. THATCHER.

Sworn to and subscribed before me this 11th day of March, A. D. 1882.

SAMUEL GOODWIN,
Notary Public, Kings Co.

Cert. filed in N. Y. Co.

E'd: A. N.

(Endorsement: U. S. Patent Office, April 3, 1882.)

3323 STATE OF NEW YORK, }
City and County of New York, } *ss:*

Norvin Green, being duly sworn, says:

1. I am the president of the Edison Electric Light Company, and have been so since its organization.

2. I give a general attention to its affairs, but without entering into the management of details. The entire management of the company's affairs, in all their details, are entrusted to Sherburne B. Eaton, vice-president, and all facts concerning the company are necessarialy known to him.

3. I have read the affidavits of William E. Sawyer and Robert Street, dated the 10th of March, 1882, and of the said Street and E. S. Whitmore, and the said Sawyer, dated the 11th of March, 1882.

4. So far as I am able to learn, the Edison Electric Light Company has never authorized any person to offer a pecuniary or other inducement to Mr. Sawyer, directly or indirectly, as consideration for his giving testimony. No such matter has been broached or spoken of to me, and upon my best information and belief, I declare that all statements or suggestions to the contrary are untrue.

NORVIN GREEN.

Sworn and subscribed before me, this 20th day of April, 1882.

CHARLES ROTH (28),
Notary Public, N. Y. Co.

(Endorsed: U. S. Patent Office, May 8th, 1882; affidavit of Norvin Green.)

3324 City of New York,
County of New York, } *ss:*

Sherburne B. Eaton, being duly sworn, says:

1. I am the vice-president and executive officer of the Edison Electric Light Company, and have been such since the company first began active business in New York about January, 1881, and since that date I have given my entire time to its business, being the only one of its officers, except the secretary, who has done so, and I am cognizant of all its affairs of whatsoever nature. During the time above named, I have not been away from the office of the company for a single day, but have been on duty every day at the office of the company in general charge of its executive matters. On the contrary, from this company having ever attempted or proposed to obtain evidence from William E. Sawyer, or any other persons, by offering pecuniary or other inducements for the same, they have had repeated propositions made to them, on behalf of said Sawyer, for the sale of affidavits, to be sworn to by him, and have unconditionally and unequivocally refused the same.

2. For many years I have been in the habit of keeping a daily diary in which is entered the important events of that day which are not likely to be recorded elsewhere; that is to say, in the usual office correspondence or otherwise, where they would be likely to be preserved and easily found. By this diary I see that on the 9th day of January, 1882, a Mr. Sawyer, who announced himself as father of Prof. William E. Sawyer, and as residing at the Brandreth house, called upon me at 11 o'clock in the forenoon, and spent three-quarters of an hour with me. My entry says: "He wishes to invalidate his son's patents taken out in the name of Sawyer and Man. He says he desires no compensation, nor does his son, but he thinks the attorney's fees for drawing the papers would be about $2,500. He said nothing whatever about having the
3325 attorney divide that money with him. His plan is as fol-
lows: He says the 'law is that where a patent is taken out on application made by two persons as co-inventors, if there is, in point of fact, but one such inventor, such fact invalidates the patent, and Prof. Sawyer and William Sawyer both propose to furnish affidavits saying that Mr. Man was not a co-inventor. Mr. Sawyer says that Mr. Man will not dare to deny this, and that even if he should, he would have no corroborative testimony, Mr. William Sawyer himself, he having been a mechanic, being the only third person, who was present at the experiments.'"

3. By the diary of January 12, I also see that Mr. Sawyer called again, and to see if we had reached any decision about his offer of the preceding Tuesday above referred to, to give us the points to invalidate the Sawyer-Man patents.

4. Again, I find by the diary for January 26, 1882, that I was called upon by some person claiming to represent Mr. Sawyer. The entry in my diary of this date is as follows: "Prof. Sawyer and the paper carbon. At four o'clock this afternoon a man called on me, and stated that he came from Prof. Sawyer, and said he had

an affidavit which Sawyer was willing to make. He read it to me. He said Sawyer wished no compensation for making the affidavit, but would take one thousand dollars for six months on his, Sawyer's note. The affidavit stated Sawyer's testimony was full of errors. That in February, 1879, Sawyer and Man both abandoned the carbon paper as impossible practically. That they did not touch paper carbon then until January, 1880, when Edison's article was printed, that then, in January, 1880, Man and Chever came to Sawyer and told him they could make from 150 to $200,000 by filing a claim against Edison. That they afterwards, through their counsel, coached Sawyer on what to swear to. That he told them he would not swear to most of what they wanted him to swear
3326 to, as it was absolutely false, and that thereupon it was
agreed that Man himself should swear to the doubtful and untrue things. That it was on such false evidence the case was won before the Patent Office, and that Sawyer wishes now, as justice to Edison, to tell his story, and to ask the Patent Office to reverse its decision. I told the party our company would have nothing to do in the matter," etc., etc.

5. I find also that on February 6th the same person called again, and the diary entry relating to that interview is as follows: "Sawyer's affidavit. Sawyer's agent called on Saturday and told me that Bergmann had told him that our company would like the affidavit to use or not, as we might think best, but that we would not pay for it. Sawyer's representative then asked me to buy a note as an outside transaction, and not have it considered as payment on account of the affidavit. I told him that was simply whipping the devil round the stump. I told him we could do nothing whatever which would be in point of fact the payment of money to Sawyer for an affidavit. To-day Bergmann sends me a letter written to him by Robert Street, Sawyer's partner. Money is what they want. I repeated to Bergmann in reply, the conclusion already reached by Edison, Lowrey, myself and others, namely, that we could not afford to pay Mr. Sawyer any money for his affidavit." Regarding the extracts from my diary which are made in this affidavit, the entries of which they are extracts, were made on the days when the events recorded on those specific days, took place, that is to say, upon the days they purport to have been made upon, and in each and every case they represent accurately and truthfully the event, conversations and other matters which they purport to represent, and are full, correct and true accounts of just what occurred.

6. About this time, that is to say, about February 6th, I learned for the first time that the New York Herald of December 24,
3327 1879, contained a letter purporting to have been written
by W. E. Sawyer, the contents of which I was advised by the counsel of the company, would materially aid Mr. Edison upon the question of abandonment by Sawyer and Man of their experiments upon paper carbon, and I resolved to have a motion made to open the case to put in that testimony, and with this view I conferred with Major Wilber, Mr. Lowery, and Mr. Edison, and finally

instructed Major Wilber to visit the Herald office to procure a copy of the letter and proof of its authenticity if possible. In a few days Major Wilber reported to me that he was unable to procure a copy of the paper, but had made a manuscript copy, and was unable to obtain an affidavit from any one connected with the Herald, which would prove that Sawyer was the author of the letter. I mentioned this to Mr. Lowrey one day, on or about March 6th, 1882, when he was present in my office, and we sent for Major Wilber, whose office is in the same building, and after some conference I instructed Major Wilber to call upon Sawyer himself, and to ask him to give us an affidavit admitting that he was the writer of that letter. Major Wilber expressed strong aversion to visiting Sawyer for any purpose, particularly as he said that Sawyer was a man who would wilfully misrepresent anything said to him, if it was for his interest, and as it was well understood between us that his affidavits upon other subjects had been offered for sale to the company, Major Wilber gave it as another reason for objecting to the visit that Sawyer would speak to him about them, and no one could know what he would say by way of misrepresentation of the interview. I replied to Major Wilber that he must not permit himself to discuss any other subject with Mr. Sawyer, and to stick closely to the business in hand, and with that understanding and instruction Major Wilber left my office saying that he would prepare an affidavit in advance for Sawyer, expressing what he understood to be the truth, and confine himself strictly to obtaining Mr. Sawyer's
3328 assent to that statement. He returned to my office
the following day saying that he had seen Sawyer, and that Sawyer, although he had admitted writing the letter, refused to make an affidavit to that effect, unless he was paid for it. Major Wilber handed to me at the same time, in accordance with the usual custom of our office, a written report of what he had done, which report is endorsed upon the back of the affidavit prepared by him. That report has remained in my possession to this time, and is attached hereto with the office-file envelope in which it was contained. I have stated the whole of the instructions and authority given to Major Wilber. He was certainly not authorized to do anything with Mr. Sawyer, except to request in the ordinary way that he should make affidavit of the truth of a fact which we believe there can be no dispute about, but which it was difficult for us to make technical proof of.

7. Mr. Bergmann has no connection with this company, and has never been authorized or requested in any way to intervene, or act for it in this, or any other business. Whatever he may have said or done with Mr. Sawyer, if anything, has been entirely without our knowledge, authority, or consent.

8. In addition to what appears stated in my diary in respect to communications sent to me purporting to be on behalf of Mr. Sawyer, I find also on file the following letter, dated New York, January 17, 1882.

"DEAR SIR: I wish you would decide immediately on my proposition or convey to Mr. Thatcher some idea of when I may look for a dicision.

Respectfully, W. E. SAWYER."

3329 The original is hereto attached. I know no other proposition to which that could relate than the proposition made to me by Mr. Sawyer, Sr., on the 9th of January. Nor do I know any Mr. Thatcher who is referred to, but I presume he was the messenger, and that he is the Mr. Thatcher who has made an affidavit in this case. I told the messenger who brought this letter that I could not give Mr. Sawyer encouragement that we should buy such affidavits.

9. I have read all the affidavits of Street, Sawyer, Thatcher and Whitmore, filed in opposition to our motion to open the interference between Edison and Sawyer-Man, and any and all statements there made to the effect that this company or any of its officers, or any person acting as its authorized agent, or any person whatever representing the company with any authority from it, has at any time bought or agreed to pay William E. Sawyer any money, or to give him any compensation of any kind whatsover for making an affidavit, or giving any testimony, or doing anything whatever in connection with patents or any other business, is utterly and entirely false to the best of my knowledge, information and belief, and neither in the case of William E. Sawyer nor in any other case whatsoever has this company ever purchased or sought to purchase any testimony of any nature or description whatsoever.

10. All transactions on behalf of this company, involving any payment of money, must eventually come before the board of directors and pass through the treasurer's account. The treasurer is Egiston P. Fabbri, Esq., banker and member of the house of Drexel, Morgan & Co., and the directors are—

Norvin Green,
James H. Banker,
Grosvenor P. Lewery,
Robert L. Cutting, Jr.,
Sherburne B. Eaton,

Henry Villard,
J. F. De Navarro,
Nathan G. Miller,
Thomas A. Edison,
Egisto P. Fabbri.

3330 The secretary of the company is Calvin Goddard, Esq., and he with myself have our only office in the office of the company, and are the only ones of the officers who devote our time to its affairs and all and every part of its business whatsoever is done by us or one of us; neither the president or treasurer take any part therein, except in an advisory way, and neither of them kept an office in the office of the company.

SHERBURNE B. EATON.

Sworn to and subscribed before me this 21st day of April, 1882.

WM. H. MEADOWCROFT,
[L. S.] *Notary Public, New York County.*

Letter from Major Wilber to S. B. Eaton, V. P., giving details of interview with William E. Sawyer, on March 7, 1882. Also form of affidavit.

Filed in safe, March 10, '82.
Opened April 13, 1882.
The Edison Electric Light Company, 65 Fifth Ave., New York.

STATE OF NEW YORK, }
County of New York, } *ss:*

William E. Sawyer, being duly sworn, deposes and says, that he is the William E. Sawyer who is joined with Albon Man in an interference now pending in the United States Patent Office, titled "Sawyer and Man *versus* Edison."

3331 Further that he wrote and caused to be published certain letters in the New York Herald, a newspaper published in the city of New York, at dates as follows: December 24th, 1879, January 5th, 1881, and January 6th, 1881. (Copies of which are hereto appended.)

Further that he is the author of a work entitled "Electric Lighting by Incandescence, and its Application to Interior Illumination," published by D. Van Nostrand, in the city of New York, in the year 1881.

The first exhibit referred to in the affidavit of Sherburne B. Eaton.

Sworn to and subscribed before me, this — day of ——, 1882.

WM. H. MEADOWCROFT,
Notary Public, New York County.

(Endorsement: March 7, 1888. I, this morning, rode with Wm. E. Sawyer from his hotel (St. Stephen) to his office. I asked him to make oath to enclosed affidavit. He admitted to me that it stated only the truth, but declined to give the affidavit unless he was paid money for the same, saying it would cost "you" (meaning the Edison Elec. Light Co.) several hundred dollars to prove the facts, and "I (meaning himself) don't propose to prove them unless you pay me." Z. F. Wilber.)

3332 W. E. Sawyer. Rob't Street.

Sawyer & Street, electrical engineers, 111 Liberty street.

NEW YORK, *January* 17, 1882.

DEAR SIR: I wish you would decide immediately upon my proposition or convey to Mr. Thatcher some idea of when I may look for a decision.

Respectfully, W. E. SAWYER.

The second exhibit referred to in the foregoing affidavit of Sherburne B. Eaton.

WM. H. MEADOWCROFT,
Notary Public, New York Co.

(Endorsement: 2; affidavit of S. B. Eaton; U. S. Patent Office, May 8, 1882.)

STATE OF NEW YORK, }
City and County of New York, } *ss:*

Grosvenor P. Lowrey, being duly sworn, says:

1. I reside in the city of New York, am a lawyer by profession—a member of the firm of Porter, Lowery, Soren & Stone, at No. 3 Broad street, in the city of New York, and a director of the Edison Electric Light Company, and a member of the executive and finance committee which, under the by-laws, exercises virtually all the powers of the board of directors.

3333 2. I have given much attention to the affairs of the company since its organization in 1878, and it is my practice to attend a part of each day at its office for the purpose of consulting with Major Eaton, who is principal managing officer, upon any and all questions of business which may arise.

3. I have read the affidavits of William E. Sawyer and Robert Street, purporting to be sworn to and subscribed before Samuel Goodwin, notary public, on the 10th day of March, 1882, and also the affidavits of Robert Street, E. S. Whitmore, William E. Sawyer and Galen C. Thatcher, purporting to be sworn before the same notary on the 11th day of March, and I believe I am fully acquainted with all the principal facts and circumstances to which these affidavits purport to relate. So far as they charge the Edison Electric Light Company with having authorized or entertained any proposition or idea of obtaining the evidence of Sawyer or any other person through Street or any other person upon a pecuniary or other consideration in the manner charged, or in any other surreptitious or improper manner, they are false.

4. Some time in January, 1882, Major Eaton, vice-president of the Edison Electric Light Company, informed me that he had been visited by persons professing to represent Sawyer, who read or showed to him a paper drawn in the form of an affidavit to be signed by Sawyer, and which Sawyer was willing to swear to. He informed me that at the same time these persons stated that Mr. Sawyer would desire either to be paid for his affidavit, or to get money in some way as a consideration for making it. I did not read any of these papers, but was told their purport by Major Eaton. On the first occasion when he spoke to me on the subject, he ended his communication of the facts by saying, "Of course, we can do nothing of the sort," to which I responded, "Certainly not," and nothing more was said. On a subsequent occasion, when he told me of another visit, and still again that an attempt had 3334 been made through Mr. Bergmann to get Mr. Edison to consider a similar application, and said, "Even if the facts are as stated, the manner in which they are brought to our attention, and the condition upon which they are offered to us preclude us from using them," to which I assented. At one of these times he informed me that he had received through the mail a paper pur-

porting to be a complete affidavit signed by Sawyer. About this time I was asked by Major Eaton for my judgment upon the propriety of a motion to reopen the interference between Sawyer and Man and Edison upon the paper carbon, in consequence of the discovery of a letter of Sawyer's, published in the New York Herald, and which was thought to be material. I advised him that the letter, if authentic, furnished the very best possible evidence of an abandonment, being a clear admission of that fact by Sawyer, with whom interest, pride and every other motive would concur to make him claim everything possible, and being part of a boasting letter where he might make such claims without responsibility, and would certainly make no disclaimer against his interest and pride unless it were certainly and notoriously true, and that in that view the letter seemed to me to be material evidence equally binding upon the parties opposed to us in the interference, whether one of the applicants had or had not parted with his interest in the invention, and in connection with this advice, I suggested to him that he might, in my opinion, with propriety include the affidavit of Sawyer, which had been sent in by mail, it having been voluntarily given without any condition restraining the free use of it; and I added that if we could, by reopening the case, get an opportunity to examine Sawyer orally, we should, perhaps, be able to ascertain the truth in a manner to which there could be no objection. At this time, or within a few days after, being at the office of Major Eaton, he sent for Major Z. F. Wilber for a consultation in respect to this motion, and I heard all that occurred between them.
3335 Major Wilber reported that he had tried in vain to obtain a copy of the New York Herald containing the letter, but exhibited a manuscript copy made from the Herald files, and he added that it was impossible to get any Herald editor to make a voluntary affidavit, and that it seemed difficult to name the witnesses by whom its authenticity would be proved as required under ordinary circumstances on motions for a new trial. I asked if Sawyer had been applied to for proof of authorship, saying that I could scarcely conceive it possible that he would refuse to give proof of a fact the truth of which must be so well known to his associates. Major Eaton asked Major Wilber if he knew Sawyer, and being answered in the affirmative, requested him to go to Sawyer and see if he would make such an affidavit. Major Wilber expressed strong dislike of having any communication with Sawyer, saying that he was notoriously untruthful, and no one could know how he would misrepresent anything that was said to him. Both Major Eaton and I said there could be but little danger of misrepresentation if Major Wilber would not permit himself to be drawn into a discussion of any other matter than simply the one concerning which he was to make the visit, and with this understanding he left Major Eaton's room taking with him the manuscript copy of the Herald letter. He came into my office at 3 Broad street next day and said it was useless to talk to Sawyer, that he admitted writing the letter, but said "It will cost you $200 or $300 to prove it, and you may just as well pay me that as to pay it to somebody else." Major

Wilber said that finding a voluntary affidavit would not be given, he had left Mr. Sawyer, and there was no further result of the visit. In the conversation between Major Wilber and Sawyer they both referred to the fact as being well known that various applications had been made to the company for the purchase and sale of affidavits by Sawyer, which had been refused, and Wilber declared that he would not speak to Sawyer at all, except that it was
3336 doubtful whether we could make the proof of this letter in any other way.

5. Within a day or two after that Major Eaton announced to me that he had been speaking of this letter in the presence of Mr. Arnoux, of the firm of Arnoux & Hochhausen, when Mr. Arnoux said that he was present when the letter was written. Major Eaton told me that he immediately requested Mr. Arnoux to make an affidavit of this fact which would sufficiently prove the authorship of the letter, and added, "We shall now be able to go on."

6. I know Albon Man who is joint applicant with Mr. Sawyer. He was at my office some two months ago, about the time of the decision in this matter, but whether before or after I cannot remember; but it was certainly before the making of this motion, and before it had been advised by me. I think Mr. C. C. Allen, who is an associate with Mr. Man in the Eastern Electric Light Company, which is, I believe, the owner of all the Sawyer and Man inventions, was also present. In the course of conversation Sawyer came to be spoken of, and his general character being under discussion, I informed Mr. Man that Mr. Sawyer's affidavits had been offered for sale to our company. I did this with perfect freedom, accompanying it with the statement that the offers had been declined. Mr. Man expressed no surprise, but both he and Mr. Allen received the statement naturally as a thing that did not at all surprise them, and I think something was said by them about his having done the same with other people. The remark upon this subject was in a passing way on both sides, and I speak of it only to give evidence to the Commissioner that the Edison Electric Light Company not only was not enlisted in any such business as is suggested by the Sawyer and Street affidavits but that when it happened,
3337 naturally and in a convenient way I gave information to Mr. Man of the fact.

G. P. LOWREY.

Sworn and subscribed before me, this 19th day of April, 1882.

WM. H. ALDEN,
Notary Public (63), *N. Y. Co.*

(Endorsement: 3, affidavit of Grosvenor P. Lowrey; U. S. Patent Office, May 8, 1882.)

STATE OF NEW YORK, } *ss:*
County of New York, }

P. B. Wilber, being duly sworn, deposes and says:

I am of lawful age, and a citizen of Cincinnati, temporarily resident in New York.

I have read the affidavit of Z. F. Wilber, dated April 19, 1882, and especially that portion describing a visit by him and interview with Wm. E. Sawyer, on the 12th day of April, 1882. I was present at such interview and heard the conversation. The account given of it by Z. F. Wilber, in the affidavit referred to is a full, complete and correct account of the conversation he had with Mr. Sawyer.

P. B. WILBER.

Sworn to and subscribed before me, this 19th day of April, 1882.

WM. H. MEADOWCROFT,
[L. S.] *Notary Public, New York Co.*

(Endorsement: 4; affidavit of P. B. Wilber; U. S. Patent Office, May 8, 1882.)

3338 STATE OF NEW YORK, } *ss:*
County of New York, }

W. H. Meadowcroft and R. N. Dyer, both residents of the city of New York, being duly sworn, depose and say:

1. That they were both present at an interview between S. Bergmann and Robert Street, upon April 5th, at the office of S. Bergmann & Co., No. 108 Wooster street, New York.

2. That the substance of such interview is faithfully and truthfully set out in a minute thereof attached to the affidavit of Philip H. Klein, Jr., dated April 20, 1882, and there forming part of Exhibit G.

3. That such minute, forming part of Exhibit G, was made immediately after the interview, and upon the date set forth therein; and was read over and was signed by them at that date.

WM. H. MEADOWCROFT.
R. N. DYER.

Sworn to and subscribed before me this 21st day of April, 1882.

WM. H. ALDEN, JR.,
Notary Public, New York Co. (63).

(Endorsed: 5; affidavit of W. H. Meadowcroft; U. S. Patent Office; May 8, 1882.)

3339 STATE OF NEW YORK, } *ss:*
County of New York, }

Charles E. Chinnock, being duly sworn, deposes and says as follows:

1. That he is of lawful age; is electrician of the Metropolitan Telegraph and Telephone Company, of New York city, and resides in Brooklyn, New York.

2. That he knows Siegmund Bergmann, of the firm of S. Bergmann & Co., of 108 Wooster street, New York, and Robert Street, of the late firm of Sawyer & Street, electricians, New York city.

3. That late in February or early in March, at least more than six weeks ago, affiant met Mr. Bergmann accidentally on the street,

whereupon Mr. Bergmann asked him to go into a saloon with him, which he did, that they found in the saloon Mr. Street, with whom Mr. Bergmann had some casual conversation, and then said to Mr. Street: "Street, you've had that money pretty near long enough; ain't it about time you paid me that hundred dollars; I don't want to be running over here after it so often." Street said, "Don't worry about it, I'll repay it as soon as I can make a raise; I'm a little hard up just now." Bergmann then told him if he couldn't pay it all at once, to pay part of it at a time, and Street said he would. The conversation was not in a rough, boisterous tone, but Mr. Bergmann asked for the money in a gentlemanly and moderate
3340 way, but the conversation was sufficiently loud for me to hear it, and the above is the substance of the conversation.

After a few words more we (Mr. Bergmann and I), left the saloon, and further affiant sayeth not.

(Signed) C. E. CHINNOCK.

Sworn to and subscribed before me, this 17th day of April, 1882.

(Signed) FRED'K HAYNES,
[L. S.] *Notary Public, Kings County, N. Y.*

(Endorsed: 6; affidavit of C. E. Chinnock; U. S. Patent Office; May 8, 1882.)

3341 STATE OF NEW YORK, }
Counoy of New York, } *ss:*

Siegmund Bergmann, being duly sworn, deposes and says:

1. I am a member of the firm of Bergmann & Company of Nos. 108 to 114 Wooster street, in the city of New York, and am a manufacturer of electrical apparatus.

2. I know Robert Street, who has made an affidavit in the matters of interference between Sawyer and Man and Thomas A. Edison, dated the 10th day of March, 1882, and have known him for eight or ten years. We w*a*re formerly shopmates in the employ of Mr. Windram. Mr. Street is now in business as an electrical engineer, and I, being a manufacturer of electrical apparatus, and desirous of securing work and employment from all persons who are in any way interested in the business, and have been in the habit from time to time of seeing Mr. Street and keeping up a friendly acquaintance.

4. On the 7th of November, 1881, Street called at my office, and after a few minutes' conversation asked me to loan him one hundred dollars. I understood at the time that Street was associated with Sawyer, and that they were together electricians of the company, called the Eastern Electrical Manufacturing Company, and partly because of willingness to befriend him, and partly because I through- it impolitic to decline, since he might be in the way of either influencing business to me or of preventing it coming to me, I decided to lend him the money; but said, "You must pay this back promptly," and he promised that he would do so very soon. I then turned to my book-keeper and directed him to draw from my per-

sonal account a check for one hundred dollars. Mr. Street asked me then if I would not get the cash, as he had no means of using
3342 a check. I said, "I am going right down town, and I will go to the bank with you and get the money there." By my direction, therefore, the check was drawn to my order, and the check is attached to the affidavit of Philip H. Klein, Jr., dated April 20, 1882, and is marked "Exhibit A." I directed that there be taken from him at the time a receipt in my general receipt book, which was done, and which receipt is this day detached from the book, and is now attached to the affidavit of Philip H. Klein, Jr., dated April 20, 1882, and marked "Exhibit B." I do not think that up to that time Street had ever said anything to me concerning this interference, or any interference between Sawyer and Edison, although he was in the habit of freely talking about the Sawyer inventions, and claiming that Sawyer had all the valuable patents and inventions on electric lighting, and if this was true, and I had no means of knowing whether it was true or not, I regarded it as a reason why I should keep in friendly relation with Mr. Street, who might be able to get me important employment as a manufacturer. Nothing ever, that I remember, was said at this interview upon any subject except his desire to borrow one hundred dollars. I went with Street to the bank where I drew the money and handed it to him.

4. Afterward, and some time in the month of January, Street brought to me a paper, which I was told was in the handwriting of Mr. Sawyer, and which he said Mr. Sawyer would be willing to swear to. I read the paper over, and we had some conversation concerning the subjects to which it related. I cannot remember now that I had ever heard of that interference proceeding before that time. As I have no connection whatever either with Mr. Edison or the Edison Company except that I manufacture for them upon orders given to me, just the same as I do for any other person. I did not see why this matter should be mentioned to me. I, however, was desirous to serve both Mr. Street and the Edison
3343 Company in any proper way, and without looking into the matter any further, I had a copy made of that paper at the time and enclosed it at once to Mr. Edison. A true copy of the proposed affidavit of Sawyer is annexed to the affidavit of Philip H. Klein, Jr., dated April 20, 1882, and is marked "Exhibit D." I asked Street for permission to take the copy, to which he assented, but when I attempted to copy it in my letter-press book, he objected to having a letter-press copy taken, the reason being as I understood, because the original was in Sawyer's handwriting. I therefore took out the first page which had been put in the copying book and directed my book-keeper to make a manuscript copy, which he did. I received no answer whatever from Mr. Edison, and meeting him a few days after, I asked him if he had anything to say upon the subject, and he replied that he had nothing to do with business of that sort, and that he had sent the paper to Major Eaton.

At this interview, all that I said to Mr. Edison was, "I suppose you have received my letter; what reply shall I make to Mr. Street," and he made the answer above stated. In the meantime I received from Mr. Street a letter under date of February 6th, which I immediately forwarded to Major Eaton. In answer to that I received under the same date, a letter of S. B. Eaton. These two letters are annexed to the affidavit of Philip H. Klein, Jr., dated April 20th, 1882, and marked Exhibits E and F respectively. This is absolutely all which has ever occurred between Street and myself, or between myself and Edison, or any other person relating to the inventions of Sawyer, or Sawyer and Man in interference in this matter, either directly or indirectly, which in any way related to the matter in interference, or to the patents of Sawyer and Man; nor have I ever received any instruction, request or communication whatsoever from Mr. Edison, or any one for him or from the company, or any of its officers relating to this subject, except as above stated.

3344 5. I have read the affidavit of W. E. Sawyer herein, dated March 10th, and that of Robert Street dated the same day. I find in those affidavits that Sawyer swears (1) that Street said that I had offered him one thousand dollars for the purpose of inducing Sawyer to throw over the side of Sawyer and Man in the interference suit then pending for what is known as the "carbon filament electric incandescent lamp;" (2). That subsequently on the 7th of November, Street came to Sawyer and handed him twenty gold coins of five dollars each, saying: "That shows the Edison crowd means business. Bergmann says you will get the rest as soon as you testify for them;" and (3) that Street swears he has read the "foregoing" affidavit, and that the twenty gold coins of five dollars each mentioned therein were paid to him for the purpose specified. I am advised by Grosvenor P. Lowrey, counsellor-at-law, that these affidavits fail to make any allegation against me capable of being traversed; since I cannot say that Street did not make to Sawyer the statements alleged, (although they were entirely false if they were so made); and since Street's affidavit does not identify Sawyer's affidavit under the term "foregoing affidavit," and since he does not say that the gold coins were paid to him for the purpose "specified" in Sawyer's affidavit; and since the allegation that the other statements contained in the foregoing affidavit: (even if the affidavit referred to is the affidavit of Sawyer of that date) amounts to no more than an averment that Sawyer speaks truly when he swears that Street made such statement to him, and is not an averment of the truth of those statements if made. But waiving all criticisms of these affidavits I declare that so for as they either expressly or by implication, charge me with having made any offer of money, or other inducements for the purposes specified in the affidavit of Sawyer, they are absolutely untrue.

6. Since the 7th of November, I have on several occasions asked Street to return me the $100 borrowed; on one occasion in
3345 the saloon where he resides, about the end of February, or
1st of March, in the presence of Charles E. Chinnock, of the
Bell Telephone Co., of New York. I met Street by chance and said

to him, "Street, it is about time that you had paid me back some of that money." He answered that he would as soon as he could raise some money. I said that he need not pay it all at once, but could pay a part at a time. He said that he would do so. This loan is the only pecuniary transaction I have had with Robert Street within the past five years.

When I heard of this matter, by being informed by Major Eaton, of the affidavits of Street and Sawyer, I immediately went to find Street; I succeeded in finding him in the saloon where he resides, and I demanded of him that he should come with me to the office of the Edison Electric Light Co. and correct the false statements made in his affidavit, or to correct the erroneous interpretation which had been put upon those affidavits. He at first denied that he had made any affidavit. He then asked me whether I had seen the original affidavits, and said there must have been some mistake about it, because he was sure that my name was not mentioned in those affidavits. He added that he would like to see the paper from Washington and read it. As he refused to go with me to the Edison Electric Light Company's office, I asked him to come with me to my office, and he did so. I immediately sent to the company's office for the papers and for Major Eaton. Mr. Meadowcroft, who is Major Eaton's clerk, came at once with the papers. Mr. R. W. Dyer came in by chance. In the presence of these gentlemen the affidavits were read over. I turned to Mr. Street and asked him to state the truth and to say that these affidavits were false. He replied that he could not say anything until he saw Mr. Sawyer. I repeatedly urged him to state the truth and to say, as he and I knew the fact to be, that the transaction in respect to the $100.00 was only a loan made to him as a friend, having no reference 3346 whatever to any other matter. He repeated again that he could have nothing to say until he saw Mr. Sawyer. I asked him to state whether I had attempted in any way to bribe him, or to bribe Mr. Sawyer through him, and he replied that he did not think so but that he could not remember just then, but that he must see Mr. Sawyer. He constantly replied to all my questions that he could not remember but that he must see Mr. Sawyer. He also said that if I wanted to see him I ought to see him alone, and not in the presence of two or three witnesses. I then charged him with perjury, and with attempting to prejudice and injure me with one of my principal employers, the Edison Company. After the interview had ended, Mr. Meadowcroft made a short minute of what had occurred, and which was signed by himself, Mr. Dyer and myself, and all that is stated in that minute is strictly true. Said minute is attached to the affidavit of Philip H. Klein, Jr., dated April 20, 1882, and is there marked Exhibit G.

8. On the 12th day of April I received at my office a letter from W. E. Sawyer, the orignal of which is hereto annexed, marked Exhibit A, to which I have not made and do not intend to make, any response.

(Signed) S. BERGMANN.

Sworn to and subscribed before me, this 20th day of April, 1882.
(Signed) WM. H. MEADOWCROFT,
Notary Public, New York County.

W. E. Sawyer, electrical engineer, electric railways and lighting,
No. 61 Broadway.

New York, *April* 11, 1882.

3347 Dear Sir: I would like to see you very particularly on importance business and at once.

Truly yours, W. E. SAWYER.

Exhibit "A." Wm. H. Meadowcroft, notary public, N. Y. Co.

(Endorsed: 7; U. S. Patent Office, May 8, 1882; affidavit of S. Bergmann.)

State of New York, }
City and County of New York, } *ss:*

Thomas Alva Edison, being duly sworn, says:

1. I have read the affidavits of William E. Sawyer and Robert Street, dated the 10th and 11th of March, 1882, and filed, as I am informed, in opposition to a motion before the Commissioner of Patents for a rehearing of the interference between Sawyer and Man and myself.

2. I have never authorized or requested Mr. Bergmann, Major Wilber or any person whomsoever to take any action whatsoever for me or for the Edison Electric Light Company in respect to evidence to be furnished by William E. Sawyer, and so far as those affidavits by implication or express statement can be construed to charge the contrary they are utterly false.

3. With Mr. Bergmann I have no connection whatever, except that he is a member of a manufacturing firm from whom the
3348 Edison Electric Light Company, in which I am a stockholder, purchases a certain class of manufactured articles, and I have never even spoken to Mr. Bergmann in respect to any matter in controversy between me and Sawyer or Sawyer and Man, except that about three months ago he came to me and said that Sawyer was coming around to get him to lay a proposition before me that he (Sawyer) would confess or make known the truth concerning some of the matters involved in this interference. I stopped Mr. Bergmann in his explanation, and after telling him that I would have nothing whatever to do with Mr. Sawyer, I advised him (Bergmann) also to have nothing to do with him, and never to talk with him upon any subject, except in the presence of a witness. In giving this advice to Bergmann, which is all that I have ever said to him, I was advising him according to my own practice, for in the last two years I have received a great many letters from Sawyer asking for interviews, to which letters I have never even returned an answer. The last of these letters was received a few days ago and is hereto annexed.

4. Just about the time, or perhaps a day or two before Bergmann had this conversation with me, he sent me what purported to be a form of affidavit prepared to be signed and sworn to by Sawyer. I sent this paper directly to Major Eaton, he being the executive and managing officer of the Edison Electric Light Company (which is the owner of my invention in interference), and the proper person to represent that company in all legal business, and I communicated to him the next time I saw him my strong objections to having the company entertain any proposition or enter into any communication with Sawyer, and I have no further knowledge of any of the matters which are, or seem to be, covered by the affidavits of said Street and Sawyer.

3349 5. I have made inquiries as to the action of Messrs. Wilber and Bergmann, and am entirely convinced that the affidavits are untrue in all material points relating to them. Neither the company nor myself can prevent such propositions being made to us, but we can refuse to entertain them, and this I have done, and am informed and believe the company has also done so in the most unequivocal manner.

T. A. EDISON.

Sworn and subscribed before me, this 21st day of April, 1882.

WILLIAM H. MEADOWCROFT,
[L. S.] *Notary Public, N. Y. Co.*

Received April 14, 1882.
Answered not 188

W. E. Sawyer, electrical engineer, electric railways and lighting,
No. 61 Broadway.

NEW YORK, *April* 11, 1882.

DEAR SIR: I would like to see you very particularly on important business.

Truly yours, W. E. SAWYER.

When will it, and where will it, and under what circumstances will it, if at all, be convenient for you to see me?

Exhibit referred to in the foregoing affidavit of Thomas A. Edison.

WM. H. MEADOWCROFT,
Notary Public, N. Y. Co.

From W. E. Sawyer, N. Y.
Electrical engineer, April 1, p. m. 2-cent stamp.
61 Broadway, N. Y. city. P. O.

THOMAS A. EDISON, Esq.,
65 Fifth Ave.,
N. Y. city.

(Endorsement: Affidavit of Thos. A. Edison, U. S. Patent Office, May 8, 1882.)

3350 STATE OF NEW YORK,
City and County of New York, } *ss:*

Egisto P. Fabrri, being duly sworn says:

1. I am a member of the firm of Drexel, Morgan & Co., bankers, of the city of New York, and treasurer of the Edison Electric Light Company, and all disbursements by or for that company necessarily pass through my accounts as such treasurer.

2. I have read the affidavits of Sawyer, Street, Thatcher and Whitmore, dated the 10th and the 11th of March, in the matter of a motion to reopen the interference between Sawyer and Man and Edison.

3. I have no personal knowledge concerning the matters spoken of in those affidavits, but upon my general information and knowledge as to the company, its affairs and management, I believe that all statements or suggestions that the company or any person who has been in any way requested or authorized by it has given or offered to give to Sawyer or any other person any corrupt inducement to testify in this or any other matter are absolutely and entirely erroneous.

E. P. FABBRI.

Sworn to and subscribed before me this 20th day of April, 1882.

WM. H. MEADOWCROFT,
[L. S.] *Notary Public, N. Y. Co.*

(Endorsement: Affidavit of E. P. Fabbri; U. S. Patent Office, May 8, 1882.)

3351 STATE OF NEW YORK,
County of New York, } *ss:*

Calvin Goddard, being duly sworn, deposes and says:

1. I am of lawful age, a resident of the city of New York, and am secretary of the Edison Electric Light Company.

2. I have read all the affidavits of Street, Sawyer, Thatcher and Whitmore, filed in opposition to the motion to set aside the decision rendered in the interference case, Sawyer and Man *vs.* Edison, and all statements therein made to the effect or from which it might be inferred that the Edison Electric Light Company, or any of its officers, or any person acting as its authorized agent, or any person whatever representing the company with any authority from it, has ever at any time bought or sought to buy any affidavits or testimony whatever, or has agreed or offered to agree to pay William E. Sawyer or any other person, any money or to give any compensation whatever, directly or indirectly, for making any affidavit or giving any testimony, are utterly and entirely false to the best of my knowledge, information and belief, and neither in the case of William E. Sawyer, nor in any other whatever, has this company ever purchased or sought or ever desired to purchase any testimony of any kind or nature.

C. GODDARD.

Sworn to and subscribed before me this 21st day of April, 1882.

WM. H. MEADOWCROFT,
Notary Public, N. Y. County.

(Endorsement: 11; affidavit of Calvin Goddard; U. S. Patent Office, May 8, 1882.).

3352 STATE OF NEW YORK, } ss:
City and County of New York, }

I, Z. F. Wilber, being duly sworn, do hereby depose and say:

1. I am of lawful age and a solicitor of patents by profession, and I am and have been for more than the two years last past in charge of the soliciting of patents for the Edison Electric Light Company, and I am also and have been engaged in many of the interferences arising in the Patent Office upon applications, filed by me as solicitor in their behalf.

2. That on, prior to and for several days subsequent to the 6th and 7th days of March, 1882, I was engaged in preparing papers for a motion in the interference case of Sawyer and Man *vs.* Edison, pending in the United States Patent Office, said motion having for its object the setting aside of the decision rendered and the reopening of the case to permit the introduction of newly discovered evidence which had been brought to my attention after the rendition of the decision in the case.

3. A portion of such newly discovered evidence consisted of certain printed publications attributed to William E. Sawyer, one of the parties in the case, namely, three published in the New York Herald, one under date of December 24, 1879, one under date of January 5, 1881, and one under date of January 6, 1881, each signed as printed in said paper, William E. Sawyer; and also certain passages in a work published by D. Van Nostrand of New York, in 1881, entitled "Electric Lighting by Incandescence and its Application to Interior Illuminations," by William Edward Sawyer.

3353 4. I attached special importance to this evidence, and it seemed exceedingly desirable that it should be gotten into the case. It also seemed proper that the motion to the end should be accompanied by proof establishing at least *prima facie* Mr. Sawyer's authorship thereof. I made endeavors to obtain printed copies of the New York Herald of the dates specified, for attachment to that motion, but the endeavors were fruitless. Being well aware of the unwillingness of newspaper men generally to give voluntarily testimony as to publication in newspapers, I judged that it would be useless to apply to the editor or editors of the paper for voluntary affidavits as to their knowledge of Mr. Sawyer's authorship. I mentioned this matter of the difficulty of obtaining satisfactory *prima facie* proof of authorship in a preliminary proceeding, such as a motion wherein we had no power to compel the testimony of witnesses, to Major S. B. Eaton, vice-president of the company and general manager of its affairs.

5. On the morning of March 6, 1882, Major Eaton sent for me (our offices are in the same building), and on repairing to his office I found him and Mr. Grosvenor P. Lowrey there, whereupon we had a conversation upon the matter of proving the authorship. It was suggested that perhaps Mr. Sawyer himself would admit the naked fact of authorship, and I was asked if I knew him, and I replied, yes. In the conversation It had stated that to hunt up the information, find how the letters reached the Herald, were written, &c., as we had had to do in the case of a letter published in the New York Sun, already in evidence in the case, would entail considerable expense, possibly several hundred dollars. As a matter of ordinary business economy, in order to save if possible, such expenditure and to get the proof of authorship in the simplest form, it was decided that I should see Mr. Sawyer and ask him to formally admit the authorship of the publications referred to. I may here state that, outside of mere routine matters in contested cases,
3354 I take no steps whatever, unless I have first consulted Major
Eaton and have his approval or his instructions.

6. In this matter my instructions went only to this extent, that I should see Mr. Sawyer and obtain, if possible, in proper form his admission of authorship. I was neither directed or authorized to see him on any other matter or point whatever, or to enter into any negotiations with him on this or any other subject whatever, or to offer to him or to promise to him any money or any other consideration in any form whatever, directly or indirectly, for the admission we sought, nor do I remember that any such matters were mentioned or discussed. Nor have I ever made to Mr. Sawyer any proposition as to any affidavit or testimony whatever different from what is hereinafter stated. Nor have I ever offered him any inducement whatever for making any affidavit or giving any evidence, and the affidavit of Mr. Sawyer, so far as it purports to state any material fact concerning my interview with him, is utterly false. The whole of that interview, as to every material fact or circumstance, is correctly and fully hereinafter stated.

7. Although I was exceedingly averse to seeing Mr. Sawyer under the circumstances, I deemed it my duty to. As I believed that he certainly could not object to admitting the naked fact of authorship, I prepared before going to see him an affidavit paper embodying just what, and all that was wanted from him. The identical affidavit paper is now attached to the affidavit of Major S. B. Eaton, dated April 21, 1882, and is there marked Exhibit —. I then on that day sought Mr. Sawyer, at what I had understood to be his office, but found he had moved thence, but ascertained that he lived at the Hotel St. Stephen, on Eleventh street, to which place I went, but word was given at the hotel office that Mr. Sawyer was not in. On the next day,
April 7, I again called there, sent my card up to him,
3355 word was brought to me that he would be down in a minute.
In a few minutes he appeared, greeted me, said he was late in starting to his office, could not I get into his coupé and we would talk as we rode. I assented. I had with me the form of affidavit

before noted, manuscript copies of the letters published in the Herald, and a copy of the book referred to. I opened my business immediately, showing him the copies of the letters and of the book, and asking if he wrote them. He replied that he guessed he did. ("I guess I did" were his exact words.) I then showed him the proposed affidavit I had prepared in advance, and asked him if he would not execute it, so as to put his admission into legal form. He replied that it would cost the Edison Company several hundred dollars to prove what I asked him to admit, and that he would not give that money to the company, that he might as well have that money as notaries and lawyers; that he would give the affidavit for cash-down money, but not without money. I told him that it was a pretty hard thing to do, making a charge for telling a bit of truth which could be proven anyhow. He then took up the talk and made a long statement, saying that he felt kindly towards Edison, that Edison was undoubtedly the real and first inventor of a paper-carbon lamp; that it would so appear if all the facts could be brought out, that he, Sawyer and Man, never were joint inventors of the matters in dispute, that he, Sawyer, had had the original idea, as between himself and Man, that he had had memoranda in his own note books proving this inventorship, which he had destroyed to prevent production in this case, but that he still had letters and other memoranda corroborative thereof, that whatever he and Man had done in the matter resulted unsuccessfully, and that they had totally abandoned the ider of paper carbon for electric lighting and had sought for a proper carbon in another direction long prior to the newspaper accounts of Mr. Edison's success. He stated that evidence existed to fully prove
3356 these things, but that he controlled it, and he didn't propose to give it away for nothing, that he could produce witnesses and documents, if it were made worth his while, fully substantiating every statement he made to me. And thereupon he made a proposition that he would give testimony when called on setting forth the facts he had recited to me, and would furnish witnesses and documentary evidence fully corroborating himself and that he would immediately give the admission of authorship desired for $2,500; $500 to be paid cash down on executing affidavit admitting authorship; $500 in a few days, and $1,500 after he testified. I told him that it was impossible to pay money on any such account, meaning thereby that no evidence would be bought. He undoubtedly construed it to mean that money could not be given outright, for he then said, money need not be paid for it, that all that was necessary was that he be notified that some one would loan him money and he would take some mining stock he had to such party and borrow the money on it. I then told him it was a funny kind of business to engage in, that I didn't see how he could honorably propose such a thing. He went on to say he couldn't help it, that he had two little girls to provide for, that Anderson Little and others had gone back on him after getting all his stock in his light company; that he was very hard up, must raise some cash immediately, and was bound to do it; that the cheapest and easiest way for the

Edison Company to procure their just rights was to enlist his aid in the matter. He called my attention to the fact that in testifying in the case he had so testified that he could easily repudiate any idea of joint inventorship. I then told him I had no authority to enter into any such negotiations; that my power extended only to procurement in legitimate way of proper testimony. He asked me if I wouldn't communicate the proposition to the officers of the company. As I felt it to be politic to be rid of him pleasantly, and to
leave him without his having any such feelings of anger or
3357 animosity as a point-blank refusal of his proposition or re-
fusel to report it might engender in him, I assented thereto, and promised him to do so, and further, at his solicitation, to let him know by 4 p. m. that day, if there was any feeling favorable to his proposition.

8. I, that day, reported my lack of success in my mission to Major Eaton by a report written on the back of the proposed affidavit, which, as before stated, is now attached to the affidavit of Major Eaton in this matter. I also reported the proposition to Major Eaton, who said promptly that the company could go into no such business, that it were better to lose than to win by buying evidence. Accordingly, I had nothing further to communicate to Mr. Sawyer, and therefore did not communicate with him.

9. The entire conversation relative to this matter took place in the coupé. On arriving at his place of business he requested me to go up and see his office, and I did so. It was a front room one flight up. Two or three men, whom I did not particularly notice, were in the room. On the floor was a railroad model, consisting of a few feet of track and a small model of a locomotive thereon. Mr. Sawyer sat down at a desk, I did not sit down; said, "You see I'm on electric railways, too; is it anything like yours?" I told him it didn't look like ours. A few general remarks passed as to the large future in electric inventions generally, and possibly in electric railways, and as to their being room enough in the field for all inventions, after which I left. I was not in his office over three minutes. I had no roll of papers in my hand while there. The few papers I took with me had been exhibited and disposed of, his proposition in the cab and put into my pocket. There was no urging him to sign anything, or to do anything whatever, there were no remarks there or anywhere as to any questions whatever being
reduced to writing.

3358 10. About the same time I had called on Mr. Wm. H. Ar-
noux who was mentioned in one of Mr. Sawyer's Herald letters as the recipient of the lamp, therein alluded to, to ascertain, if possible, its final disposition and whereabouts. Mr. Arnoux promised to enquire and let me know. On March 9, 1882, Major Eaton brought Mr. Arnoux to me saying that Mr. Arnoux saw Mr. Sawyer write one of the Herald letters, and was willing to make affidavit thereto. I immediately drew up a brief affidavit of the facts relating thereto, which Mr. Arnoux executed and which is attached to the motion for reopening now pending. This supplied part of the proof I had asked Sawyer to give us.

11. I did not see Mr. Sawyer again until the 12th day of April, 1882, on which day I received from him a note requesting me to call on him, which note is hereto attached as Exhibit A.

On that day I accordingly called on him at 61 Broadway, in the city of New York, accompanied by my brother, P. B. Wilber. Entering his office, I found him seated at a desk, also a smallish gray-haired and whiskered elderly gentleman, whom I did not know. Mr. Sawyer asked me to take a seat, motioning to me close to him, asked: "Who's that—a friend?" pointing to my brother, just in my rear. I answered him, "He is my brother." I then said to him, "I received your note requesting me to call; what did you send for me for?" His answer was, "I sent to see you about those affidavits in the Patent Office; we've got into a pretty fix over them; can't we yet fix it all up?" I said, "Well, we are in no fix, but we can't satisfactorily explain without any help in fixing up." He then said, "Well, I ought to have heard from you that day; if I had they wouldn't have gone in." My reply was: "I said then if our folks considered favorably of your proposition I would let you know by four that day; as they didn't, I hadn't anything to let you know or see you about." He answered, "My proposition; you 3359 mean yours." I interrupted him, saying, "Look here, Sawyer, it is no use discussing that, for you know you have lied about it in your affidavit, and you will lie again if it suits you." He then said, "I suppose you have brought a witness along to garble this conversation." To which I answered, "Nothing of the kind; I can tell the truth about it; you'll do the garbling and lying, but if this is all your important business, I'll be going—is it?" To which he said, "Well, yes." I thereupon said, "Well, I'll leave, then," and quitted the room. The two conversations hereinbefore detailed are all the conversations I have had with Mr. Sawyer for several years, and they are accurately and fully detailed as to every material matter and circumstance.

(Signed) Z. F. WILBER.

Sworn to and subscribed before me, this 19th day of April, 1882.

(Signed) WM. H. MEADOWCROFT,
[L. S.] *Notary Public, N. Y. County.*

W. E. Sawyer, electrical engineer, electric railways and lighting,
No. 61 Broadway.

NEW YORK, *April* 11, 1882.

3360 DEAR SIR: I would like to see you very particularly, on important business, and at once.

Truly yours, W. E. SAWYER.

"Exhibit A." Wm. H. Meadowcroft, notary public, New York county.

From—
W. E. Sawyer
Electrical engineer
61 Broadway,
New York city.

New York
April 6.30.
P. O.

U. S.
Postage.
2

Z. F. Wilber, Esq.,
65 Fifth avenue,
New York city, N. Y.

(Endorsement: 12; affidavit of Z. F. Wilber, U. S. Patent Office, May 8, 1882.)

3361 State of New York, City and County of New York, } *ss:*

Philip H. Klein, Jr., being duly sworn, says:

1. I am twenty-four years of age, and reside at 132 Avenue C, in the city of New York, and am employed as book-keeper by Bergmann & Co., electrical-instrument makers, of 108 Wooster street, in said city, Mr. S. Bergmann is the Mr. Bergmann of that firm.

2. I know Robert Street. I saw Mr. Street for the first time in my life at the office of Bergmann & Co. on the 7th day of November, 1881. Mr. Street called and found Mr. Bergmann in his office, which is a small room about ten feet by twenty in size, in which stands my desk. I remained in the room, occupied with my duties, all the time Mr. Street was there. A conversation was carried on between Messrs. Street and Bergmann in an ordinary tone, but I do not remember the conversation, except that after a few minutes Mr. Bergmann turned to me and directed me to draw a check for Mr. Street for one hundred dollars, which I did. Mr. Street and Mr. Bergmann left the room together, Mr. Bergmann saying, "As I am going down town, we can go to the bank and get the money, which will save you trouble." The check was drawn to Mr. Bergmann's order, as all his cash checks are drawn, and it is hereto attached (marked Exhibit A). Mr. Bergmann mentioned at the time, in order that I might understand, as I suppose, for the purpose of keeping his check book, that this was a loan, and I accordingly entered it to Mr. Street on the stub, and I took a receipt therefor in our ordinary receipt book, which receipt I have detached from said book and attached hereto (marked Exhibit B). After that and between that time and the 26th day of January, 1882, Mr. Street called several times to see Mr. Bergmann without finding him in, and on the last occasion asked me to say to Mr. Bergmann that he
3362 wished very much to see him, and was tired climbing the
long stairs, and wanted Mr. Bergmann to come to his office.

3. On the 28th day of January I entered the office and found Mr. Street there with Mr. Bergmann. Mr. Bergmann handed me a paper and asked me to make a copy of it, which I immediately did in Mr. Street's presence. Mr. Bergmann had tried to have it copied by the letter press, but it did not copy well. The letter book, which is in my charge, showed that one page of the letter had been tried but had very imperfectly copied. I cut that sheet out on the 11th

of April, and it is hereto attached (marked Exhibit C). The same sheet was subsequently used for another letter on account of the copying of the first letter being so imperfect, and my assistant bookkeeper informs me, which I believe to be true, that in copying he did not observe that this sheet had been used before.

4. The copy made by me I enclosed to Thomas A. Edison, by direction of Mr. Bergmann, and it is hereto annexed (marked Exhibit D). I never saw Mr. Street again to my knowledge until the 4th day of April, but in the meantime a letter was received at Mr. Bergmann's office, signed by Robert Street, which I sent to Major Eaton, vice-president of Edison Electric Light Company, and which is hereto annexed (marked Exhibit E), and afterwards, on or about its date, Mr. Bergmann received a letter from Major Eaton, which is hereto annexed (marked Exhibit F).

5. On the 5th day of April, 1882, Mr. Bergmann entered his office accompanied by Mr. Street, and by Mr. Bergmann's request I went immediately to the Edison Electric Light Company's office and requested Major Eaton to come to the office or to send some person, and in my presence he requested Mr. Meadowcroft, who is a clerk in his office, to go. I immediately returned with Mr. Meadowcroft there, and
found Mr. R. N. Dyer in the office with Mr. Street and Mr.
3363 Bergmann. After we came in there ensued a conversation,
in which Mr. Bergmann upbraided Mr. Street for trying to injure him with the electric light company, and asked him whether it was not true that the $100 was a loan, to which Mr. Street replied that he could not remember whether it was a loan or what he got it for, but that at any rate he was not going to talk on that subject. Mr. Bergmann repeated the question several times and in different forms, and Mr. Street refused to answer, but he did not deny that the money was received as a loan. Mr. Bergmann then said: "You are a perjurer, and I will have you arrested for it, see if I don't. I can prove that I loaned you that money, and that I have asked you for it several times, in the presence of witnesses, right around the corner here." Mr. Street made no reply to this. After the conversation Mr. Meadowcroft made immediately at the office a minute of the conversation which had taken place, which minute was signed by Messrs. Meadowcroft, Dyer and Bergmann, and also by myself. All that is contained in that statement occurred just as there stated, and it is attached hereto, marked Exhibit G.

6. On the occasion when I copied the letter in January, as Mr. Street went out of the office, Mr. Bergmann said: "I will let Mr. Edison see the paper, and if he wants to do anything of that sort I will let you know." Mr. Bergmann then directed me to send the letter to Major Eaton, adding: "I don't know why this man comes to me to bother me; I don't want to have anything to do with it; it is not my business."

PH. H. KLEIN, Jr.

Sworn to and subscribed before me, this 20th day of April, 1882.

A. H. NONES,

[L. S.] *Notary Public*, 470 *Broadway, N. Y.*

3364 "Exhibit A." Ap'l 20, 1882. A. H. Nones, N. P.

(U. S. int. rev. 2.)

No. 77. New York, *Nov.* 7, 1881.

People's Bank of the City of New York pay to the order of S. Bergmann one hundred dollars in current funds.

$100. S. BERGMANN.

(Corner of Canal and Thompson Sts.)

(Endorsed: S. Bergmann.)

"Exhibit B." Ap'l 20, 1882. A. H. Nones, N. P.

$100.00. Nov. 7, 1881.

Received of Mr. S. Bergmann one hundred dollars.

ROB'T STREET.

3365 "Exhibit C."

Jan'y 28.

Messrs. Edison Lamp Co., Menlo Park, N. J.

Gents: We will send 6 resistance boxes and only charge for 5, but will require the one you have as a sample to go by. Please return it to us, and oblige.

Yours very truly, BERGMANN & CO.

We are going ahead to make the resistance box for which you have given us the measurement of the wire; but should like to know whether you want it in a box or like the resistance boxes for mercury pumps.

Exhibit C, A. H. Nones, N. P., Ap'l 20, 1882.

3366 "Exhibit D." Ap'l 20, 1882. A. H. Nones, N. P.

State of New York, }
City and County of New York, } *ss:*

William E. Sawyer, of the city, county and State of New York, being duly sworn, deposes and says, that in his testimony in the interference suit between W. E. Sawyer and Albon Man on the one side, and Thomas A. Edison on the other side, concerning the priority of invention of what is known as the incandescent horseshoe lamp, which suit is now pending in the United States Patent Office, there are numerous errors that, as a matter of simple justice to said Edison, deponent earnestly desires to correct; that deponent has repeatedly asked the attorney prosecuting the interference suit on behalf of Sawyer and Man to permit him, deponent, to correct such errors, but without avail; that deponent has been informed that the suit is about to be decided against Mr. Edison and, notwithstanding the fact that deponent will be the gainer thereby, deponent's sense

of right and justice will not permit him to remain silent and allow injustice to be done; that the said Albon Man and himself, as early as February, 1879, abandoned the horseshoe lamp, after numerous discussions, in the course of which the idea was voted to be a failure; that said Man declined either to himself advance the money necessary to procure a patent, or to permit the Electro-Dynamic Light Co. to pay the same because it would be a mere waste of money, and the entire subject was dropped and not again alluded to until nearly a year later, when an account of Mr. Edison's discovery was published; that then said Man and one C. A. Cheever came to deponent and represented that there was from $100,000 to $250,000 to be made out of the Edison people, if we would put in an interfering application, no matter what it might
be, that the Edison patent was about to issue and no time
3367 must be lost, and papers were drawn which were submitted
to deponent to sign, that upon the representations of said Man that the papers were all right, deponent signed the same without being fully aware of what was claimed; that deponent was then informed that $100,000 would be divided between said Man and his friends and the deponent, as the result of the transaction; that repeatedly thereafter deponent was coached by said Man, and the attorney on behalf of Sawyer and Man, as to what deponent's testimony should be; that deponent informed them that he would not swear to the things desired, but would leave all that to said Man, because deponent could not conscientiously swear to what he believed to be doubtful or false; that it was thereupon arranged that the parts of testimony really affecting the Edison invention should be left to said Man, who has made certain desultory experiments, and that deponent should so leave the matter; and with this understanding between said Man and the attorney and deponent, deponent went upon the stand; that deponent signed deponent's testimony without first reading it and has since found that, already stated, it contains numerous errors, the correction of which deponent deems but an act of right and justice towards said Edison.

And deponent respectfully requests of the Commissioner of Patents the privilege of correcting his testimony in accordance with the facts as known to deponent.

—— ——.

Sworn to and subscribed before me this 26th day of Jan. A. D. 1882.

—— ——.

3368 "EXHIBIT E." April 20, 1882. A. H. Nones, N. P.

W. E. Sawyer. Robert Street.

Sawyer and Street, electrical engineers, 111 Liberty street.

NEW YORK, *Feb. 6th*, 1882.

FRIEND BERGMAN: From what I can understand, the Edison Co. are making fools of themselves; they want us to accede to their wishes, but do not want to make any concessions to us, we were willing to carry out our part to the letter, but their proposals are too one-sided for us. Nothing can be done now under twice the original, and everthing will of course go against the E. Co., as it did in the first place. If they mean any kind of sensible business let me know at once, or let the matter drop forever and the result will be as I have already told you.

Yours, &c., R. STREET.

(Endorsed: 35; 19113; 35; Feb. 6, 1882; S. Bergman, S. B. Eaton; encloses R. Street's letter *re* Sawyer's proposition.)

3369 "EXHIBIT F." April 20, 1882. A. H. Nones, N. P.

The Edison Electric Light Company, 65 Fifth avenue.

Norvin Green, pres.; S. B. Eaton, vice-pres.; E. P. Fabbri, treas; C. Goddard, sec'y.

NEW YORK, *Feb. 6th*, 18—.

S. Bergmann, Esq., city.

DEAR SIR: Referring to your letter of this date enclosing letter from Mr. Street, let me say that Mr. Sawyer's representative called here Saturday with your last communication to him and told me that Mr. Sawyer would do nothing unless he was paid for it. I have already fully discussed the subject of buying an affidavit from Mr. Sawyer, with Mr. Edison, Mr. Lowrey and others of our directors, and we all agree that it would be the most foolish thing in the world for us to do. That is, therefore, the ultimatum of the company in this matter. Please accept my thanks for your kind services in this matter, and believe me we shall always be glad to reciprocate your courteous attention.

Very truly yours, S. B. EATON,
Vice-president.

3370 "EXHIBIT G." April 20, 1882. A. H. Nones, N. P.

Mr. S. Bergmann, R. N. Dyer and W. H. Meadowcroft were all present at an interview between Mr. Bergmann and Robert Street, April 5, 1882, at the office of Bergmann & Co., between 4.30 and 5 o'clock p. m., when the annexed affidavits were read by Mr. Street; after Mr. Street had read the annexed affidavits, Mr. Bergmann asked him if he had made the statements contained therein, to which Mr. Street replied that he couldn't say. He wanted to see the original to see if his signature had been forged. Mr. Bergmann reminded Mr. Street that he (Bergmann) had loaned Street $100 in the presence of a witness and on the distinct understanding that it was a loan. To this Mr. Street made no reply—and Mr. Bergmann again asked Street if he had made the statements contained in the affidavits, to which Street said he did not know, he could not remember. Anyway, he said he was not going to say anything now. Mr. Bergmann then asked him if he (Bergmann) had ever attempted the acts of bribery alleged in the affidavit, to which Street said he could not remember every word that had ever been said to him. Street further said he did not know or remember having made such affidavit. Also he said in reply to a question of Bergmann's that he didn't recollect that Bergmann had done anything to bribe him.

Mr. Bergmann asked him (Street) why he had brought Sawyer's letter to him, Bergmann—to which Street said he wasn't going to say anything now.

Signed by us, April 5, 1882.

WM. H. MEADOWCROFT.
RICHARD N. DYER.
S. BERGMANN.

Witness to all three signatures,
P. H. KLEIN.

3371 City and County of New York, }
State of New York. }

William E. Sawyer, residing at the Hotel Brighton, corner of 42nd St. and Broadway, in the city of New York, being duly sworn, deposes and says that on or about November 5, 1881, while doing business at 111 Liberty St., in said city, deponent's partner, Robert Street, residing at 130 Eldridge St., in said city, came to deponent and said that he had an important matter to communicate, to wit, that one S. Bergmann, a friend of his doing business for T. A. Edison in Wooster St., in said city, had offered him, Street, the sum of one thousand dollars for the purpose of inducing deponent to throw over the side of Sawyer and Man in the interference suit then pending between Sawyer and Man and Thos. A. Edison for what is known as the carbon filament electric incandescent lamp; that deponent was busy and said no more about the matter than to remark it was very singular the Edison people were getting so hard pushed as to have to resort to bribing to secure their patents.

And deponent further states that on or about November 7th, 1881, said Street came to deponent and handed him twenty gold coins of the denomination of five dollars each, saying, "That shows the Edison crowd means business; Bergmann says you will get the rest as soon as you testify for them." Deponent said he did not want the money, but its payment might some day be of use, and he would receive it; and deponent gave two of the coins to said 3372 Street and the remainder he gave away to various persons immediately thereafter.

WM. E. SAWYER.

Sworn to and subscribed before me, this 10th day of March, A. D. 1882.

SAMUEL GOODWIN,
Notary Public, Kings Co.

Certificate filed in N. Y. Co.

Ex'd: A. N.

CITY AND COUNTY OF NEW YORK, }
State of New York. }

Robert Street, residing at 130 Eldridge street, in the city of New York, being duly sworn, deposes and says that he has read the foregoing affidavit; that the 20 gold coins of $5 each mentioned therein were paid to him for the purpose specified; and furthermore that the other statements contained in the foregoing affidavit are *thus*.

ROB'T STREET.

Sworn to and subscribed before me, this 10th day of March, A. D. 1882.

SAMUEL GOODWIN,
Notary Public, Kings Co.

Certificate filed in N. Y. Co.

Ex'd: A. N.

(Endorsement: U. S. Patent Office, May 8, 1882; 22; 19023; 22; March 11, 1882; affidavit of Philip H. Klein; Sawyer-Man-Edison; W. E. Sawyer's affidavit *re* S. Bergmann's offer of 1,000 dollars and payment of 100 dollars in gold coin on account of same; also memo. of Meadowcroft *re* Street's subsequent interview with Bergmann in presence of witnesses named.)

3373 COMPLAINANT'S EXHIBIT PATENT OFFICE PROCEEDINGS NO. 8.

Decision of Commissioner of Patents on Motion to *to* Open Interference. May 11, 1886. T. G., Ex'r.

CONSOLIDATED ELECTRIC LIGHT CO. }
vs. } H, 3553.
EDISON ELECTRIC LIGHT CO. *et al.* }

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the records of this office of the decision of the Commissioner, July 24, 1882, in the matter of the interference, Edison *vs.* Sawyer and Man, for improvement in electrical lamps.

In testimony whereof I, M. V. Montgomery, Commissioner of Patents, have caused the seal of the Patent Office to be [SEAL.] affixed this 18th day of June, in the year of our Lord one thousand eight hundred and eighty-five, and of the Independence of the United States the one hundred and ninth.

M. V. MONTGOMERY,
Commissioner.

3374 U. S. Patent Office.

EDISON
vs.
SAWYER AND MAN. } Motion to Reopen.

Electrical lamps.

Application of Thomas A. Edison filed December 11th, 1879.

Application of William E. Sawyer and Albon Man filed January 9th, 1880.

Messrs. Dyer & Wilber, for Edison.
Mr. Amos Broadnax for Sawyer and Man.

On January 20, 1882, the examiner of interferences upon the testimony presented in this case, awarded priority of invention of the matter in interference to Sawyer and Man. Appeal from said decision was duly taken by Edison to the board of examiners-in-chief, but prior to the consideration of said appeal, motion was made to reopen the case and allow the taking of further testimony alleged to be newly discovered. Said motion is based upon the affidavits of Z. F. Wilber, George W. Dyer, William E. Sawyer and Anthony Arnoux, and it is claimed that if said testimony is admitted it will establish the following points:

"1st. That Sawyer and Man were not and are not joint inventors in the eyes of the law.

"2d. That whatever either or both did jointly or severally,
3375 in respect of the invention in controversy prior to the filing of their application, amounted only to unsuccessful and abandoned experiments.

"3d. That Sawyer himself, in an enduring and solemn manner, has given Edison credit for the invention of the matter here in issue, taking credit to himself or to himself and Man only for carbon manufactured from hydrocarbon liquids, and 'for live willow twin carbon.'"

In support of the first point the affidavit of William E. Sawyer is filed, dated December 21, 1881, in which he says: "That his testimony given in certain interference suits, before the Commissioner of Patents, in which it inferentially appears that Albon Man was joint inventor of certain inventions not specified, was made upon the erroneous belief that such statement was true; that since such time this deponent has been advised that he was in error, and that such acts of the said Albon Man did not, in law, make him a joint inventor with this deponent."

This affidavit does not identify this case as one in which the testimony was given upon the erroneous belief that Man was a joint inventor with him.

At the hearing certain affidavits were filed on the part of Sawyer and Man, reflecting injuriously upon Mr. Wilbur and others connected with the prosecution of the application of Edison, in reply to which affidavits were filed denying each and every of the injurious statements made by Sawyer and others, in which there is some corroboration and some identification of this case with the matter stated in Sawyer's affidavit above quoted. Standing alone, however, there is not sufficient on this point to warrant the granting of the motion.

In support of the second point, copies of letters are filed purporting to have been written by Sawyer, and published in the New York Herald of dates December 24th, 1879, and January 4th and 6th, 1880.

3376 On the argument it was claimed that these letters showed an abandonment of the invention by Sawyer, if he had ever made it. In reply to this argument my attention was called to certain assignments, of record in this office, by Sawyer and Man to the Electro Dynamic Light Company, of dates anterior to any of said letters, conveying to said company this invention among others, and it is claimed that even if Sawyer did write the letters, he had no right or power to abandon the invention at that time.

If it be conceded that the letters were written by Sawyer, of which I think there is no doubt, and that they had reference to the invention now in issue, I think it must be held that Sawyer at that time had no right or power to abandon the invention, and therefore, so far as abandonment is concerned, the letters are without force and effect.

On the particular point now under consideration, however, said letters have force. In his letter of December 24, 1879, Sawyer says: "If you care to settle the question of priority of invention upon the horseshoe lamp as between Mr. Edison and myself, you may inspect one of those lamps which broke down at No. 94 Walker street about a year ago, and after many experiments was so far condemned that Mr. Man and I concluded we would not waste enough money on it to pay for a patent." Again he says: "To avoid any question, I placed said abandoned institution in the hands of Messrs. Arnoux & Houchhausen, No. 2 Howard street yesterday (Monday) morning at 9 o'clock." In his letter of January 4, he says: "Notwithstanding the assertion that one of Mr. Edison's electric lamps has been running for 240 hours, I still assert, and am prepared to back up my assertions, that Mr. Edison cannot run one of his lamps up to the light of a single gas jet (to be more definite let us call it twelve candle power) for more than three hours."

His letter of January 6, 1880, does not seem to have any-
3377 thing material in it, except to show that it is one of a series
of letters written by Sawyer about that time.

The quotations above given have a tendency, at least, to show that whatever had been done by Sawyer and Man prior to the time said letters were written in relation to the invention herein claimed, was simply experimental, and that their experiments had fallen short of success. Sawyer not only says that their efforts had proven ineffective, and were considered by both himself and Man as worthless, but that the abandoned institution had been placed in the hands of parties where it could be found. In his second letter he very forcibly denies the truthfulness of statements made as to the operativeness of Mr. Edison's lamps. Notwithstanding these letters were written and published, as above stated, on the 9th of January, 1880, an application, executed by Sawyer and Man, describing and claiming the invention in question, was filed in this office.

In a work published by Mr. Sawyer, and received at this office on March 12th, 1881, Mr. Sawyer says on page 72: "The carbonizing of live willow twigs, with a view to obtaining a suitable bent carbon, by Sawyer and Man, and the carbonizing of paper and bamboo by Edison, substantially close the account of incandescent carbon." On page 78 he says: "The filament originally used by Mr. Edison was prepared by cutting card-board into the desired shape, and carbonizing the same by placing the loops thus formed in layers within an iron box with intervening layers of tissue paper, closing the box to exclude oxygen, and raising the whole to red heat in a furnace."

Taking all of the statements of Mr. Sawyer together without further explanation, I am compelled to reach the conclusion that the experiments made by himself and Man were not successful, and that they did not have the invention completed on December 24, 1879.

The statements contained in his book seem to ascribe this particular invention to Mr. Edison, although the book was published a year after the application of Sawyer and Man was made. 3378

Mr. Edison's application was filed on December 11, 1879, in which the invention is fully described and claimed.

The affidavits filed in support of the motion seem to show clearly that this testimony now sought to be introduced is newly discovered. It is urged on behalf of Sawyer and Man that letters published as these were, should have been known to Mr. Edison, or to others within his employ. It cannot be presumed that persons read all that is contained in each of the daily newspapers published in the city of New York, and when it is expressly denied by those who have charge and management of Mr. Edison's matters that they did have such information, and did know of the publication of these letters until after the testimony regularly taken had been completed, I must conclude that such is the fact.

In view of all these facts disclosed by the affidavits filed, I think that Edison should be permitted to prove, if he can, that Sawyer and Man were not joint inventors, and that what experiments were made by them were mere experiments, and did not show a complete invention.

The decision of the examiner of interferences of January 20, 1882, is set aside and the case reopened and he is directed to fix times for the taking of the testimony referred to in this motion, with suitable time for rebutting testimony on the part of Sawyer and Man.

E. M. MARBLE,
Commissioner.

Ex'd: C. F.
H. M. H.
July 24, 1882.

(Endorsement: U. S. Patent Office; Commissioner's decision; Edison *vs.* Sawyer and Man; July 24, 1882; Recorded vol. 23, fol. 306; 16156; D. 82; 12191; D. 85.)

3379 Copies sent.

Room No. 1.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *July* 31, 1882.

In Re Interference SAWYER AND MAN *v.* EDISON. } Before the Examiner of Interferences.

Electric lamps or lights.

Sawyer and Man, care A. Broadnax, 57 Broadway, N. Y. city; T. A. Edison, care Dyer & Wilber, Washington, D. C.:

Please find below a communication from the examiner in charge of interferences in regard to the above-cited case.

Very respectfully,
E. M. MARBLE,
Commissioner of Patents.

As and for the purpose set forth in the Commissioner's order of the 24th inst., the times for taking testimony in this case are extended as follows:

Edison's testimony-in-chief to close Aug. 20, '82.

Sawyer and Man's testimony in rebuttal to close Sept. 2, '82. Hearing Sept. 22, 1882.

J. B. CHURCH,
Examiner of Interferences.

(Endorsed: 7768; 47; office to Sawyer and Man and Edison; intf.; hearing Sept. 22, 1882; July 31, 1882.)

3380 Copy sent.

Room No. 1.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Aug.* 8, 1882.

In Re Interference SAWYER AND MAN *vs.* EDISON. } Before the Examiner of Interferences.

Electric lamps or lights.

Sawyer and Man, care A. Broadnax, N. Y. city; T. A. Edison, care Rich'd N. Dyer, Menlo Park, N. J.:

Please find below a communication from the examiner in charge of interferences in regard to the above-cited case.

Very respectfully,
E. M. MARBLE,
Commissioner of Patents.

Per stipulation the times for taking testimony in this case are extended as follows:

Edison's testimony-in-chief to close, Oct. 1, '82.
Sawyer and Man's testimony in rebuttal, to close Oct. 31, '82.
Hearing November 20, 1882.

J. B. CHURCH,
Examiner of Interferences.

(Endorsement: 7768; 49; office to Sawyer and Man and Edison; intf. hearing p'p'd to Nov. 20, '82; Aug 8, '82.)

3381 Copy sent.

Room No. 1.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Sept.* 30, 1882.

In Re Interference SAWYER AND MAN vs. EDISON. } Before the Examiner of Interferences.

Electric lamps or lights.

Sawyer and Man, care A. Broadnax, New York city; Thomas A. Edison, care R. N. Dyer, Menlo Park, N. J.:

Please find below a communication from the examiner in charge of interferences in regard to the above-cited case.

Very respectfully,

E. M. MARBLE,
Commissioner of Patents.

Per stipulation the times for taking testimony in this case are extended as follows:

Edison's testimony-in-chief to close Oct. 16, '82.
Sawyer and Man's testimony in rebuttal to close Nov. 15, '82.
Hearing, Dec. 5, 1882.

J. B. CHURCH,
Examiner of Interferences.

(Endorsement: 7768; 51; office to Sawyer and Man and Edison; Hearing p'p'd to Dec. 5, 1882; Sept. 30, 1882.)

3382 Copy sent.

Room No. 1.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Nov.* 28, 1882.

In Re Interference SAWYER AND MAN
v.
EDISON.
} Before the Examiner of Interferences.

Electric lamps and lights.

Sawyer and Man, care Amos Broadnax, N. Y. city; Thos. A. Edison, care R. A. Dyer, Menlo Park, N. J.:

Please find below a communication from the examiner in charge of interferences in regard to the above-cited case.

Very respectfully,
E. M. MARBLE,
Commissioner of Patents.

Per stipulation the times for taking testimony in this case are extended as follows:

Sawyer and Man's testimony in rebuttal to close Dec. 15, 1882.
Hearing January 5, 1883.

J. B. CHURCH, *Examiner.*

(Endorsement: 7768; 53; office to Sawyer and Man *vs.* Edison; hearing p'p'd to Jan. 5, 1883; Nov. 28, 1882.)

3383 Copies sent.

Room No. 1.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Dec.* 17, 1882.

In Re Interference SAWYER AND MAN
v.
EDISON.

Electric lamps and lights.

Sawyer and Man, care Amos Broadnax, New York city; T. A. Edison, 65 Fifth avenue, New York city, care R. N. Dyer:

Please find below a communication from the examiner in charge of interferences in regard to the above-cited case.

Very respectfully,
E. M. MARBLE,
Commissioner of Patents.

Per stipulation the times for taking testimony in this case are extended as follows:

Sawyer and Man's testimony in rebuttal to close Jan. 15, '83.
Hearing Feb. 5, '83.

J. B. CHURCH, *Examiner.*

(Endorsement: 7768; 55; office to Sawyer and Man *v.* Edison; hearing p'p'd to Feb'y 5, 1883. Dec. 17, 1882.)

3384 WASHINGTON, D. C., *Feb.* 5, 1883.

In Re Interference SAWYER AND MAN
vs.
EDISON.

To the Hon. Com'r of Patents:

In the above interference it is stipulated that the dates be extended one month, and the Commissioner is requested so to order.

GEORGE W. DYER,
For Edison.
AMOS BROADNAX,
For Sawyer and Man.

Dated Feb. 5, 1883.

(Endorsement: U. S. Patent Office, Feb. 9, 1883; 7768; 56; Sawyer and Man *v.* Edison; stipulation app'd, J. B. Church, ex., 10-2-'83.)

3385 Copy sent.

Room No. 1.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Feb.* 10, 1883.

In Re Interference SAWYER AND MAN
v.
EDISON.
Before the Examiner of Interferences.

Electric lamps and lights.

Sawyer and Man, care Amos Broadnax, N. Y. city; Thos. A. Edison, care R. N. Dyer, 65 Fifth Ave., N. Y. city:

Please find below a communication from the examiner in charge of interferences in regard to the above-cited case.

Very respectfully,
E. M. MARBLE,
Commissioner of Patents.

Per stipulation the times for taking testimony in this case are extended as follows:

Sawyer and Man's testimony in rebuttal to close Feb. 15, 1883.
Hearing March 5, 1883.

J. B. CHURCH,
Examiner of Interferences.

(Endorsement: 7768; 57; office to Sawyer and Man *vs.* Edison; hearing p'p'd to M'ch 5, 1883; Feb. 10, 1883.)

3386 In the United States Patent Office.

Sawyer and Man
vs.
Thomas A. Edison.

In the above-entitled interference it is consented—the Commissioner of Patents concurring—that the hearing be set down for Friday, the 16th day of March, 1883, and the Commissioner is requested to order accordingly.

AMOS BROADNAX,
For Sawyer and Man.
GEORGE W. DYER,
For Edison.

Dated Feb. 26, 1883.

(Endorsement: 7768; 59; Sawyer and Man *vs.* Edison; stipulation app'd; J. B. Church, 28-2-'83. U. S. Patent Office, Feb. 27, 1883.)

3387 Copies sent.

Department of the Interior,
United States Patent Office,
Washington, D. C., *Feb.* 28, 1883.

In Re Interference Sawyer and Man *vs.* Edison. Before the Examiner of Interferences.

Sawyer and Man, care A. Broadnax, 8 and 10 Pine street, New York city; Thomas A Edison, care Geo. W. Dyer, Washington, D. C.:

Per stipulation the day of hearing is postponed to March 16, 1883.

J. B. CHURCH,
Examiner of Interferences.

(Endorsement: 7768; 60; office to Sawyer and Man and Edison; intf.; hearing p'p'd to March 16, '83; Feb'y 28, 1883.)

3388 In the United States Patent Office.

William E. Sawyer and Albon Man
v.
Thomas A. Edison.

Interference, carbon for electric lights.

Notice of Motion.

To George W. Dyer, Esq., solicitor for Edison.

Sir: Take notice that upon the hearing of this interference, I will move the honorable Commissioner of Patents, or such other officer in the Patent Office as may have cognizance of the same, that the whole of the depositions of Alexander Walsh and Robert White taken in this interference to rebut the testimony on behalf of Edison under the Commissioner's order to open the case, dated July 24, 1882, be received in evidence notwithstanding the fact that some parts of said depositions are objected to upon the grounds that the same is incompetent under the said order of the Commissioner, and tha- upon the hearing of said motion I will use the record in this case and also certain affidavit, copies of which are hereto annexed.

AMOS BROADNAX,
Attorney for Sawyer and Man.

Dated March 6, 1885.

WASHINGTON, D. C., *March* 8, 1883.

Good service.

GEO. W. DYER
For Edison.

3389 In the United States Patent Office.

WILLIAM E. SAWYER and ALBON MAN
vs.
THOMAS E. EDISON.

Interference, carbons for electric lights.

Motion.

To the honorable Commissioner of Patents:

In the above-entitled cause it is moved on behalf of Sawyer and Man that the whole of the depositions of Alexander Walsh and Robert White, taken in this interference to rebut the testimony on behalf of Edison, under the Commissioner's order to open the case, dated July 24, 1882, be received in evidence notwithstanding the fact that some parts of said depositions are objected to upon the ground that the same is incompetent under said order of the Commissioner. In support of the foregoing motion the following affidavit is respectfully submitted.

AMOS BROADNAX,
Att'y for Sawyer and Man.

Dated March 6, 1883.

CITY, COUNTY, AND STATE OF NEW YORK, *ss:*

Amos Broadnax, being duly sworn, says that he is an at-
3390 torney and counsellor-at-law, and as such has conducted the proceedings in the above-entitled interference on behalf of Sawyer and Man, and is familiar with all the facts and circumstances attending the production and taking the testimony on their behalf; that the facts sworn to by said Walsh and White were unknown to deponent at the time of taking the rebutting testimony on behalf of Sawyer and Man; that at the time of taking such testimony both of said witnesses were in the employ of said Edison, and that the testimony and evidence adduced and given by them

was entirely unknown to this deponent, and, as he verily believes, to Sawyer and Man and to those holding under them; that said testimony is newly discovered evidence, and was unknown to deponent and, as he verily believes, was unknown to any of the parties in interest under Sawyer and Man until within a very short time before said depositions were taken; that said depositions were taken on due notice to the adverse parties, and upon cross-examination by counsel; that said depositions are pertinent and material, and, in the judgment of deponent, ought to be received in evidence; that the ends of justice require that said depositions should be considered as part of the evidence in this case in that they rebut fully and fairly important parts of the case on behalf of Edison, as will appear by the depositions themselves and by the record already in.

AMOS BROADNAX.

Sworn to and subscribed before me this 6th day of March, 1883.

[L. S.] J. EDGAR BULL,
Notary Public, New York Co., N. Y.

3391 (Endorsement: Sawyer and Man *v.* Edison. Motion filed by Sawyer and Man. This case having been reopened by the Com'r for a specific purpose, any enlargement or modification of the order should be made by him and not the examiner of interferences. With this understanding the motion is respectfully transmitted to the Com'r. J. B. Church. 16, 3, '83. The testimony of Walsh and White may remain in the case and Edison may have thirty days from notice of this order in which to reply thereto. With this modification the motion is granted. E. M. Marble, Com'r. March 17, 1883. U. S. Patent Office, March 8, 1883.)

3392 DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *March 17th*, 1883.

In Re Interference SAWYER AND MAN *vs.* EDISON. } Before the Examiner of Interferences.

Subject-matter: Electric lamps or lights.

Sawyer and Man, care A. Broadnax, 8 and 10 Pine street, N. Y. city;
T. A. Edison, care Geo. W. Dyer, Washington, D. C.:

In accordance with the decision of the Hon. Commissioner, of even date herewith, Edison is allowed until April 17, 1883, to reply to the testimony of Walsh and White. Hearing May 7, 1883.

J. B. CHURCH,
Ex. of Interferences.

J. C. PERNIE,
2nd Assist. Ex.

266—286

(Endorsed: 7768; 61; office to Sawyer and Man and Edison; intf.; h'g p'p'd to May 7, 1883; March 17, 1883.)

3393 Interference—WILLIAM E. SAWYER and ALBON MAN
vs.
THOMAS A. EDISON.
No. 7768.

Electric lamps or lights.

1880.

Actions.

Statement Oct. 25, 1880.
Sept. 25, '80. Notice of intf. sent.
Oct. 25, '80. Pre. h'g p'p'd to Nov. 10, '80 and p. n.
Nov. 11, '80. Times fixed for taking testimony and p. n.
Hearing Feb. 7, '81.
Nov. 22, '80. Hearing p'p'd to March 2, '81 and p. n.
Nov. 23, '80. Hearing p'p'd to Apr. 4, '81 and p. n.
Dec. 9, '80. Letter to B. H. & P. & Edison.
Feb. 14, '81. M'n granted, appl. waived and p. n.
Feb. 23, '81. Letter to both parties.
M'rch 2, '81. H'g p'p'd to May 10, '81 and p. n.
Apr. 18, '81. H'g p'p'd to June 21, '81 — p. n.
May 20, '81. H'g p'p'd to July 21, '81 and p. n.
June 20, '81. H'g p'p'd to Aug. 22, '81 and p. n.
June 21, '81. H'g of m'n set for June 29 at 10 a. m. and p. n.
June 29, '81. H'g of m'n indefinitely p'p'd and p. n.
Aug. 9, '81. H'g p'p'd to Sept. 21, '81 and p. n.
Sept. 27, '81. H'g p'p'd to Nov. 2, '81 and p. n.
Oct. 21, '81. H'g p'p'd to Dec. 2, '81 and p. n.
Dec. 5, '81. Letter to Sawyer and Man.
Dec. 13, '81. H'g p'p'd to Dec. 24, '81 and p. n.
Jan. 19, '82. M'n gr'nt'd and p. n. L. A. 5 d's.
Jan. 20, '82. Decided in favor of Sawyer and Man and p. n. S. A. 20 days.
3394 Feb. 9, '82. Letter to Sawyer and Man.
July 31, '82. H'g Sept. 22, '82 and p. n.
Aug. 8, '82. H'g p'p'd to Nov. 20, '82 and p. n.
Sept. 30, '82. H'g p'p'd to Dec. 5, '82 and p. n.
Nov. 28, '82. H'g p'p'd to Jan. 5, '83 and p. n.
Dec. 17, '82. H'g p'p'd to Feb. 5, '83 and p. n.
Feb. 10, '83. H'g p'p'd to M'rch 5, '83 and p. n.
Feb. 28, '82. H'g p'p'd to M'rch 16, '83 and p. n.
M'rch 17, '83. H'g p'p'd to May 7, '83 and p. n.
(See Com'r decision.)
June 2, 1883. Dec. in favor of Sawyer and p. n. L. A. 20 days.
Ex'd: H. M. H.
I. M. F.

(Endorsement: 12189; D., '85.)

3395 In Interference—SAWYER AND MAN *vs.* EDISON. } Paper Carbons for Incandescent Electric Lamps.

Present: George W. Dyer, counsel for Edison, and Amos Broadnax, counsel for Sawyer and Man.

Parties met pursuant to agreement, at the office of Amos Broadnax, at No. 10 Pine street, 11th October, 1882.

Counsel for Edison, in behalf of Edison, puts in testimony a book entitled "Electric Lighting by Incandescence," by William Edward Sawyer, published by D. Van Nostrand, of New York, 1881. The same is marked Edison Exhibit "Sawyer Book."

Book objected to by counsel for Sawyer and Man as incompetent, irrelevant and immaterial, and not evidence in any sense.

Counsel for Edison also puts in evidence copy of the New York Herald, of December 24, 1879, and the same is marked Edison Exhibit "Herald, December 24, 1879."

Also copy of the New York Herald of January 5, 1880; the same is marked Edison Exhibit "Herald, January 5, 1880."

Also copy of New York Herald of January 6, 1880; the same is marked Edison Exhibit "Herald, January 6, 1880," 11th October, 1882, J. E. B.

Counsel for Sawyer and Man enters the same objection to the said papers that he entered to said book.

3396 Counsel for Sawyer and Man admits that the book marked Edison Exhibit Sawyer Book was written and published by William E. Sawyer, one of the parties of this interference, at the date set down in said book, and that letters signed W. E. Sawyer, in the New York Herald of December 24, 1979, and January 5 and January 6, 1880, were written and published by William E. Sawyer one of the parties to this interference, at the date shown in said newspapers; but counsel for Sawyer and Man, nevertheless, reserves his right to use all legal objections against the said book and said articles in said newspapers, excepting the fact that the book and said articles in said newspapers were written and published by William E. Sawyer; and counsel for Sawyer and Man reserves especially the right to show that William E. Sawyer is not now and never has been a party in interest to this interference; and that at the time he wrote the letters in the newspapers put in evidence he did not own the whole or any part of the invention in controversy excepting as a mere stockholder in the Electro-Dynamic Light, Company; and that at the time he wrote the book in question he had no interest whatever in the inventions; that he was openly hostile to the owners of said inventions, patents and the other patents granted to said Sawyer and Man; that one of his avowed purposes in writing said book was to destroy and injure the patents and inventions theretofore made and obtained by William E. Sawyer and Alban Man, both jointly and severally, meaning so many of them as were then owned by the Electro-Dynamic Light Company, and that the statements in said books in many particulars are false and

malicious. And counsel for Sawyer and Man gives notice to counsel for Edison that as he understands the decision of the Commissioner, he may put in rebutting testimony, not only to the book and the newspaper articles, but also to the testimony-in-chief put in on behalf of Mr. Edison, and that if the counsel for Mr. Edi-
3397 son has a different understanding of the Commissioner's decision, then he gives notice that he will move the Commissioner immediately, or as soon as he can prepare the necessary papers for leave to put in such testimony and request counsel for Edison to state upon the record whether he agrees with counsel for Sawyer and Man as to his right to put in such rebutting testimony under the decision of the Commissioner in opening his decision.

Counsel for Edison accepts the notice above given, and states that he does not know what construction will be given to the order of the Commissioner in reopening the case.

Counsel for Edison further gives notice that he here closes his testimony.

[SEAL]

J. EDGAR BULL,
Notary Public, N. Y. Co., N. Y.

(Endorsement: U. S. Patent Office, March 16, 1883. Ex'd: J. A. M., M. McK.)

3398 United States Patent Office.

SAWYER AND MAN
vs.
EDISON.
In Interference. Paper Carbons for Incandescent Electric Lamps.

Present: George W. Dyer, counsel of Edison, and Amos Broadnax, counsel for Sawyer and Man.

Parties met pursuant to agreement, at the office of Amos Broadnax, No. 10 Pine street, New York, November 9, 1882.

ALEXANDER WELSH, a witness produced on behalf of Sawyer and Man, being duly sworn, in answer to interrogatories propounded by AMOS BROADNAX, testified as follows:

1 Q. What is your name, age, residence, and occupation?

A. My name is Alexander Welsh; I am twenty-six years of age; I reside in Jersey City, New Jersey; am carbonizer and experimenter; my street address is No. 93 Manderville avenue.

2 Q. You say that your occupation is that of a carbonizer; do you mean by that that you are engaged in carbonizing or making carbons to be used in electric lighting?

A. I do.

3 Q. What kind of electric lighting—arc lighting or incandescent lighting?

A. Incandescent.

4 Q. Where are you at present employed?

A. By the Consolidated Electric Light Company, at the corner of Front and Adams streets, Brooklyn, New York.

5 Q. How long have you been employed by the Consoli-
3399 dated Electric Light Company, and its predecessor, the
American Electric Light Company, if you were employed at
all by the American Electric Light Company?

A. I was employed by the Consolidated, and its predecessor, the American Electric Light Company, from the middle of March last (*i. e.*, 1882).

6 Q. Previous to your employment by the Consolidated Electric Light Company, were you employed by the American Electric Light Company, as carbonizer?

A. Yes.

7 Q. Previous to your employment by the American Electric Light —, where and by whom were you employed?

A. By the Edison Lamp Company, at Menlo Park.

8 Q. When did you go into the employ of the Edison Electric Lamp Company, at Menlo Park?

A. To the best of my recollection it was about October, 1879.

9 Q. Are you acquainted with Thomas A. Edison, one of the parties to the interference?

A. Yes.

10 Q. What were you employed to do, and what, in fact, did you do, when you commenced your employment with the Edison Lamp Company, at Menlo Park?

A. I set or fastened carbons to the electrodes; measured resistances of carbon; got up lamps for patenting purpose—that is "model lamps," and assisted in experimental work in connection with the incandescent system.

11 Q. What, if anything, did you have to do with making of the carbon for incandescent lighting when you went in the employ of the Edison Light Company?

A. I had nothing to do at first with making of carbons; but handled all the carbons that were then made; and some time afterward was given full charge of the carbonizing.

3400 12 Q. How long had you been in the employ of the Edi-
son Lamp Company before you began to assist in making
the carbons?

A. From three to four months.

13 Q. How long did you remain in the employ of the Edison Lamp Company?

A. Till the 1st of February, 1882.

14 Q. State, if you know, whether or not at the time you went in the employ of the Edison Lamp Company they were making carbons for incandescent lighting, of paper?

A. They were.

15 Q. State, if you know, how long they had been making such carbons of paper at the time you went there.

Question objected to by counsel for Edison as involving matters *for* which the witness could have had no personal knowledge; and for the further reason that it calls for evidence not rebutting in its character, and not authorized by the decision of the Commissioner in reopening this interference. Question withdrawn.

16 Q. State whether or not, at the time you went in the employ of the Edison Lamp Company Mr. Edison and the employees of that company were engaged in experimenting with carbons made of paper for incandescent electric lighting.

Question objected to on the ground that it calls for evidence not rebutting in its character, and not authorized by the decision of the Commissioner in reopening this interference.

Counsel for Sawyer and Man responds, that, according to his understanding of the Commissioner's decision, he has the right to rebut now any of the testimony put in on behalf of Edison, 3401 and that at the proper time, and upon proper notice; he will move the Commissioner for leave to read any testimony he may now put in to rebut any testimony heretofore put in on behalf of Edison.

A. They were.

17 Q. State, if you know, what kind of paper they were experimenting with.

Same objection.

A. Blotting paper, bristol or card board, tissue paper, parchmentized paper, bank-note paper and various other kinds of paper, the names of which I do not now remember.

18 Q. State whether or not they succeeded in making carbons of blotting paper and used them in their lamps successfully for incandescent electric lighting.

Same objection.

A. Blotting paper was carbonized successfully and was used in quite a number of lamps.

19 Q. When was that?

Same objection.

A. Blotting paper was used in a number of experiments at various times as late as the summer of 1881.

20 Q. State, if you know, when it was that blotting paper was first used by Mr. Edison for incandescent electric lighting.

Same objection.

A. To the best of my recollection, somewhere about the latter part of 1878; I could not say positively that it was blotting paper. My information comes in this way, it comes from lamps that were there and said to have carbons made of blotting paper, with dates on the lamps.

21 Q Do you know, of your own knowledge, whether those lamps had paper carbons in them or not?

Same objection.

3402 A. I do not.

22 Q. State when, of your own knowledge, you first knew

blotting paper to be used by Mr. Edison and his employees for making carbons for incandescent electric lighting.

Same objection.

A. Winter of 1879–'80.

23 Q. State when, of your own knowledge, you first knew of Mr. Edison and his employees using paper to make carbons for incandescent electric lighting.

Same objection.

A. Winter of 1879–'80.

24 Q. State, if you know, to what extent blotting paper was used by Edison and his employees to make carbons of for incandescent electric lighting, and to what extent the carbons were used in the lamps.

Same objection.

A. A large number of carbons were made from very thin blotting paper together with some other kinds of paper, carbonized and used as incandescent conductors in his lamp. A large number of the carbonized blotting paper loops were sealed in lamps and placed in circuit about Menlo Park.

25 Q. Did you carbonize any of these loops yourself and place them in the lamps?

Same objection.

A. I did.

26 Q. Many of them?

Same objection.

A. I should say a hundred or more.

27 Q. State, if you know, whether these carbons were illuminated to incandescence in these lamps.

Same objection.

3403 A. They were.

28 Q. State, if you know, for how long a time these loops were kept at a state of incandescence.

Same objection.

A. I have known the loops to the lamps to be burned in the photometer room at what was supposed to be forty-eight candle power for many days; and also many of the lamps containing these carbons were burnt outside, in and around the buildings of the park, for a long time.

29 Q. Did you remain continually in the employ of the Edison Lamp Company at Menlo Park from October, 1879, until the time you left there in February, 1882?

A. I did.

30 Q. State, if you recollect, of making any specimens of paper carbon in narrow strips in the early part of July, 1881?

Same objection.

A. I do recollect it.

31 Q. State, if you recollect, what paper you used in making those carbons.

Same objection.

A. Blotting paper, bristol and card board, tissue paper; there may have been others, but I don't recollect.

32 Q. Upon whose request or direction did you make those specimens?

Same objection.

A. Made at the request of Mr. Charles Batchelor, by note delivered to me by Mr. Atchison.

33 Q. Have you got that note?

Same objection.

3404 A. I have not.

34 Q. State as near as you can when you made those specimens of carbon?

Same objection.

A. They were made in the early part of July, and shortly before the taking of testimony in this case, as I know from the fact that Mr. Batchelor told me personally that the strips so carbonized were to be used as exhibits in this case.

Counsel for Edison objects to so much of the preceding answer as relates to witness' conversation with Mr. Batchelor, on the ground of being hearsay evidence.

35 Q. Referring now to the specimens of carbon made of blotting paper, please to describe exactly how those carbons were made.

Same objection.

A. The pieces of blotting paper were placed upright in an iron mould, the dimensions of which were about four inches high, four or five inches long, and about an inch and a half or two inches in width; the spaces between the sheets of paper, and also between the sheets of paper and the sides of the mould, were filled with powdered charcoal; the base of the mould, which, in this case, was used as a cover, was then luted around the edge with pipe clay, and then pressed down on the opening of the iron mould; it was then placed in the fire-pot of the steam boiler and allowed to remain until it reached a red heat, which was about a half hour's time; it was then taken out, placed on an iron table, cold water was then thrown on the mould, and in a few minutes the cover removed; the contents being red at the time of removal, the air coming in contact with the heated material caused it to oxydize, and the paper carbons were thereby injured.

3405 36 Q. During the carbonization of the paper in this box, was there any pressure upon the carbon, either by the lid of the box, or anything put in the box for that purpose?

Same objection.

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TRANSCRIPT OF RECORD.

SUPREME COURT OF THE UNITED STATES.

OCTOBER TERM, [illegible]

No. [illegible]

THE CONSOLIDATED ELECTRIC LIGHT COMPANY,
APPELLANT,

vs.

THE McKEESPORT LIGHT COMPANY.

APPEAL FROM THE CIRCUIT COURT OF THE UNITED STATES FOR
THE WESTERN DISTRICT OF PENNSYLVANIA.

FILED OCTOBER 17, [illegible]

(14,326.)

A. No pressure other than the pressure of the charcoal.

37 Q. Of what quality were these carbons after they were taken out of the box?

Same objection.

A. About as poor as could be.

38 —. Why were they such poor carbons? I mean what was the cause of the carbons being so poor?

Same objection.

A. Imperfect carbonization and oxydization.

39 Q. How should they have been treated to obtain a good carbonization, or as good as could have been obtained in that box?

Same objection.

A. They should have been held down by weights both upon and between the layers of blotting paper; then the box carefully filled with charcoal; the base or cover fastened securely with good luting; then placed in the furnace with scarcely any perceptible heat at first, and kept there for about four hours under slowly increasing heat. After removal from the furnace the mould should be allowed to cool naturally in the open air until the mould became perfectly cold, and the contents then removed.

40 Q. Please to state why you did not treat the blotting paper in the manner last described by you, so as to obtain the best results you could under the circumstances?

Same objection.

3406 A. I was directed by Mr. Batchelor to turn the carbons out in the shape and manner first described, as they would be used as exhibits in this cause, and he was not particular, as the points he desired to prove could be easily proven by such specimens.

41 Q. Why did he throw water on the hot box instead of allowing it to cool gradually in the air?

Same objection.

A. He did that in order that Mr. Batchelor might get the carbonized blotting paper that morning in order to take it into New York.

42 Q. Why could he not wait until the box cooled without throwing water on it?

Same objection.

A. Because he was anxious to take the specimen into New York by the 8-o'clock train, to use them as exhibits in this case, and as quarter before 8 the box was taken from the fire-pot, under the steam boiler, it was necessary, in order to cool it in time, to pour water on it.

43 Q. In your opinion, did the pouring of water on the box, and opening the box before it had time to cool, injure the carbons and render them of even poorer quality than they would have been had the box been allowed to cool gradually without the water?

Same objection.

A. Yes.

44 Q. Were all the specimens of carbon that you made at that time for Mr. Batchelor made by treating the paper in the same way the blotting paper was treated?

Same objection.

A. There was a slight difference in the treatment.

45 Q. How was the other paper treated, of which the other specimens were made?

Same objection.

3407 A. The other papers were placed in an iron box the same kind as before described, in the same manner as before described, with the exception of the tissue paper, which was laid between carbon in plate form, and nickel plates, and then filled in and around with charcoal. They were then placed in the furnace, and allowed to remain from a half an hour to an hour, or until they reached a dull-red heat; they were then taken out, placed on a table, allowed to remain until they became quite cool; they were then taken out.

The card-board was placed in the moulds before described, some in layers with the spaces filled with charcoal, and in other instances the card-board was fastened together, a number of layers by means of mucilage, glue, and paste made of flour and water. These were in like manner placed in moulds, and the powdered charcoal only put around them.

46 Q. Referring to the carbon made of the card-board and the tissue paper, were they also heated in the furnace of the boiler?

Same objection.

A. They were not.

47 Q. In what kind of a furnace were they heated, and to what degree of heat, and during what time were they subjected to the heat?

Same objection.

A. They were heated in a revibratory furnace, which was especially for carbonizing, and were allowed to remain there from half an hour to an hour; were only dull red in color, and must have been at a very low degree of heat. After being taken from the furnace, they were allowed to remain there until they became quite cool, so you could bear your hands on them easily. They were so cool that there was no chance of their oxydizing.

3408 & 3409 48 Q. Were the boxes cooled by throwing water on them, or were they allowed to cool by mere radiation in the atmosphere?

Same objection.

A. No water was thrown on the boxes. They were allowed to cool by radiation in the atmosphere, and were about two hours in cooling.

49 Q. Referring now to the tissue-paper carbon and the cardboard carbon, what condition were they in when taken out of the box; I mean of what quality was the carbon?

Same objection.

A. The carbon was poor, but only owing to the fact of incomplete carbonization.

50 Q. Referring now to the carbon specimens of carbon made of blotting paper, what was done with them after they were taken out of the box?

Same objection.

A. The carbons made of blotting paper showed signs of oxidation, or, in other words, were white in places where they had been burnt, and also were wet in places. The white portions were cut off or scraped off. They were then placed in a box and sent immediately to the station where Mr. Batchelor was then waiting. That's the last I saw of them.

51 Q. Of what shape was the box in which they were placed?

Same objection.

A. To the best of my recollection it was a brown-paper box about four inches square and three inches in height, which had formerly contained some hardware, I think door knobs.

52 Q. Were all the specimens of carbon put in that box?

Same objection.

3410 A. Only the specimens of blotting paper.

53 Q. How many specimens were there of blotting-paper carbon?

Same objection.

A. I think about eight in number.

54 Q. Please to give the size of the specimens as near as you can recollect.

Same objection.

A. They were of various thicknesses; of from extremely thin to paper about one-sixteenth of an inch in thickness; some of the pieces were in strips of from three to four inches in length, one-half inch to one inch in width; and other pieces were in squares of from three to four inches; some of the paper was very nearly one-eighth of an inch in thickness.

55 Q. When you made these specimens of carbon from blotting paper was Mr. Charles Batchelor present?

Same objection.

A. He was not.

56 Q. Who was present?

Same objection.

A. A young man by the name of Robert White, who fired for me at that time, and myself were the only ones present.

57 Q. Is that true as to all the specimens you made at that time?

Same objection.

A. Yes, sir.

58 Q. During the time you were in the employ of the Edison Electric Lamp Company did you make any other specimens of carbon to be used as exhibits in any case?

Same objection.

3411 A. I did not.

59 Q. How long after you went in the employ of that company was it before you had charge of the carbonizing department?

Same objection.

A. About three to four months.

60 Q. How much of your time since that has been given to the carbonization of different materials for incandescent electric lighting?

Same objection.

A. My whole time.

61 Q. Is there any difficulty in making a good practical illuminating carbon conductor for incandescent electric lighting, of blotting paper?

Same objection.

A. There is not.

Direct examination closed.

Counsel for Edison, not waiving any of his rights of objection, or waiving the objections heretofore made, proceeds to the cross-examination of this witness.

62 X Q. At what time of the day or night was it when you began to make these specimens you have just testified about?

A. The specimens of bristol or card board, tissue paper, either in sheets or fastened together by the materials named, were made in the afternoon and evening of the day or two before the blotting paper was made; the blotting paper was made in the morning; was put in the fire-pot of the steam boiler about 7.15, or somewhere about that time; was taken out about a quarter to eight.

63 X Q. Was Mr. Charles Batchelor present when the specimen from card or bristol board or tissue paper were made?

3412 A. He was not.

64 X Q. Then, as I understand, he was not present at any time during the making of any of these specimens, is that so?

A. It is.

65 X Q. Did you have any conference with him as to the way in which the specimens were to be made?

A. I had no conference with him in regard to the manner in which the specimens were to *made be,* except such directions as were given me in the note delivered me by Mr. Atchison; and the fact of his telling me that he was not particular about them.

66 X Q. When and where did he tell you that.

A. In the office of the lamp factory on the night previous to the carbonization of the blotting paper.

67 X Q. Was any one else present?

A. No, sir.

68 X Q. Have you read the testimony of Charles Batchelor about these exhibits?

A. No, sir.

69 X Q. Or heard it read?

A. No, sir.

70 X Q. Has not th*a* substance of it been stated to you?

A. No, sir.

71 X Q. Did you write or send any message to Mr. Batchelor after these specimens were made?

A. I sent no message to Mr. Batchelor, except an inquiry upon receipt of the note from him, through Mr. Atchison, as to what kind of carbons he wanted.

72 X Q. By whom did you send that inquiry or message?

A. I'm not positive; but my recollection is it was one of the young men in my department.

73 X Q. What were the names of these young men?

A. I don't recollect. There were so many changes that I don't recollect who were in there at that time.

74 X Q. Do you remember the names of any of them?

3413 A. One was a young man by the name of Orion Fords; another. Harry Slate; another man about forty years of age, named Brennan; another by the name of Robert White. There may have been some others; but I am not positive of any others.

75 X Q. Where is Robert White now?

A. I don't know where he is now.

76 X Q. Where was he the last you heard from him?

A. I saw him some time ago, and then understood he was going to work for the Steam Heating Company.

77 X Q. Did you have any directions from Mr. Batchelor to use water to cool off the carbonizing box about which you testified?

A. I did not.

78 X Q. Did you have any directions from Mr. Batchelor about the length of time the mould should be in the fire-pot of the steam boiler?

A. I did not.

79 X Q. Or about the length of time the mould should be in the furnace?

A. I did.

80 X Q. Did you understand that you made the specimens of bristol card-board and tissue paper substantially in accordance with Mr. Batchelor's instructions?

A. I did.

81 X Q. When and where was it that Mr. Batchelor told you that these specimens were to be used as exhibits?

A. In the office of the lamp factory, on the night previous to the carbonization of the blotting paper.

82 X Q. Was that your first knowledge that they were to be so used?

A. No, sir.

83 X Q. How did you get the first information of that fact?

A. To the best of my recollection, it was through Mr. Atchison, the bearer of the note to me.

84 X Q. Was this when he brought the note?

3414 A. It was.

85 X Q. Why didn't you make the blotting-paper specimens at the time you made the others, or immediately after?

A. Because they weren't ready.

86 X Q. What was needed to be done to make them ready?

A. The blotting paper was left by mistake at the laboratory, and they neglected to send it down until the last moment.

87 X Q. Why couldn't you have sent for it?

A. In the first place I wasn't anxious to do the work, because it was to be done so poorly, and also because Mr. Atchison told me that it would be brought down.

88 X Q. Do you know where Mr. Atchison is now?

A. He is in Europe somewhere; I couldn't say where.

89 X Q. Do you know where Mr. Batchelor is now?

A. Mr. Batchelor is in Europe.

90 X Q. Did you understand at the time that these exhibits were to illustrate methods of carbonization previously employed by Sawyer and Man?

A. I do not know about that. No; I did not understand that they were to be used for that purpose.

Examination adjourned until 10 o'clock, a. m., November 10, 1882.

NOVEMBER 10, 1882.

Cross-examination of Mr. WELSH continued:

Witness wishes to correct his answers to the 88th and 89th X Q's by the statement that he does not know positively that Messrs. Batchelor and Atchison are now in Europe, but that he had heard that they are.

Witness continues his answer to X Q. 90, as follows:

3415 I did not understand that those carbon specimens were intended to represent the Sawyer-Man method, but were intended to prove that the Sawyer-Man method was impractical.

91 X Q. Did you hear Robert White testify in this cause to-day?

A. I did.

92 X Q. Did his statement agree with your recollection of the transaction?

A. Except in some few particulars it did, one was with reference to the time when the carbons were placed in the fire pot of the steam-boiler furnace; and another, as to whether Mr. Francis Upton was present at the time the blotting paper was prepared.

93 X Q. At what time did you commence work in the morning in July, 1881, at Menlo Park?

A. About 7 a. m.

84 X Q. Was the boiler making steam at that hour?

A. I think it was.

95 X Q. Have you any independent recollection of the time consumed in the carbon blotting-paper experiment or specimens, independent of the time of commencing work at 7 o'clock, and the train leaving at 8?

A. I haven't exactly an independent recollection of that, but I can say positively that not more than one hour was consumed in placing the papers in the box, carbonizing them, and taking them out.

96 X Q. What was your business or occupation before you commenced at Menlo Park?

A. The export commission business.

97 X Q. Where was that business carried on, and for how long a time?

A. Carried at No. 10 Murray street, New York city, and I think up to about August, 1879.

98 X Q. Beginning at that date?

A. I was in the business about three years.

99 X Q. After you had charge of carbonizing at Menlo Park, did you continue in such charge the remainder of the time you were there?

3416 A. I did.

100 X Q. Why did you leave at all?

A. I left on account of difficulties with Mr. Upton.

101 X Q. Did he discharge you?

A. He did not.

102 X Q. You left voluntarily, did you?

A. I was suspended until such time as we should reach East Newark, and immediately came to New York and went into the employ of the isolated department of the Edison Company.

103 X Q. How long were you in their employ?

A. Until the middle of March, 1882.

104 X Q. Why did you leave their employ?

A. Because I was dissatisfied with the employment and treatment, and felt assured of doing better elsewhere.

105 X Q. What was the nature of your difficulty with Mr. Upton?

A. Because he made promises which he failed to fulfill, which led, in consequence, to a very bad feeling between us.

106 X Q. Didn't he complain to you that you were incompetent and untruthful?

A. He did not.

Redirect examination of witness:

107 R. D. Q. Did you go to Robert White's house to see him, or did you send him a note stating that you wanted to see him?

A. I went to his house to see him.

108 R. D. Q. Did you see him?

A. I did.

109 R. D. Q. When?

A. Last night about 6 p. m.

110 R. D. Q. But previous to that when did you last see him?

3417 A. I think it was about two months ago—maybe longer.

111 R. D. Q. When did you first learn that Mr. Atchison and Mr. Batchelor were in Europe?

A. They left the Park for Europe while I was there and I knew of letters being received by parties in the Park from them.

112 R. D. Q. That does not prove that they are in Europe now. How do you know they are in Europe now?

A. I only know from the fact that I was told so by some gentlemen at 65 Fifth avenue, about a month or so ago.

113 R. D. Q. Is that the last information you have as to their whereabouts?

A. It is.

114 R. D. Q. You say in answer to 102 X Q., that you were "suspended until such time as we should reach East Newark;" what do you mean by that? Where were you when Mr. Upton suspended you, if Mr. Upton did suspend you?

A. I was at Menlo Park, and was informed by Mr. Upton that a line of experiments were to be carried on previous to the removal to East Newark, and that they were not going to run regularly for the time; he said that they would not need me until they got down to East Newark.

115 R. D. Q. And was it for that reason that you were suspended?

A. That was the only reason given me by Mr. Upton or any one else.

116 R. D. Q. Have you since been solicited to return to the employ of Mr. Edison?

A. I have.

117 R. D. Q. By whom?

A. By Mr. Upton, at No. 65 Fifth avenue, N. Y., in the month, I think, of March, 1882, and since that time have had some talk about returning to the Edison Company, but nothing definitely settled upon.

3418 118 R. D. Q. With whom did you have this last-mentioned talk?

A. I think with Mr. Vail, at 65 Fifth avenue, N. Y., and some other of the gentlemen whose names I don't remember; and also with Mr. Mackinsey, at the Pearl-street station of the Edison Company about a month ago.

Cross-examination :

119 X Q. What Mr. Vail was that?

A. Superintendent of the isolated department.

120 X Q. What Mackinsey was it?

A. I don't know his first name, but saw him at Menlo Park, where he was engaged to do experimental work, as I understood, and whom I believe, was considered a great friend of Mr. Edison.

121 X Q. What did Mackinsey do at the Pearl-street station?

A. I don't know.

122 X Q. Is he a middle-age man?

A. I should say he was about forty, or a little over.

123 X Q. What kind of a looking man?

A. Large man, with full beard.

ALEX. WELSH.

Subscribed and sworn to before me, this 10th day of November, 1882.

J. EDGAR BULL,
Notary Public, N. Y. Co., N. Y.

3419 *Second Deposition.*

Parties met pursuant to adjournment.

Present: Counsel as before.

Alexander Welsh, a witness recalled on behalf of Sawyer and Man, in answer to interrogatories propounded by Mr. Broadnax, testified as follows:

1 Q. State, if you please, whether you have been sworn and testified in this case before.

A. I have.

2 Q. State whether or not since you gave your testimony in this case before, you have made any carbons of paper.

A. I have.

3 Q. Please to state what kind of paper you used to make such carbons of.

A. Ordinary blotting paper.

4 Q. Please to produce any samples of the blotting paper you may have, of which you made such carbons.

A. I here hand you a piece of blotting paper such as I used in making such carbons.

Sample of blotting paper produced by witness offered in evidence and marked Welsh's Exhibit Blotting Paper.

Objected to as being new testimony, not contemplated or covered by the decision of the commissioner in reopening this interference.

5 Q. Please to state how many specimens of carbon you made of blotting paper since your last examination, and please to produce your first specimens, or lot of specimens, you have made.

Same objection.

A. I don't know the exact number of specimens,
3420 & 3421 but I have here a number of specimens made of the
first lot, some of which are in single sheets or pieces,
and in other cases, where several sheets were fastened together by mucilage, glue, and in one instance, where two sheets of paper are carbonized together by merely laying one on the other.

Same objection.

6 Q. Do you mean by your last answer that, in some cases, you stuck two or more thicknesses of blotting paper together with mucilage or glue, and carbonized them in that way?

Same objection.

A. I do.

7 Q. And in some instances you carbonized the paper of single thickness?

Same objection.

A. I did.

8 Q. Please to state when you made these specimens of carbon.

Same objection.

A. The first lot were made on the 14th of this month, on Tuesday.

9 Q. Please to produce the specimens of carbon made by you on that occasion.

Same objection.

A. I now do. I produce first the specimens made of single thickness of blotting paper.

Specimens offered in evidence, marked "Welsh's Exhibit First Lot of Blotting-paper Carbon, single thickness."

3422 I next produce two specimens of blotting-paper carbon of
two thicknesses of blotting paper. These were carbonized
by merely laying one sheet upon the other.

Specimen offered in evidence, and marked "Welsh's Exhibit Blotting-paper Carbon, two thicknesses, first lot."

I next produce one specimen of carbon of four thicknesses of blotting paper stuck together by mucilage, then pressed in a vise and carbonized.

Specimen offered in evidence, and marked "Welsh's Exhibit Blotting-paper Carbon, four thicknesses, first lot, mucilage."

I next produce one specimen of carbon of four thicknesses of blotting paper stuck together with glue, pressed in a vise and carbonized.

Specimen offered in evidence, and marked "Welsh's Exhibit Blotting-paper Carbon, four thicknesses, first lot, glue."

Same objection.

10 Q. Please to state whether you carbonized all of these several specimens at one time.

Same objection.

A. I did.

11 Q. Please to describe exactly how you carbonized them.

Same objection.

A. I first took the iron box which I now produce and poured in charcoal to the depth of about one-half inch, and pressed it down with a piece of wood with another small piece fastened crosswise on the end. I then placed some sheets of blotting paper on the charcoal, then sprinkled charcoal on the blotting paper, and
3423 pressed it down gently with a piece of wood, then placed in more paper and charcoal until the box was filled, all being pressed down with a stick or piece of wood. I then took the lid or cover to the box and fastened it to the box by a clay luting. I then placed the box in a blacksmith's portable forge and kept it there about an hour, bringing the box to a cherry-red heat. I then took the box from the fire and allowed it to cool before taking the contents out. I took the contents out and brought them over here within a day or so afterwards and gave them to you.

The iron box produced by the witness as having been used by the witness in making the carbon offered in evidence and marked "Welsh's Exhibit First Iron Box."

12 Q. Please to state whether you subsequently made a second lot of blotting-paper carbons, and if so, when you made them.

Same objection as before.

A. I did, on the 17th inst.

13 Q. Please to produce, if you can, any specimens of blotting paper of which you made the second lot of carbon.

Same objection.

A. I can't produce a specimen of blotting paper the same as was used in making the second lot of carbons, but the blotting paper was exactly the same as has been already offered in evidence accompanying first lot.

14 Q. Please to produce such specimens of carbon as you may have of the second lot.

Same objection.

A. I first produce twelve carbon loops or horseshoes made from blotting paper, also several sheets of blotting-paper carbon, and some pieces of blotting-paper carbon made at two different
3424 times on the 17th, and carbonized in the same manner and same box as the first lot was carbonized.

Specimens of carbon produced by the witness*es* offered in evidence and marked "Welsh's Exhibit Horseshoe Carbons and Strips and Sheets, second lot."

15 Q. State, if you please, whether you have put any of these specimens of carbon in an electric circuit and passed the current through them.

Same objection.

A. I have.

16 Q. With what result?

Same objection.

A. I merely placed the carbons in a circuit with a Leclanche battery, to see whether I could get the current through them, and to determine the resistance of some of the specimens.

17 Q. What did you find the resistance or conductivity of the carbons to be?

Same objection.

A. The resistance was about sixty ohms of the pieces I tested, and the conductivity was good.

18 Q. Are the pieces you tested among the exhibits you have produced?

Same objection.

A. They are.

19 Q. Can you designate them from among the specimens?

Same objection.

A. One of them was one of the horseshoe loops and the others were some of the narrowest strips of lot two; I couldn't pick them out any better than that.

3425 20 Q. State whether or not you tested any of these carbons in an incandescent electric lamp.

Same objection.

A. I have not.

21 Q. Why did you not put some of them in the lamps and test them?

A. I would have done so, but I had no facility for doing so.

22 Q. Do you mean by your last answer that you have no lamps and no means of making and exhausting any?

Same objection.

A. I do.

23 Q. State whether, in your opinion, suitable carbons for incandescent electric lamps could be made of the specimens of carbon you have produced.

Same objection.

A. Very good carbons could be made from the specimens produced, and used as incandescent conductors in lamps.

Not waiving any objections heretofore made, counsel for Edison cross-examines as follows:

24 X Q. I wish you would describe a little further about this second lot of blotting-paper carbon, what the manipulation was previous to carbonization.

A. The papers were cut in shapes, the horseshoes being cut from blotting paper by means of a knife and chisel, and the other pieces were cut in squares and strips with a scissors. The paper was not compressed or in any way treated before being placed in the box.

25 X Q. Then I understand that each of these specimens of the second lot was made from a single thickness of blotting paper, is that so?

3426 A. It is.

26 X Q. When you put some of these carbons in an electric circuit, how long did they remain in the electric circuit?

A. To the best of my recollection, about two minutes.

27 X Q. How many of them did you put in an electric circuit altogether?

A. About three or four.

28 X Q. How did you determine the resistance?

A. By a galvanometer.

29 X Q. What was this resistance measured upon, the single loop or the strips of carbon?

A. To the best of my recollection, it was on the strips.

30 X Q. Have you preserved and produced all the specimens that were the result of your carbonization on the 14th and 17th of November?

A. I have.

31 X Q. Did you prepare these specimens with your best skill?

A. No, sir; I did not.

32 X Q. Why not?

A. Because they were only intended to illustrate the Sawyer method.

33 X Q. My question was not whether these were the best specimens you could have made in any way, but whether they were the best specimens you could make in the way you did, with your best skill?

A. With the facilities that I had, they were about as good as I could make them. I could have made the carbons more dense, stronger and straighter, with a different method of heating.

34 X Q. In making these carbons in the way you did, did you use the skill you had acquired while in the employment of the Edison Lamp Company?

Question objected to as immaterial, and for the further reason that the witness was directed to carbonize paper after the 3427 method described by Albon Man in his testimony in this case, as near as he could and as near as his facilities would permit. And that his testimony shows that he did so.

A. Yes.

35 X Q. Is the Exhibit First Iron Box in the same condition now that it was when you used it in the carbonization of the specimens you have produced to-day?

A. It was not in the same condition when I carbonized the first lot.

36 X Q. When did its condition become changed?

A. During the carbonization of the second lot.

37 X Q. What happened to it then?

A. The fire being very hot at the bottom, it setting at the same time on a wrought-iron stand, it melted and stuck together, and we were obliged to pull them apart.

38 X Q. In preparing this box for carbonization, did you lute the cover on with great care and with your best skill?

A. Yes, sir; I observed care in putting it on.

39 X Q. Is not such care and skill in this particular essential?

A. It is not.

40 X Q. Why then the need of any luting at all?

A. I put it on merely in case of accident to the box, such as tipping over, to hold the cover in its place and to keep the cover on.

Redirect by Mr. Broadnax:

41 R. D. Q. Was it necessary in making these specimens of carbon that the cover on the box should be luted at all, or that the box should be made air tight?

3428 A. Not necessarily, only sufficiently so to keep the charcoal in. When the box is left open the draught draws the charcoal out and exposes the contents to the air.

ALEX. WELSH.

Sworn to before me this 23rd day of November, 1882.

J. EDGAR BULL,
Notary Public, N. Y. Co., N. Y.

3429 Albon Man, a witness produced in behalf of himself and Sawyer, being duly sworn, in answer to interrogatories propounded by Mr. Broadnax, testified as follows:

1 Q. What is your name, age, residence, and occupation?

A. My name is Albon Man; am fifty-six years of age; I reside at 118 Putnam avenue, Brooklyn, New York; am a counsellor-at-law; my principal business is the management of trust estates; I have charge of large numbers of very large estates, known as the Lorillard estates, in the city of New York.

2 Q. State, if you please, whether you are the same Albon Man who has heretofore testified in this interference.

A. I am.

3 Q. Please state whether you are well acquainted with William E. Sawyer, and state, if you please, what has been Mr. Sawyer's relation to you since the fall of 1879, and towards the Electro-Dynamic Light Company, and the patents and inventions of Sawyer and Man owned by that company. Please confine your answer to the time embraced between the fall of 1879 and April, 1881.

A. I am well acquainted with Mr. Sawyer; Mr. Sawyer's attitude towards myself, personally, with rare exceptions, when he came to me for personal favors, has been one of hostility; not so much as to my individuality, but more particularly to the interest which I held and represented during that period. Towards the Electro-Dynamic Light Company, and the patents and inventions referred to, his attitude was continually hostile during that period.

4 Q. Please to state the facts and circumstances that brought about this hostility, and also the manifestations and acts of hostility of Mr. Sawyer pertaining to the patents and inventions in question.

A. I was a large stockholder of the Electro-Dynamic Light Company, and by my own stock and that of my friends, held the
3430 controlling interest in that company; I was vice president of
the company and was acting president most of the time, and I think, chairman of its executive committee. In the fall of 1879 Mr. Sawyer was anxious to obtain a license to use the patents and inventions belonging to the Electro-Dynamic Light Company; I met him at his office, I should say the last of November or first of December, at the corner of Courtlandt alley and Walker street, in the city of New York, in reference to that subject-matter; he, Mr. William E. Church and myself were the only persons present; he requested me to have the Electro-Dynamic Light Company give him the license which he desired, and offered to pay for it, if the company would give it, a royalty that should be satisfactory to the company; he specified the amount and terms, but I cannot now recollect the exact particulars regarding it; before then the matter had been presented to the executive committee and trustees of the company, and it had been decided that it was not advisable to grant such a license to Mr. Sawyer. I told him frankly that the company would not grant him such a license. He said I could do it if I wanted to; I said to him, Anyway, the company won't do it; he was very angry, and threatened that he would do all he could to injure the company and its patents and inventions unless he got the license; I told him he couldn't get it. From that time forward he was continually hostile to us; he resigned his position as secretary of the company and as a director, commenced the organization of a hostile company, exhibited the lamps and apparatus of the Electro-Dynamic Company as belonging to his new organization. He endeavored to get different people, who had been employed by the Electro-Dynamic Light Company, to take out patents for little things which had been used by the Electro-Dynamic Light Company, and to assign them to his new organization. He spoke belittingly of the patents and inventions of the company to different stockholders of
3431 the company and to others, endeavored to sell his stock
short at a price that was deemed altogether insufficient; he got hold of gentlemen that were proposing to put in large amounts of capital for the working of the patents of the Electro-Dynamic Light Company, and dissuaded or endeavored to dissuade them from doing so, and claimed generally that the patents and inventions held by his new organization and company would supercede and render valueless the patents and inventions of the Electro-Dynamic Light Company and told falsely, as I believed, and still

believe, to many persons that came to me with the stories, that he would break up and destroy the patents held by the Electro-Dynamic Light Company. He published articles and wrote a great many letters defamatory of the company, to person that brought them and showed them to me, and as he subsequently said to me in the spring of 1881, he had done all he could, or dared to do, to injure the company and its patents, and thought he had made a good fight of it; but that notwithstanding all he had been able to do he had not succeeded as he expected, and that he was then sorry that he had done it; he told me at that time that he had written and paid for articles to have them inserted in the newspapers with the object of injuring the company and its patents; had written books and published them with that object, and to glorify and render profitable his interest in the Eastern Electric Manufacturing Company; that he had succeeded to some extent—at any rate, he had prevented the Electro-Dynamic Light Company from making anything, and that I didn't know the half part of what he had done. I asked him if he considered his course an honorable one. He said, that wasn't the question. It had been a question of bread and butter to him, and that if he could have completely broken those patents of the Electro-Dynamic Light Company he would have done it. Yet he believed that it was all a mistake, and
that he would have done better to adhere to the old company
3432 (meaning the *the* Electro-Dynamic Light Company). That
at least there were honorable men connected with that, and complained that he had been fleeced and cheated by those connected with the Eastern Electric Manufacturing Company. I told him that I thought he had acted dishonorably in regard to the thing, especially toward myself; that he had injured himself beyond recovery by the manner in which he had conducted himself; that he knew that the inventions and patents of the Electro-Dynamic Light Company were honest and true, and that they were the foundation patents of electric lighting, and that he had destroyed himself in endeavoring to destroy them. He said, "Yes, I know it is so, and now that they are altogether held by one company, we can defy the world. I have not," said he, "injured these things so much as you think. I would, if I could, but now I am glad I didn't succeed. Of course," said he, "I couldn't do anything to aid the old company in supporting the patents in applying for reissues, or doing things as long as they were not helping me, and I was fighting them; but now I will do anything that I can, and sign any papers that are right." I said to him, "I do not see, Sawyer, how you can do much to aid in sustaining these patents now. We have compelled you to testify in the past, and we can compel you to do so again; but you have ruined your reputation and are a load to carry, and nothing I so much regret as that I ever mixed up my brains with yours in working out these inventions; the most you can do is to sign such application as may be necessary for reissues and things of that kind. If we need you as a witness, we shall call you if we can't avoid it. The greatest help you can be to us is to go and behave yourself, and be a man in the future." Mr. Sawyer replied: "I'll do so. I knew all

the time, down at the bottom, you have been my friend, and neither you, nor anybody connected with the old company (meaning the Electro-Dynamic Light Company), have never injured me as 3433 others have, and you have helped me notwithstanding all I have done, when nobody else would. Now I'll stop drinking, in fact, I have stopped, and you'll see I'll be a man, and you won't have occasion to be ashamed of me any more; I tried to prevent the trade between the two companies, but I couldn't succeed, and now I am glad of it, for I know there are men now connected with it who don't want to cheat everybody they have anything to do with." I said to Mr. Sawyer, " Don't make the mistake of supposing that you can ever recover the position that you have lost in the estimation of honorable men; you can never do it, but you be an honest man yourself and have the satisfaction of being so, and, if you behave yourself, you will realize in the end handsomely from your electric work, and from the inventions you and I worked out especially; and if you don't do it you will not prevent others from doing so, and injure yourself." He said, " Well, I guess I have had moral lecture enough for to-day. You'll see that I will do right." He bid me good day, and went off. This took place almost immediately after an agreement had been reached for the sale of the Electro-Dynamic Light Company patents and inventions to the Eastern Electric Manufacturing Company, and before the transfer had been made. The conversation took place in this room (No. 3 Mercer street—at my office); within a week afterwards—or at most ten days—he was apparently as hostile as ever, and berating me, and every one that I had anything to do with, to different people, as I was told. I called upon him and asked him to see Mr. Broadnax with reference to the execution of some papers. He treated me very coolly; said that he might do it, but he would do it when he got good and ready. From that time forward his attitude towards me, and towards the Eastern Electric Manufacturing Company, so far as I know, has been hostile. The above is the substance of the conversation which took place immediately after the agreement to transfer the patents to the Eastern Electric Manufacturing Company.

3434 NEW YORK, *November* 13, 1882.

Parties met pursuant to adjournment.
Present: Same parties.

5 Q. You say, in answer to question 6, that Mr. Sawyer told you that he had written and paid for articles to have them inserted in the newspapers, with the object of injuring the company and its patents; had written books and published them with that object, and to glorify and render profitable his interest in the Eastern Electric Manufacturing Company; please to state whether or not, at the time Mr. Sawyer made such statement, he admitted to you that the statements contained in said newspaper articles and said books were untrue, and were written and published by him for the purpose of injuring the patents and inventions of the Electro-Dy-

namic Electric Light Company. Please state fully what Mr. Sawyer said on that subject, if anything?

Objected to as leading.

A. I taxed Mr. Sawyer with making untruthful statements; that these things which he had written and published were not true, and that he knew it at the time. He said, "Of course I knew that well enough; but you would not expect me to say anything in favor of those patents when I am fighting them, and I know as well as you do that they were good, but I can do with truth say anything against them, and I could not away with anything I have said against them; and you will find, if you look at it carefully, and what I have written and published as statements against them I am in no case direct and positive, for I have avoided making positive statements, and what I have said and done against them is rather by implication than anything else, sometimes by omitting to say something, and sometimes by saying something about the patents
3435 and inventions of others, especially Mr. Edison, and bringing in at the same time some omission or partial statement in regard to the Sawyer and Man invention injurious to them. You'll find I have said nothing positive." I said: "That may be so, Mr. Sawyer. I don't want to study it. It seems to me you have gone just as far as you dared to, endeavoring at the same time to avoid criminal liability; I do not think anything you can say or do will be of advantage to us; no man can descend to the depths you have, and be able afterwards to throw discredit on his deviltry."

6 Q. State what, if anything, Mr. Sawyer said to you respecting the joint inventorship of the inventions for which the joint patents were granted to Sawyer and Man.

A. At the time to which I have referred, and in the conversation, I referred to the subject-matter of the joint inventions, for which patents were taken out in the name of Sawyer and Man, and told him that I had heard that he denied that they were joint inventions, to other people; I said, "You have never done so to me, or pretended to any such thing, and I don't believe you would dare to; but your course in regard to them, so far as I am concerned, appears to me to be simply infamous; you in substance declare not only me, but yourself, to be perjurers." He said: "Well, I have been driven by my necessity to a great many things that I ought not to have done, and which I am ashamed of; I have tried to make people believe that they were not joint inventions, but I did not in any case positively state so; of course joint inventions are easier attacked than any other, and I was going for all the weak points." At a great many times prior to this, from and after the spring of 1879, I was told by different people that Mr. Sawyer claimed that the inventions for which patents were taken out in the name of Sawyer and Man, were not truthfully joint inventions, and that he claimed them as his own invention. I many times taxed him with making such statements, and he
3436 positively denied to me as often as I spoke to him on the

subject, that such was the fact. He frequently said to me, "I am not damned fool enough to do such a thing as that; but you must not expect me to aid you in sustaining these thing which I have helped to get up myself, which you won't allow me to have any use of at all."

7 Q. Please to examine the book I now show you, and which is marked Edison's Exhibit Sawyer's Book, in this case, and state if you know who wrote and published it.

A. I think Mr. William E. Sawyer wrote and published it, or caused it to be published. He told me in the winter of 1881, that he was writing such a book, and in the latter part of the winter or the early spring, I received a copy of it, enclosed, I think, by him, through the mail, or by messenger. It may have been his father, instead of him who sent the book to me. I think Mr. William H. Church was the messenger, if I mistake not.

8 Q. I call your attention to the following statement contained in said book on page 72: "The carbonizing of live willow twigs with a view to obtaining a suitable bent carbon by Sawyer and Man, and the carbonizing of paper and bamboo by Edison, substantially closes the account of incandescent carbons." Please state whether that statement, in so far as it implies that Mr. Edison carbonized paper and bamboo for use in electric lighting in incandescent electric lamps before paper was carbonized by yourself and Mr. Sawyer, and successfully used in incandescent electric lamps, is true.

A. I cannot know of my own knowledge at what time, if ever, Mr. Edison carbonized paper for the purpose of using it in incandescent lamps. If Mr. Edison did not do so prior to the spring of 1878, when we did so, any implication that Edison was the prior and first person to make and use paper carbons for incandes-
3437 cent electric lamps, which might arise from this statement,
is false. I consider the statement as one of those referred to by Mr. Sawyer in his conversation with me, containing a pregnant omission intended by him to damage and injure the patents of the Electro-Dynamic Light Company. The omission to which I refer is an omission to state the carbonizing of paper for use in incandescent lamps by Mr. Sawyer and myself, while at the same time mentioning the carbonizing of paper by Edison, as though he was the sole person who did it.

10 Q. I read to you the following statement found in the same book on page 78: "The filament originally used by Mr. Edison was prepared by cutting card-board in the desired shape and carbonizing the same by placing the loops thus formed in layers within an iron box with intervening layers of tissue paper, closing the box to exclude oxygen, and raising the whole to red heat in the furnace." What have you to say in answer to the implication that appears upon the face of that statement?

A. My answer is the same as my reply to the last question, with the addition or explanation that Mr. Sawyer omits to state that we cut paper into forms for carbonizing, carbonized them afterwards, and used them successfully in incandescent electric lamps, and this, as I understand it, before Mr. Edison did any such thing. At any rate we did it in the spring of 1878, in substantially the method stated in the book, as I before testified in this case.

11 Q. I read to you the following statement contained in said book, on page 86: "The Sawyer and Man experiments were of an extensive and deversified character, and among the earliest attempts to obtain a practical lamp, was the including of an arc or loop of carbon in the circuit of the radiator (Fig. 52). This carbon loop was originally employed in March, 1878, a rod of retort carbon being turned true in a lathe and bored out to form a tube; from this their flanges were cut; and after being clamped 3438 between carbon washers, the upper part was left standing, and the lower part broken out. It was not until the following winter that the carbonizing of different substances in the form of a loop and especially twigs of live willow was attempted with varying results; a year later Mr. Edison greatly improved the manufacture of these loops by processes much better calculated to attain the end desired than those employed by Sawyer and Man, whose success in this direction was limited." Please to state whether that statement contains the whole truth, as you know it, and what of falsehood it contains by implication, if any.

A. The statement does not contain the whole truth, by reason of omiting the statement that paper washers cut out in the form of a flat circular ring, were carbonized and used in incandescent lamps successfully by us prior to, or about the same time, as the turning out of the retort carbon, referred to in that statement; I characterize this omission as one of the same character as those in my last two answers; the statement that the carbonizing of different substances by Mr. Sawyer and myself did not take place until the following winter, is not true; it took place for the most part, in the winter and spring of 1878, including horn, paper, sugar, glues, several different kinds of wood, and other things; I cannot, at this moment, recollect what, but a variety of things; some of them we attempted to use by combination of the carbon after formed, and some by direct use of the carbon in the form of the substances before carbonization: I do not think that any of these experiments were as late as the winter following, though some may have been in the early part of December, 1878; if so, they were renewals of previous experiments.

12 Q. I call your attention to an article published by Mr. Sawyer in the New York Herald of December 24, 1879, said article being entitled, "Sawyer on Edison and the Herald," and is dated 3439 New York, December 23, 1879, and addressed to the editor of the Herald, and I read to you from said articles the following statements:

"If you care to settle the question of priority of invention upon the horseshoe lamp between Mr. Edison and myself, you may inspect one of those lamps which broke down at 94 Walker street about one year ago, and after many experiments, was so far condemned that Mr. Man and I concluded we would not waste enough money on it to pay for a patent. This lamp is at present just exactly as it was removed from the bracket, hermetically sealed in a glass globe filled with nitrogen gas, and in just exactly the same condition it was a year ago. To avoid any question, I placed said abandoned institution in the hands of Messrs. Arnoux & Hochhausen, No. 2 Howard street, yesterday, Monday morning, at nine o'clock." What answer, if any, have you to make to that statement?

A. That it is not true, so far as I am concerned, and I do not think it was true with Mr. Sawyer, that he and I ever concluded that "we would not waste money enough on it to pay for a patent." I never came to any such conclusion at any time, nor in any way. Neither did I ever abandon, or intend to abandon, the arc form of carbon, or the lamp in question, which I know, and I deny the right of Mr. Sawyer to allow Mr. Edison, "The Wizard," or anybody else, to patent it. I knew nothing of the putting of the lamp in the hands of Arnoux & Hochhausen. It was not put in their hands by my consent. It belonged to the Electro-Dynamic Light Company; and as soon as I found that it had gone into the hands — any one else, I endeavored to get hold of it, and eventually succeeded in getting it and putting it in as an exhibit in this case. I gave Messrs. Arnoux & Hochhausen orders, when I found it was in their possession, not to give it to any one, and especially not to let it go back to Mr. Sawyer.

3440 13 Q. Please to read the whole of the article from which I quoted, and to which you referred in your last answer, and state if you find one word in it about the use of carbonized paper as the illuminating conductor in incandescent electric lighting?

A. I do not see anything of the kind in the article.

14 Q. I call your attention to an article in the New York Herald of January 5, 1882, said article being entitled, "A challenge to Edison," dated January 4th, 1880, and addressed to the editor of the Herald, and signed W. E. Sawyer; please read the whole of said article, and state whether you can find anything in it bearing upon the subject-matter of this interference, and make any answer to said article you may desire.

A. I have read said article; I see no reference in it to the subject-matter of this interference so far as paper carbon is concerned; I see no further answer to make to it.

15 Q. I call your attention also to an article in the New York Herald of January 6, 1880, entitled, Mr. Sawyer's exhibitorium; which article is dated January 5, 1880, addressed to the editor of the Herald, and signed W. E. Sawyer; please to read the whole of that article, and state if you find anything in its bearing upon this interference, and make any further answer to the article as you desire?

A. I have read the article referred to; I see no reference whatever in this article to the subject-matter in this case, unless it be the statement that he had been working simply and solely with a view to a genuine scientific success, in reference to which I hereby remark that his methods for such a purpose or with such a view, were extremely peculiar, and it seems to me, utterly inconsistent with the statement.

16 Q. State if you recollect going to Mr. Sawyer, upon my request, within a short time after the declaration of interference in this case, and asking him to execute the papers necessary to divide this application, so that we could go on and prosecute the claims 3441 not in interference, and, if yea, please state with what result you made such application to Mr. Sawyer, and what he said to you at the time, as far as you can remember the conversation?

A. I recollect calling upon Mr. Sawyer for the purpose very shortly after the declaration of interference in this case, at your request, and asking him and urging him that he should execute the necessary papers which he then had in his possession; he declined to do so, and said he would do nothing to help the Electro-Dynamic Light Company; I reminded him that he was a large stockholder in the Electro-Dynamic Light Company, and urged his personal interest in the matter; he replied that he appeared of record to be a stockholder there, but that he had parted with all his interest, as I understood, to the Eastern Electric Manufacturing Company, or those who were aiding him in supporting it; that he would be a fool to aid in getting out patents which might be in the way of that company; but after all when I urged him still further, on the ground of honesty and right, and his personal obligations to me, he said in substance that if they (the Eastern Electric Manufacturing Company) didn't do what he wanted them to he might be in a position to do it; he'd see. I asked him for the papers and he refused to give them to me; I called on him once or twice afterwards within a day or two, and urged him in a similar manner with a similar result.

17 Q. State if you recollect going to Mr. Sawyer upon my request, with the necessary papers to apply for a reissue of the patent granted to Sawyer and Man for an electric light system, said patent being numbered 205,303, and dated June 25, 1878, and of requesting Mr. Sawyer to execute said papers; and state what the result of your application to Mr. Sawyer was for such execution, and what Mr. Sawyer said to you, as you can recollect, upon that occasion.

A. I went to Mr. Sawyer at your request a number of times to get him to sign an application to reissue the patent to which you refer; he uniformly declined to do so, and gave reasons 3442 for it similar to those I have mentioned in my last answer; his attitude toward me and toward the Electro-Dynamic Light Company in reference to these matters upon these occasions when I called upon him was uniformly hostile, and I remember his telling me, in substance, that he would rather hurt us than help us. He did finally execute the papers, after an agreement had been reached to sell the patents and inventions of the Electro-Dynamic Light Company to the Eastern Electric Manufacturing Company, at or about the same time the agreement was carried out.

Counsel for Sawyer and Man offer in evidence certified copies of the following papers, to wit:

Memorandum of an agreement between William E. Sawyer and Albon Man, dated March 19, 1878, recorded April 4, 1882.

Also, agreement between William E. Sawyer and Albon Man, dated May 11, 1878; recorded April 4, 1882.

Also, general release by William E. Sawyer, dated May 21, 1879, and recorded April 4, 1882.

Also, an assignment from Albon Man to the Electro-Dynamic Light Company, July 15, 1878; recorded April 4, 1882.

Also, assignment of William E. Sawyer to Albon Man, dated May 14, 1878, and recorded May 16, 1878.

Also, three assignments of Sawyer and Man to the Electro-Dynamic Light Company, both dated July 15, 1878, and recorded May 29, 1879.

3443 Assignment of William E. Sawyer to Electro-Dynamic Light Company, dated October 16, 1878, recorded October 22, 1878.

Also, assignment of Sawyer and Man to Electro-Dynamic Light Company, dated November 6, 1878, recorded November 12, 1878.

Also, assignment of Sawyer and Man to Electro-Dynamic Light Company, dated October 14, 1878, recorded October 22, 1878.

Also, assignment of Sawyer and Man to Electro-Dynamic Light Company, dated February 3, 1879, recorded May 29, 1879.

Also, assignment of W. E. Sawyer to the Electro-Dynamic Light Company, dated December 9, 1878, and recorded March 14, 1879.

Also, assignment of Sawyer and Man to Electro-Dynamic Light Company, dated December 9, 1878, recorded March 14, 1879.

Also, assignment of Wm. E. Sawyer to Electro-Dynamic Light Company, dated June 28, 1879, and recorded Q. 24, p. 10.

Also, assignment of Sawyer and Man to Electro-Dynamic Light Company, dated Jan. 8, 1880, recorded W. 24, p. 380, Jan. 9, 1880.

Also, assignment of Wm. Sawyer to Electro-Dynamic Light Company, dated July 30, 1879, recorded September 2, 1879.

18 Q. I place in your hand the original of the above assignments; please to examine them and state whether or not they were all duly executed?

3444 A. They were, by myself and Mr. Sawyer where they were joint assignments, by myself where they were my own assignments solely, and by William E. Sawyer where they were his assignments solely.

Counsel for Sawyer and Man gives notice that the foregoing assignments, agreements, leases, etc., are put in evidence for the purpose of proving that before the patent was applied for, making the subject-matter of this interference, and before the writing and publication of any of these letters by William E. Sawyer, put in evidence on behalf of Edison, and before the writing or publishing said book, Edison Exhibit Sawyer Book, the invention making the subject-matter of this interference had been fully assigned to the Electro-Dynamic Light Company, and held and owned by it; and for the further purpose of showing that said invention had not been abandoned by Sawyer and Man, or by the owners of said invention.

Counsel for Edison objects to the above assignments for the purpose of proving the fact above referred to, but makes no objection to the proof of the execution of the instruments or their genuineness.

19 Q. State, if you know, whether at the time of the writing of the book, Edison Exhibit Sawyer Book, and the articles in the Herald, to which your attention has been called, and about which you have testified, the invention making the subject-matter of this interference was in fact owned and held by the Electro-Dynamic Light Company.

A. It was so owned and held, and the counsel for the company had prior thereto been instructed to prepare applications for letters
patent for the same. The invention making the subject-
3445 matter of this interference was formally transferred, or in-
tended so to be, by an assignment dated October 16, 1878, to the Electro-Dynamic Light Company, and the formal assignment of this invention by Mr. Sawyer and myself, dated January 8, 1880, was intended more particularly to authorize the Commissioner of Patents to issue the patent for the same to the Electro-Dynamic Light Company as assignee.

20 Q. What was the memorandum of agreement referred to in the agreement between Mr. Sawyer and yourself, dated March 19, 1878?

A. The memorandum of agreement referred to in the memorandum of agreement between William E. Sawyer and myself dated March 19, 1878, and recorded April 4, 1882, in Liber A 28, page 117 of Transfers of Patents, was made in a small memorandum book signed by Mr. Sawyer first on February 15, 1878, and was in words and figures following: "Advances to William E. Sawyer on account of experiments in electric lighting made by Albon Man, and not to exceed in amount $250, and to be returned by Sawyer within fifteen months from date in case Man is not satisfied to go on after seeing result of preliminary experiments, for which these advances are made. Dated February 15, 1878. Signed, W. E. Sawyer." Then followed a list of payments made to Mr. Sawyer; there was made at the same time, or before, a memorandum of agreement, signed by Mr. Sawyer that all inventions upon electrical subjects which had been made by him, or which should be made by him, should belong to him and me jointly in the proportion of $\frac{55}{100}$ to me and $\frac{45}{100}$ to him, except certain things which he had, or claimed to have invented for electric motors, and something in regard to telegraph, I can't now distinctly recollect what, that paper has been mislaid; it was, however, superseded by the papers which have been put in evidence, and we proceeded upon a different basis from that at first con-
templated, only so far as that finding the inventions referred to
3446 in the agreement of February 15, 1878, which had already
been made and contemplated by Mr. Sawyer, not immediately applicable to the production of a practical light, I went to work out, and did work out with him, new and joint inventions, which resulted in the production of a practical light. The invention making the subject-matter of this controversy being one of the joint inventions, but our understanding and agreement in other respects

as to the interest of each party in the inventions and patents to be taken therefor, including any joint inventions of Mr. Sawyer and myself, as well as his sole inventions, was that they should belong to us in the proportions stated in the first agreement remained the same, and the disposition that should be made of the patents, to wit: that they should be assigned to a company to be formed remained the same as specified in the agreement between Mr. Sawyer and myself, dated March 19, 1878. Up to this time we had not realized that the work we were doing was the production of joint inventions, but as soon as we began to consider the question of taking out patents, this subject was brought to our attention, and we realized the fact that the inventions were joint and not the separate inventions of Mr. Sawyer. The Electro-Dynamic Light Company was formed to take, and did take the assignment of the inventions and patents, in pursuance of the agreements and assignments between Mr. Sawyer and me. The agreement of May 11, 1882, was made to put on record or perpetuate the evidence of the fact of these inventions having been the joint inventions of Sawyer and Man, and not the individual inventions of Sawyer (and are in the handwriting of Mr. Sawyer), and to modify and conform the previous agreement and understandings to the facts as they existed, and for other purposes.

21 Q. State, if you please, whether or not Mr. Sawyer had any interest in the invention making the subject-matter of this interference at the time he wrote and published Edison Exhibit 3447 Sawyer Book, and the articles in the New York Herald, to which I have called your attention, other than as a stockholder in the Electro-Dynamic Light Company, or the Eastern Electric Manufacturing Company.

A. I do not understand that he had any interest whatever in it other than adverse interest, either as stockholder or otherwise. He was nominally a stockholder of the Electro-Dynamic Light Company, but had parted with his interest, or had so used it to place it in antagonism to these patents, and his interest as stockholder in the Eastern Electric Manufacturing Company was adverse to these patents and inventions, and rendered him hostile thereto.

Question and answer objected to, as the assignments themselves are the best evidence of the interest of William E. Sawyer to the inventions or applications named.

22 Q. Please state, if you know, whether or not the invention making the subject-matter of this interference, together with all the patents and inventions made by yourself and Mr. Sawyer, jointly or severally, and owned by the Electro-Dynamic Light Company, were all duly transferred and conveyed to the Eastern Electric Manufacturing Company, on or about April 6, 1881.

A. They were so conveyed and transferred; I, as an officer of the Electro-Dynamic Light Company, taking part in such transfers at the time; the transfer was made with the written consent and approval of all the stockholders of the Electro-Dynamic Light Company; said transfer having been made to William H. Church, as trustee, and by him on the same day, to the Eastern Electric Manufacturing Company, as evidenced by the assignments dated on or about that time and recorded on the fifth day of October, 1882, in Liber J. 28, pp. 429 and 433, of Transfers of Patents.

Same objection to this question and answer as to the 21st question and answer.

3448 Counsel for Sawyer and Man gives notice to counsel for Edison, that if necessary upon the hearing of this cause, he will make use of said records to prove the ownership of said patents and inventions.

23 Q. State, if you know, whether or not these same inventions and letters patents have been transferred to the trustees of the Consolidated Electric Light Company from the Eastern Electric Manufacturing Company. and are now owned by that company.

A. They have been so transferred, and are now held and owned by that company. I was present as one of the Consolidated Electric Light Company, at the time the transfer was made, and saw the assignment executed and delivered, and which assignment is dated thirtieth day of September, 1882, and recorded in Liber J. 28, p. 441, of Transfer- of Patents in the Patent Office.

Same objection repeated to the question and answer.

Counsel for Sawyer and Man gives notice that, on the hearing of this cause, he will use the record referred to to prove the present ownership of said patents and inventions, in case he should deem the same necessary.

24 Q. State whether or not you and Mr. Sawyer are now, and have always been, merely nominal parties to this interference?

A. We are, and always have been, only nominal parties in interest, the invention constituting the subject-matter of this interference was, at the time of this application for the patent, and had always been from its origination, the property of the Electro-Dynamic Light Company, and so remained until the transfer to the Eastern Electric Manufacturing Company; from which time, and until the transfer to the Consolidated Electric Light Company,
3449 it belonged to, and was the property of the Eastern Electric Manufacturing Company, and from the time of the last-named transfer, it has been, and now is, the property of the Consolidated Electric Light Company; I have no interest in the invention other than as a stockholder of the last-named company.

Same objection as before.

25 Q. State, if you know, why the Electro-Dynamic Light Company refused to go on with Mr. Sawyer early in the year 1880, and to have anything further to do with him toward the development and practical introduction of the patents and inventions owned by them, and why they refused to give him the license about which you have testified.

A. By reason of Mr. Sawyer's inebriate habits which had rapidly grown upon him from the time of the organization of the company, and because they deemed it unwise and inexpedient to endeavor to bring out these patents, and put them in practical operation under the management of Mr. Sawyer; his habits, in the judgment of the officers of that company, rendering him an unfit and improper person to have charge of such important interests; and the same reasons influenced them in refusing to grant him a license, together with other reasons.

Adjourned until 10 o'clock, 22d November, 1882.

3450 NEW YORK, *Nov. 22d*, 1882—10 o'clock a. m.

Parties met pursuant to adjournment.

Present: Counsel as before.

Counsel for Edison gives notice that he does not waive any objection to the foregoing testimony of Albon Man as inadmissible, for the reason that it is not in accordance with the decision of the Commissioner of Patents in reopening this interference.

26 X Q. What was the date of your first acquaintance and business relations with Mr. William E. Sawyer?

A. I believe I have gone all through with that.

27 X Q. What were your personal relations with him between that date and the fall of 1879?

A. I believe that our relations were personally friendly up to that time. There may have been intervals of time when Mr. Sawyer was hostile to me, I do not recollect. I had refused to furnish money to him as superintendent to conduct the business of the Dynamo-Electric Light Company. He had been angry about it at different times, but in his sober moments admitted that I was right about it and professed a friendly regard for me.

28 X Q. How long was Mr. Sawyer superintendent of the Electro-Dynamic Light *Cam*pany?

A. Up to—I should say—some time in the month of March, 1879, or about that time. Mr. Sawyer was in charge of the work that was being done by the company for the most part. I do not know that there was any office of superintendent. He and I both gave directions in regard to the work, but he was there most of the time. In my former answer in calling him superintendent I referred to his being at the shop most of the time, and while there alone superintended the work.

3451 29 X Q. After Mr. Sawyer ceased his superintendence or supervision of the work about March, 1879, who performed those duties up to the fall of 1879?

A. The work was transferred to Wallace & Sons' shops at Ansonia, Connecticut, and Mr. Edwin M. Myers, as I understood, was the acting superintendent under them, although Mr. Sawyer had agreed with them to give his time and attention to the business as I understood it, but neglected to do so, at least for the most part or to such an extent that it was not satisfactory to Messrs. Wallace. Messrs. Wallace & Sons had a contract with the company for doing the work and putting the patents and inventions in operation. This contract was with the Electro-Dynamic Light Company. That contract was afterwards rescinded by mutual agreement.

30 X Q. Did Mr. Sawyer give his assent to the making of that contract?

A. He did.

31 X Q. Was there any difficulty between Mr. Sawyer and yourselves or the Electro-Dynamic Light Company, between March, 1879, and the fall of 1879?

A. Yes, sir; I think there was between Mr. Sawyer and myself.

32 X Q. Please to fix, as nearly as you can, the date in the fall of 1879, when the hostilities of Mr. Sawyer commenced, which continued till April, 1880.

A. In the early part of the fall of 1879, I should say early in the month of September, his hostility to me took active shape. I was afterwards made fully aware of it at the time Mr. Church and I were at his place in Walker street, at the time before referred to. Mr. Sawyer was at Ansonia during the summer of 1879, and after his return in the fall was at me to give him license, as I have testified. This was brought to a positive conclusion at the time of the interview in November or December, when Mr. Church was present, corner of Courtlandt alley and Walker street; but, as I subsequently learned, he had been all the fall endeavoring to 3452 make arrangements hostile to the Electro-Dynamic Light Company.

33 X Q. Who did you learn that from?

A. From his father, from his brother, from two or three gentlemen, one of them a Mr. Goddard, who told me that Mr. Sawyer had approached him upon the subject of getting up a hostile company, and from others, who told me, I cannot recollect who they were, I think Mr. Church was one; I don't know where Mr. Goddard is, or what his business is; he was a club acquaintance of mine in Brooklyn; at the Lincoln club.

34 X Q. When Mr. William E. Sawyer and Mr. Church and yourself were together at the office, at the corner of Courtlandt alley and Walker street, when Mr. Sawyer demanded the license, upon what ground did he ask it?

A. I do not know that he specified any ground, only that he wanted it. He wanted to use it in connection with other inventions that he had in mind, or had made, or something of that kind, principally, I think, a submarine lamp, but I cannot be certain, but not confined to that, he wanted a general license.

35 X Q. Did you offer to give him a limited license?

A. No, sir; wouldn't give him any kind of license.

36 X Q. Did Sawyer say that he wanted a licence in order that he might manufacture his submarine light?

A. I should think so, or in substance that, but not confined to that; he seemed to talk and feel as though because he was one of the inventors, he ought to have the right to use the invention as he pleased, although he had sold and assigned them to the Electro-Dynamic Light Company, or united in doing so.

37 X Q. Did he at that interview speak of any other thing which he wished to manufacture beside the submarine light?

A. Yes, sir; he wished to manufacture all the things for which the company then held patents; but the submarine light was, I
think, the then present thing which he wished to make, and
3453 in connection with which he wished to use the patents be-
longing to the Electro-Dynamic Light Company.

38 X Q. Did he complain that the company were not manufacturing?

A. I think he did, and I explained to him the reason why; that he had failed to render the assistance which he had promised and agreed to render at the shops of Messrs. Wallace, in Ansonia, and had conducted himself in such a manner that Messrs. Wallace would not have him in their shops now, and that Mr. Edwin M. Meyers, who had been in charge at Ansonia, and was the man best fitted and knew the most about the work to be done, was sick, and that neither Messrs. Wallace nor the Electro-Dynamic Light Company wanted to put another man in charge, and intended to wait until Mr. Meyers was able to go on with the work; I told him that it was his own fault and nobody's else, that the work was not going on; he admitted the fact, but insisted that he should be allowed to go on as he pleased under a license.

39 X Q. Did Mr. Sawyer appear to be much disappointed at the refusal of the license?

A. He appeared angry, and made threats as I have stated.

40 X Q. Did he make threats before the refusal of the license?

A. My recollection is that, at this interview his request or demand for a license was accompanied by a threat as to what he would do if the license shouldn't be granted to him, and the threats were repeated after I told him that he could not get a license.

41 X Q. You say, in answer to the fourth question, that Mr. Sawyer "exhibited the lamps and apparatus of the Electro-Dynamic Company, as belonging to his new organization;" when and where did he make such exhibition?

A. I cannot remember the number of the street; my impression
is Fifty-fourth street and Eighth avenue or its vicinity; and
3454 also again at a place in Fulton street near Gold, in the winter
and spring of 1880; I saw the exhibition in part myself at
both these places.

42 X Q. In the same answer you say that Sawyer endeavored to get different people who had been employed by the Electro-Dynamic Light Company to take out patents for little things which had been used by the Electro-Dynamic Light Company, and to assign them to his new organization;" please give the names of the different people referred to in the above answer?

A. His father, William Sawyer, a Mr. Stillman, a Mr. Knowles, a Mr. Sharpe, now of Ansonia, Connecticut, Mr. Edwin M. Myers, of Plattsburgh, as I was informed and believe; I was so informed by Mr. Sawyer's father by Mr. Sharpe and Mr. Meyers; Mr. Meyers showed me a letter at one time from Mr. Sawyer upon this subject.

43 X Q. In the same answer you say that William E. Sawyer "spoke belittlingly of the patents and inventions of the company to different stockholders of that company and to others;" please gives the names of these people, so far as you can remember.

A. Among the stockholders were Mr. C. C. Allen, Mr. Horace Little, Mr. Jacob Hays, Mr. Lawrence Meyers, and Mr. Broadnax, among other people; I can't recollect names, but a great many people came to me and told me that Sawyer told them that the patents were of small consequence.

44 X Q. In the same answer you say that Sawyer "got hold of gentlemen who were proposing to put in large amounts of capital for the working of the patents of the Electro-Dynamic Light Company, and dissuaded, or endeavored to dissuade them from doing so," please give the names of those gentlemen?

A. I do not know them and never did; upon two occasions gentlemen came to me stating that certain parties, in one instance from Boston, and in another instance from Chicago, were in the city of New York making investigations with regard to electric lighting and the making of investments
3455 therein; that they had examined the patents of the Electro-Dynamic Light Company, and if reasonable and favorable terms could be obtained, would put all the money that was required into the working and development of these patents. They were favorable impressed with them and were ready, if suitable terms could be obtained, to go on at once; the directors of the company were called together in one case, and made terms or proposal for interesting the parties which, we were told would be satisfactory; soon afterwards the negotiator informed us that Mr. Sawyer had got hold of these parties, and dissuaded them from doing anything; the other case was somewhat similar, except that I do not think that any formal meeting of the directors of the company was held in regard to it, but the executive committee of the company told the negotiator that the terms which had been obtained in the first case could be obtained in the second; in a short time we were told that Mr. Sawyer had interfered again, and that the thing was at an end; I cannot be certain in regard to the second parties where I was told they were from; it may have been Chicago or St. Louis, but at any rate it was from some western place; Mr. Charles A. Cheever was the negotiator referred to in the above answer. There was another party from Cincinnati; I cannot give his name, for I have forgotten it, who came to me with Mr. Goddard, to whom I have before referred, but whose first name I cannot give; he professed to desire to want to put in money in the working of the patents of the Electro-Dynamic Light Company, especially in Cincinnati; Mr. Goddard told me after a little that Mr. Sawyer had got hold of him, and he had concluded not to do anything at present; there were ever so many cases of a similar character, but I cannot recollect the parties.

45 — Q. In the same fourth answer you say that Sawyer "published articles, and wrote a great many letters defamatory of
3456 the company to persons who brought them and showed them

to me," "had written books and published them, had written and paid for articles to have them described in the newspapers;" please state more in detail about these published books, articles, newspaper articles, and about the letters mentioned in the above question.

A. Mr. Jacob Hays, Mr. C. C. Allen, Mr. Broadnax and others showed me such letters from Mr. Sawyer, and, if I am not mistaken, Mr. Meyers; Mr. Lowery, counsel of the Edison Company, told me in substance, that if they could believe what Mr. Sawyer had written to them, and offered to swear to, that the patents of the Electro-Dynamic Light Company were of little or no value; different people, I don't know who, the clerks in my own office among them, showed me articles of this character, or called my attention to them at different times; some of them I read, and some of them I did not read; my friends said to me, you must be a great rascal, if what Mr. Sawyer is saying about your patents in the newspapers is true; Mr. Sawyer himself told me that he had written articles and published them in the newspapers, and paid for their insertion, that he had written those articles and published books to injure the company and its patents; some of these articles and books have, I believe, been introduced in evidence in this case. The newspaper articles have been too numerous for me to specify, and I have kept no file of them, and know more of their character by what has been told to me by others, including Mr. Sawyer, than from reading them; in fact, I have usually abstained from reading them.

46 X Q. Referring to the answer to your 20th Q. in respect to a memorandum of agreement made on or about February 15th, 1878, between yourself and Mr. Sawyer with regard to the ownership of inventions made by him, was that agreement recorded?

A. It was not, to my knowledge; I have made search for the paper and have been unable to find it, and have no copy of it.

3457 47 X Q. What are the other reasons referred to at the close of your answer to the 20th Q.?

A. One of the other reasons was that the company had a then subsisting agreement with other parties for the exclusive manufacture of its patented articles, another, that it would introduce confusion in the management of the affairs of the company, and there were other reasons, probably, as I know a great many objections were raised to granting such a license, at the meeting of the executive committee of the company at which the subject-matter was discussed prior to the refusal to Mr. Sawyer to grant him a license; I cannot now recollect to specify what these reasons were.

ALBON MAN.

Sworn to before me this 22d day of November, 1882.

J. EDGAR BULL,
Notary Public.

Adjourned until November 23d, 1882, at 10 a. m.

3458 William H. Church, a witness produced on behalf of Sawyer and Man being called and duly sworn, in answer to interrogatories propounded by Amos Broadnax testified as follows:

1 Q. What is your name, age, residence and occupation?

A. William H. Church; am fifty years old; reside at 89 Henry street, Brooklyn, N. Y.; am connected with electric lighting, and experiments therein.

2 Q. State whether you are the same William H. Church who has heretofore given testimony in this case?

A. I am.

3 Q. And are you well acquainted with William E. Sawyer and Albon Man?

A. I am.

4 Q. Please look at the book I now show you marked "Edison Exhibit Sawyer Book," and state if you recollect ever having seen it before? I do not mean this identical copy, but I mean a book published by William E. Sawyer, of which this is one of the copies.

A. I do recollect having seen a copy of this same book.

5 Q. State where you first saw it and who showed it to you?

A. I first saw it about the month of May, 1881, at the shop of the Eastern Electric Manufacturing Company; I think it was 97 Fulton street, New York; Mr. William E. Sawyer showed me several copies of the book.

6 Q. Please state what, if anything, Mr. Sawyer said appertaining to the book at the time he showed it to you.

Objected to as incompetent, and as being in the nature of hearsay testimony.

A. He said that this book contained many good things on the subject of electric lighting, and some that were not so good, 3459 in fact, were not true; that the book was written at the time that his feelings were antagonistic to the interest of the Sawyer-Man patents, and he regretted some things that he had expressed; he offered me a copy of the book, which I declined to accept, saying that I did not care for anything that was not considered entirely true; he said: "You know how I am Church; when my passions are aroused I say and do many things which I afterwards regret;" I have never read the book, or taken any interest in it.

7 Q. State whether or not at the time Mr. Sawyer offered you this book, Mr. Sawyer's interest had been harmonized with the Sawyer-Man patents.

A. It had.

8 Q. Please to state, if you know, what facts and circumstances had occurred to harmonize Mr. Sawyer's interest with the Sawyer-Man patents at the time or before Mr. Sawyer showed you this book, and made the statement you have related.

A. In the month of April, 1881, the Sawyer-Man patents were sold to the Eastern Electric Manufacturing Company by the Electro-Dynamic Light Company.

9 Q. Was Mr. Sawyer connected with the Eastern Electric Manufacturing Company, and was that company antagonistic to the Electro-Dynamic Light Company?

A. Mr. Sawyer was connected with the Eastern Electric Manufacturing Company, and it was organized by Mr. Sawyer to be antagonistic to the interests of the Electro-Dynamic Light Company.

10 Q. Was the Electro-Dynamo Light Company the owner of what is known as the Sawyer-Man patents?

—. ——.

11 Q. State, if you know, what was Mr. Sawyer's attitude toward that company and towards the patents and inventions owned by that company, previous to the time that the Sawyer-Man patents and inventions were sold to the Eastern Electric Manufacturing Company.

3460 A. It was unfriendly.

12 Q. State, if you know, why his attitude was unfriendly.

A. Previous to organizing the Eastern Company, Mr. Sawyer demanded a license from the Electro-Dynamic Light Company to manufacture lamps and operate the system of electric lighting as set forth in the Sawyer-Man patents, which was refused. Whereupon Mr. Sawyer declared to me that he would do everything in his power to break down those patents.

Objected to as incompetent and hearsay.

13 Q. State, if you recollect, when it was that Mr. Sawyer demanded the license to work under the Sawyer-Man patents and inventions, then owned by the Electro-Dynamic Light Company.

A. I think it was in November, 1879.

14 Q. State, if you recollect, when it was that the Eastern Electric Manufacturing Company was organized.

A. I think it was about January, 1880, according to my best recollection.

15 Q. Please state, as near as you can recollect, the date of the purchase or transfer of the Sawyer-Man patents or inventions to the Eastern Electric Manufacturing Company.

A. In April, 1881.

16 Q. Now, what was Mr. Sawyer's attitude, I mean his feelings and purpose in so far as you heard him express any feeling or purpose, with reference to the Sawyer-Man patents and inventions, between the time that he demanded a license to work under such patents and inventions, and the time that the said patents and inventions were transferred to the said Eastern Electric Manufacturing Company?

A. He frequently declared that he would do everything in his power to break these patents down and make them public property, for anybody to use.

17 Q. And was it during this period that Mr. Sawyer
3461 wrote and published the book, marked Edison Exhibit Sawyer Book?

A. It was.

18 Q. Then, as I understand you, it was very shortly after the transfer of the patents and inventions of the Electro-Dynamic Light Company to the Eastern Electric Manufacturing Company that Mr. Sawyer showed you this book and expressed his regret for some things contained in it?

A. It was.

19 Q. Did Mr. Sawyer at that time refer to any particular part of the book as being untrue, or did he merely state to you in a general way that the book contained some things which he regretted, and which were in fact untrue?

A. Merely in a general way without particularizing.

20 Q. Was Mr. Sawyer a large stockholder in the Eastern Electric Manufacturing Company?

A. He was, but he told me he had hypothecated most of his interest to raise money for his own personal wants.

21 Q. State whether you assisted him in the organization of that company.

A. I did.

22 Q. And were you also a large stockholder in that company?

A. I was.

23 Q. State, if you know, whether or not it was one of the purposes of Mr. Sawyer in organizing the Eastern Electric Manufacturing Company to trespass on the Sawyer-Man patents and inventions, and ultimately to get control of them?

A. It was, and he so declared to me.

24 Q. What was Mr. Sawyer's habits as to temperance and sobriety during this time between November, 1879, and the time he showed you his book, as you have stated?

3462 A. I never saw him when he was not under the influence of liquor during that time.

Examination adjourned until 9.30 o'clock a. m., 11th November, 1882.

NEW YORK, *November 11th*, 1882.

Parties met pursuant to adjournment.
Present: Counsel as before.

Examination of Mr. CHURCH continued:

Witness desires to correct his answer to Q. 20 by explaining that although Mr. Sawyer was a large stockholder in the Eastern Electric Manufacturing Company, yet he has not to his knowledge hypothecated his stock of that company. In answering that question he had in mind the stock which Mr. Sawyer owned in the Electro-Dynamic Light Company.

25 Q. State, if you recollect, at any time between November, 1879, and April, 1881, applying to Mr. Sawyer on behalf of myself or Albon Man to execute the necessary papers to reissue the patent granted to Sawyer and Man for an electric lighting system, No. 205,303, and dated June 25, 1878.

A. I do.

26 Q. State whether Mr. Sawyer did execute the paper, and if he didn't state what reason he gave for refusing to do so.

A. He refused to do so, and gave as his reason that he should do everything he could to break the patents as they then stood, unless the company gave him the license that he had requested, and he
finally executed the papers after the patents had been con-
3463 veyed to the Eastern Electric Manufacturing Company by
the Electro-Dynamic Light Company.

27 Q. State if you know, how long the papers had been prepared for that reissue before Mr. Sawyer executed them?

A. Along in October, or November, or December, 1879, that I first spoke to him about executing them.

28 Q. State, if you know, whether or not frequent applications were made to Mr. Sawyer during that time for the execution of those papers, by Albon Man, yourself or others?

A. I remember that frequent applications were made to him to execute these papers, and that he steadily refused to execute them until after patents had been assigned to the Eastern Company in 1881.

29 Q. State, if you know, whether or not one of the principal objects of selling and transferring the patents to the Eastern Electric Manufacturing Company was to get Mr. Sawyer to execute this application for this reissue and to obtain from him certain co*n*venants, agreements in writing, that he would at any time in the future, execute any and all papers that might be necessary, to amend, or in anywise correct, reissue, subdivide any of said patents and applications for patents for any of the inventions that had been previously made by Albon Man and himself.

Objected to as leading.

A. It was.

30 Q. State, if you know, whether Mr. Sawyer, immediately upon the transfer of the patents to the Eastern Electric Manufacturing Company, executed said papers.

A. He did.

31 Q. State whether you were present at such execution?

A. I don't know that I saw him sign them, but immediately after
both Mr. Sawyer and Mr. Broadnax told me that the papers
3464 had been signed. The other papers referred to were signed
at the beginning when the transfer of the patents was made.

32 Q. I call your attention to an article in the New York Herald, of January 5, 1880, entitled "A challenge to Edison," dated January 4, 1880, and addressed to the editor of the Herald, and signed by William E. Sawyer, please read the article, and state if you recollect whether Mr. Sawyer showed it to you, and what he said to you about it at the time it was written, if anything?

A. I saw the article after it was published for the first time. Mr. Sawyer wrote these articles entirely upon his own responsibility. He asked me what I thought of it. I told him I thought he was drunk when he wrote it.

33 Q. Did the conversation end there?

A. Yes.

34 Q. I call your attention to another article in the New York Herald, dated January 6, 1880, entitled "Mr. Sawyer's Exhibitorium," and addressed to the editor of the Herald, and dated January 5, 1880, please read it. State whether Mr. Sawyer called your attention to it at the time, and what, if anything, he said to you about it.

A. He did. It was substantially the same as in the previous occasion referred to in the previous answer.

35 Q. I call your attention to an article in the New York Herald of December 24, 1879, entitled, "Sawyer on Edison and the Herald," dated December 23, 1879, and addressed to the editor of the Herald, please look at it and see if you have read it.

A. I remember the article, and read it at the time of its publication, and that Mr. Sawyer expressed himself as determined to damn everything in the way of electric lighting that had been done by himself and Mr. Man, or by Mr. Edison. Said he would do it if it broke every patent that had been issued to himself and Man, and he would do all he could to destroy the confidence of the public in Mr. Edison.

3465 36 Q. Did you see this article before it was published?

A. I did not.

37 Q. How long after its publication was it that you first saw it, and who called your attention to it?

A. I saw it immediately on its publication, and Mr. Sawyer called my attention to it.

Direct examination closed.

38 X Q. When was the Electro-Dynamic Light Company organized?

A. Early in July, 1878; I think the 6th of July.

39 X Q. Under the laws of the State of New York?

A. Yes.

40 X Q. What was the business basis of that company; upon what patents, if any, was it founded?

A. It was organized upon patents issued to William E. Sawyer and Albon Man, for electric lighting.

41 X Q. Did you hold an office in that company, if so, what office?

A. I did not hold any office in that company.

42 X Q. Was you a stockholder in it?

A. I was.

43 X Q. Was Sawyer an officer and stockholder in that company, or both?

A. He was both.

44 X Q. What office did he hold and what proportion of the stock did he own?

A. He was secretary of the company, and he held a very large amount of the stock. I think a little less than one-third.

45 X Q. Upon what ground did Mr. Sawyer assert his right to a license from that company, as you have testified?

Question objected to on the ground that Mr. Sawyer did not assert any right to a license, but merely insisted upon having one.

3466 A. He wanted and demanded it, that's all.

46 X Q. Upon what ground did he demand the license?

A. No ground; he said he was going to have, and would have it.

47 X Q. Were you present on any occasion when Mr. Sawyer demanded a license from the Electro-Dynamic Light Company?

A. I was present when Mr. Man refused to accede to Mr. Sawyer's demands, and thereupon Mr. Sawyer told Mr. Man that he would do everything in his power to break down those patents.

48 X Q. What had Mr. Man to do with it at that time?

A. Nothing.

49 X Q. What did Mr. Sawyer say when he demanded the license?

A. He told Mr. Man that he wanted the right to manufacture the lamps, and operate the system of electric lighting, as patented by himself and Mr. Man, and if Mr. Man continued to refuse, he would certainly break the patents.

50 X Q. How did he propose to break the patents?

A. He did not say, neither did Mr. Man inquire.

51 X Q. Did Mr. Sawyer assert that Mr. Man knew that he could break the patents of Sawyer and Man?

A. He did not.

52 X Q. About what time was this?

A. It was in the month of November, 1879, in a small office then occupied by Mr. Sawyer in Walker street.

53 X Q. Who else was present besides those you have named?

A. No one but Mr. Man and myself and Mr. Sawyer.

54 X Q. Did you ever hear Mr. Sawyer demand a license at any one time?

A. No, sir.

55 X Q. When Mr. Sawyer demanded the license at that time did he say that he had a right to a license?

3467 A. I don't know that he did—don't remember that he did.

56 X Q. Do you remember that he did not?

A. My best recollection would be that he did not.

57 X Q. What time of the day was this?

A. About 5 o'clock I should think, in the afternoon; Mr. Sawyer's lamp had been lighted.

58 X Q. Was Mr. Sawyer sober at the time?

A. For him, tolerably so, he never was entirely sober.

59 X Q. Was he angry and offensive in his manner?

A. He was angry and offensive.

60 X Q. Did he threaten to destroy the Sawyer-Man patents, before or after Mr. Man's refusal?

A. After.

61 X Q. When he demanded the license on the occasion referred to, did he complain that the company had done nothing in the way of introducing the invention?

A. I do not recollect that he made that complaint, but the company had refused to employ him because of his intemperance.

62 X Q When did the company so refuse to employ him for the reason named?

A. In March, 1879.

63 X Q. In what business or employment was Sawyer engaged at the time he made this demand for a license?

A. He was at work upon a dynamo machine, and also upon a submarine light.

64 X Q. At the time of making this demand did Sawyer ask for employment in the company, or the license you have testified about?

A. He merely demanded the license—said nothing about employment.

65 X Q. When was the Eastern Electric Manufacturing Company organized?

A. I think either in the month of January or February, 1880.

3468 66 X Q. Did that company buy up the stock of the Electro-Dynamic Light Company?

A. No, sir.

67 X Q. What was the basis or foundation for the Eastern Electric Manufacturing Company?

A. Upon patents issued to William Sawyer, William E. Sawyer, Edwin R. Knowles; some to Mr. Stillman—principally to William Sawyer.

68 X Q. In this company were you an officer and stockholder?

A. I was neither.

69 X Q. How was this with regard to William E. Sawyer?

A. I do not know the amount of stock that he held. He was a large stockholder; don't know if he was an officer; he was electrician; he might have been director.

70 X Q. What became of the Electro-Dynamic Light Company?

A. It is still in existence.

71 X Q. And still the owner of the Sawyer-Man patents?

A. No, sir.

72 X Q. Do those patents belong to the Eastern Electric Manufacturing Company?

A. They did, but do not now.

73 X Q. Now explain how the Eastern Electric Manufacturing Company got those patents without buying any stock of the Electro-Dynamic Light Company?

A. They bought the patents of that company.

74 X Q. By that sale did William E. Sawyer get as large an interest in the Eastern Electric Manufacturing Company as he had previously in the Electro-Dynamic Light Company?

A. I don't know what his interest was in either company at the time of that sale. His interest in the dynamic company had at that time been hypothecated to raise money to meat personal expenses, as he told me.

3469 75 X Q. Did Sawyer get employment then in the Eastern Electric Manufacturing Company?

A. Had his office there. He told me he did not receive pay for services.

76 X Q. As I understand you, this transfer put an end to the hostility of William E. Sawyer to the Sawyer-Man patents.

A. It did for a time—only a very short time.

77 X Q. For how long a time?

A. Perhaps a week or two; at longest a month.

78 X Q. After the hostility of Sawyer to the Sawyer-Man patents was renewed, did he still threaten that he could break those patents?

A. He did.

79 X Q. Did he give any reason at any time of the manner in which he could break those Sawyer-Man patents?

A. He did not.

Redirect:

80 R. D. Q. In answer to X Q. 47, you say, "I was present when Mr. Man refused to accede to Mr. Sawyer's demands, and thereupon Mr. Sawyer told Mr. Man that he would do everything to break down those patents."

The next question is, "What had Mr. Man to do with it at that time?" Your answer is, "Nothing." Please state what office, if any, Mr. Man held at that time.

A. He was vice-president of the Electro-Dynamic Light Company, and acting president at that time in the place of the president, Mr. Wallace, and was the chairman of the executive committee. I misunderstood the question, supposing it had reference to what Mr. Man did at the time. Mr. Man at — time made no reply, and took no notice of the threat.

81 R. D. Q. As to this license about which you have testified, upon what terms or conditions did Mr. Sawyer want 3470 to get that license from the Electro-Dynamic Light Company?

A. He offered to pay a royalty that should be satisfactory to the company as a consideration for the license.

Recross:

82 R. X Q. Did Mr. Man give any reason for refusing the license?

A. He did not.

WM. H. CHURCH.

Subscribed and sworn to before me, this 11th day of November, 1882.

J. EDGAR BULL,
Notary Public, New York County, N. Y.

3471 NEW YORK, *November* 10, 1882.

Parties met pursuant to adjournment.

Present: Counsel as before.

ROBERT WHITE, a witness produced on behalf of Sawyer and Man, being duly sworn, in answer to interrogatories propounded by Mr. BROADNAX, testified as follows:

1 Q. What is your name, age, residence and occupation?

A. My name is Robert White; I am twenty-four years old; I reside at No. 50 Clendenny avenue, Jersey City, New Jersey; am a carbonizer.

2 Q. State where and by whom you are at present now employed?

A. I am employed by my father, at 50 Clendenny avenue, Jersey City, N. J.

3 Q. Upon what business are you at present employed?

A. Superintending the repairing of the house, *i. e.*, my father's dwelling.

4 Q. Where were you employed in July, 1881?

A. Was in the employ of Thomas A. Edison, at Menlo Park.

5 Q. State whether you are acquainted with Alexander Welsh?

A. I am.

6 Q. State whether or not you were employed by Mr. Edison as an assistant of Mr. Welsh in July, 1881?

A. I was an assistant to Mr. Welsh at that time, but Mr. Welsh hired me with the knowledge of the superintendent of the Edison electric lamp factory at Menlo Park.

7 Q. State if you recollect of assisting Mr. Welsh to make some specimens of carbon from blotting paper during the time you were employed a- the Edison electric lamp factory?

3472 Counsel for Edison objects to the question on the ground that it calls for evidence not rebutting in its character, and not authorized by the discussion of the Commissioner in reopening this interference.

A. I do.

8 Q. State when it was you assisted Mr. Welsh to make those specimens?

A. To the best of my recollection it was in July, 1881.

9 Q. Was it in the fore part of July, the middle of July, or the last of July?

Same objection.

A. To the best of my recollection it was in the fore part of July, shortly after the fourth.

10 Q. Please to state exactly how those specimens of carbons were made of blotting paper, to the best of your recollection?

Same objection.

A. The blotting paper was placed in an iron mould and covered with charcoal, and then placed in the furnace underneath the boiler, and the mould was brought up to a cherry-red heat, and in taking the mould out the cover was partly knocked off the base of the mould. It was then brought up to the carbonizing department from the boiler-room, and to hasten the cooling of it, Mr. Upton threw water upon it (Mr. Francis Upton); shortly afterwards the carbon was taken out, and we found that they were very poor specimens. I asked for what purpose they were to be used, and was told that they were to be used in a lawsuit that Mr. Edison was interested in. Mr. Francis Upton took them. Mr. Welsh informed me that Mr. Batchelor was to be at the depot to receive the carbons. Shortly afterwards the train passed the factory. I made the remark that Mr. Francis Upton would be too late to deliver those carbons. 3473 Mr. Welsh left the room shortly afterwards, and on his return I asked him if Mr. Francis Upton had seen Mr. Batchelor, and he informed me that Mr. Upton was too late. I asked him what they were going to do about the matter. He told me they were going to send them down to the city by the next train to Mr. Batchelor.

Conversational part of the above answer objected to, as in the nature of hearsay evidence.

11 Q. State, if you recollect whether these specimens of carbon, when they were given to Mr. Upton, or when Mr. Upton took them, were put into a box, and if so, what kind of a box?

Same objection as to question 7.

A. To the best of my recollection they were put in a pasteboard box—a light-colored pasteboard box; I don't remember the size as I merely glanced at it.

12 Q. Who told you that these specimens were to be used as exhibits in a lawsuit in which Mr. Edison was interested?

Same objection.

A. Mr. Welsh.

13 Q. Did you make any remark in reply to Mr. Welsh's statement at the time?

Same objection.

A. I told them they were damned poor specimens.

14 Q. Did Mr. Welsh tell you what lawsuit they were to be used in?

Same objection.

A. He did not.

15 Q. Were they in fact poor specimens?

Same objection.

3474 A. They were about as poor as could be obtained for to be carbonized.

16 Q. Do you mean, by your last answer, that the specimens of carbon were about as poor as they could be?

Same objection.

A. The manner in which they were run through would produce about as poor results as could be obtained.

17 Q. Did you, before or after that, during your employ at the Edison electric lamp factory, assist Mr. Welsh or any one else, to make such specimens of carbonized blotting paper?

Same objection.

A. Not such specimens as those were; but I have made some for the purpose of gaining experience.

18 Q. Do you mean by your last answer, that you made other specimens of carbonized blotting paper, for the purpose of gaining experience in the carbonization of paper and other substances?

Same objection.

A. I do.

19 Q. Was that before or after these specimens were made about which you have been testifying?

Same objection.

A. To the best of my recollection they were afterwards.

20 Q. How long afterwards, to the best of your recollection?

Same objection.

A. About the middle of July.

3475 21 Q. Referring to these last experiments, were they made in the same way that those were made about which you have been testifying?

Same objection.

A. They were not.

22 Q. What was done with them?

Same objection.

A. They were fastened together with some adhesive substance and covered with charcoal and weighted and run through the carbonizing furnace regularly.

23 Q. What was done with the specimens after they were made?

Same objection.

A. Mr. Welsh received them.

24 Q. Were these specimens made of blotting paper, last referred to by you, and made for the purpose of gaining experience in carbonizing, better than those you made in the box in the boiler furnace about which you have been testifying?

Same objection.

A. They were much better.

25 Q. Do you know whether or not these last-mentioned specimens were put in the lamps, and used for electric lighting?

Same objection.

A. I do not, positively; but I understood they were to be used for that purpose.

Direct examination of witness closed.

3476 Counsel for Edison not waiving any of his rights of objection, or waiving the objections heretofore made, proceeds to the cross-examination of the witness.

26 X Q. What was your business or occupation before you began work at the lamp factory at Menlo Park?

A. Plumber.

27 X Q. When did you begin work at Menlo Park?

A. To the best of my recollection, the latter part of March, 1881.

28 X Q. When did you quit work at Menlo Park?

A. To the best of my recollection, the latter part of January, 1882.

29 X Q. What did you do at Menlo Park before you began to help Mr. Welsh?

A. Nothing; I assisted Mr. Welsh from the time of entering their employ.

30 X Q. What was the special nature of your assistance?

A. Helping him in any way he desired me at the furnace.

31 X Q. Did you keep up the fire or the heat in the furnace?

A. If the fireman should be absent for a short time, I would replenish the fire.

32 X Q. What time of the day or night was it when the work was commenced on these blotting-paper carbon specimens?

A. To the best of my recollection, it was about 8'o'clock in the morning.

33 X Q. Was Mr. Francis Upton present during the whole time?

A. No, sir; he was not.

34 X Q. What portion of the time was he present?

A. When the specimens were being prepared, and on their being brought up to the carbonizing department after being carbonized.

35 X Q. Have you talked with Mr. Welsh about this matter?

3477 A. I have had a short conversation with him on this subject.

36 X Q. When was that?

A. Last night.

37 X Q. Where was it?

A. At his home.

38 X Q. How did you happen to go there?

A. He called at my house and told me he would like to see me in the evening.

39 X Q. Did he tell you that he had been testifying?

A. He did.

40 X Q. Did he tell you the substance of the testimony?

A. He did not.

41 X Q. Did he tell you what he had been testifying about?

A. He did.

42 X Q. Did he ask you to come here to-day as a witness?

A. He did.

43 X Q. Did you tell him in the conversation what you recollected about making these blotting-paper carbons?

A. I did not give him all the particulars.

44 X Q. Did you tell him substantially as you have testified that morning?

A. I did not.

Cross-examination closed.

46 R. D. Q. During the time of the making of these specimens of carbon blotting paper was Mr. Francis Upton present when the carbons were put in the box, when the box was put in the furnace of the boiler, and during the time it was in the boiler furnace, and when the box was taken out of the furnace?

A. Mr. Francis Upton was present when the specimens were being prepared, and from the time it was brought from the carbonizing department to their being delivered to him.

3478 47 R. D. Q. I do not understand just what you mean by your last answer; was Mr. Upton present when the blotting paper was put in the box?

A. He was present when it was being prepared to go into the box; to the best of my recollection, he was present when it was put in the box.

48 R. D. Q. Was he present when the box was put in the furnace of the boiler?

A. He was not.

49 R. D. Q. Was he present during the time the box was in the furnace of the boiler?

A. To the best of my recollection he was not.

50 R. D. Q. Was he present when the box was taken out of the furnace?

A. He was not.

51 R. D. Q. How far is this boiler-room from the carbonizing-room?

A. To the best of my judgment about 150 feet.

52 R. D. Q. Now, when this box was taken out of the boiler furnace, was it taken directly to the carbonizing-room?

A. It was.

53 R. D. Q. And was it in the carbonizing-room that Mr. Upton threw the water on the box?

A. It was.

54 R. D. Q. During the time of the carbonization of these specimens, was Mr. Batchelor present any of the time?

A. I did not see him.

Examination of witness closed.

ROBERT WHITE.

Subscribed and sworn to before me this 10th day of November, 1882.

J. EDGAR BULL,
Notary Public, N. Y. Co. N. Y.

3479 Edward R. Knowles, a witness produced on behalf of Sawyer and Man, being duly sworn, in answer to interrogatories propounded by Mr. Broadnax, deposes as follows:

1 Q. What is your name, residence, age and occupation?

A. My name is Edward R. Knowles; age, thirty-one; residence, 122 South Elliott place, Brooklyn; occupation, civil and electric engineer.

2 Q. State whether you are acquainted with William E. Sawyer and Albon Man, and if yea, state when you made their acquaintance as near as you can't recollect?

A. I am acquainted with them; I first met Mr. Sawyer about the 2d of November, 1878, at his laboratory in 94 Walker street; also met Mr. Man at the same place, about the same time, or shortly after.

3 Q. State how you came to make the acquaintance of Mr. Sawyer and Mr. Man?

A. I made their acquaintance through being engaged by them to make drawings for their inventions and to obtain patents.

4 Q. State whether you had any business or social relations with Mr. Sawyer in May, 1879?

A. I was engaged in making drawings for him at that time.

5 Q. State, if you know, whether there occurred between Mr. Sawyer and Mr. Man any difference in their relations, and if so, please state what you know or what Mr. Sawyer told you about it?

A. Well, there occurred a difference between Mr. Sawyer and Mr. Man; I went there at Mr. Sawyer's office from day to day to get drawings, and about the 20th of May Mr. Sawyer told me that he had a split with the Electro-Dynamic Light Company, that they could not agree together, and that the laboratory would be closed.

6 Q. What laboratory do you refer to?

3480 A. The Electro-Dynamic Light Company's laboratory, 94 Walker street.

7 Q. State, if you know, whether that laboratory was closed subsequently, and when it was closed.

A. It was closed; I went there several times and could not get in, and it was closed about the latter part of May, 1879.

8 Q. Where did Mr. Sawyer then locate himself?

A. He took a small office at No. 80 Walker street, at the corner of Courtlandt alley.

9 Q. State, if you know, whether Mr. Sawyer went to Ansonia at that time, and, if so, about how long he remained there?

A. He went to Ansonia on the 22d May, 1879; I can't say how long he stayed there; I next saw him, however, in the early part of September, 1879, at 80 Walker street.

10 Q. State what, if any intercourse you had with Mr. Sawyer, after his return from Ansonia.

A. I still continued to make his drawings for him; he spoke about a new lamp and generator that he was devising, and hinted that it would get around the patents held by the Electro-Dynamic Light Company; he spoke of an exhibition that he was about to make at 226 West Fifty-fourth street, that he proposed to form a new company to work this lamp and machine.

11 Q. State, if you know, whether, in fact, he did form a new company, and what the name of the new company was?

A. He did form a new company; it was called the Eastern Electric Manufacturing Company.

12 Q. After Mr. Sawyer's return from Ansonia, and before the organization of the new company, what, if any, feeling did he express towards the Electro-Dynamic Light Company and Mr. Man?

A. Whenever he spoke with me upon the subject, he expressed himself as strongly opposed to them and their interests.

13 Q. State whether his expressions of opposition were pronounced and bitter?

A. They were.

3481 14 Q. And manifested a determination on his part to do what he could to injure them?

A. They did.

15 Q. State, if you know, whether Mr. Sawyer did, in fact, make his exhibition at 226 West Fifty-fourth street, and if so, state what it was.

A. He did the exhibition the first part of January, 1880.

16 Q. State, if you know, when the new company, the Eastern Electric Manufacturing Company, was organized.

A. Somewhere about the 8th of January, 1880.

17 Q. State where Mr. Sawyer's office was at that time, or his place of business.

A. It was on Elm street, between Canal and Grand, in New York.

18 Q. State whether or not you afterwards went into the employ of the Eastern Electric Manufacturing Company, and if yea, when and where?

A. I went into their employ 22d November, 1880, at 97 Fulton street, New York.

19 Q. State whether Mr. Sawyer was employed then also by that company; also state, if you know, in what capacity he was employed.

A. He was employed then as chief electrician for that company.

20 Q. State, if you know, when the shop at 97 Fulton street was opened?

A. In the latter part of March, 1880.

21 Q. What business was carried on at that works?

A. The making of incandescent electric lamps, dynamo-electric machines, and all necessary experiments and apparatus for the completion of an electric lighting system.

22 Q. In what capacity were you employed there?

A. As assistant electrician.

23 Q. How long did you remain there as assistant electrician?

3482 A. I was assistant electrician until the 22d of November, 1881.

24 Q. State, if you recollect of Mr. Sawyer writing and publishing a book entitled "Electric Lighting by Incandescence," during the time that you were employed there as assistant electrician?

A. I do.

25 Q. Please to look at this book I now show you, marked Edison's Exhibit Sawyer Book, and state if you recognize it as the book referred to by you in your last answer.

A. I do.

26 Q. State whether you made any of the drawings illustrating that book.

A. I did; a portion of them.

27 Q. State, if you know, whether during the time of the writing of such book, Mr. Albon Man visited Mr. Sawyer at the works at 97 Fulton street.

A. He did, two or three times.

28 Q. State, if you recollect, what Mr. Sawyer said upon the occasion of Mr. Man's visits as to his feelings towards Mr. Man and the Electro-Dynamic Light Company.

A. He always acted very fair with Mr. Man while he was present, but spoke against him when he was gone.

29 Q. From what you heard Mr. Sawyer say of Mr. Man and the Electro-Dynamic Light Company, what opinion did you get of Mr. Sawyer's attitude towards them during the time of writing this book?

A. I formed the opinion that he disliked Mr. Man very much, and was very much opposed to the company.

30 Q. Did his expressions leave upon your mind the impression that his hostility was pronounced and unscrupulous?

A. It did.

31 Q. State where you are at present employed.

A. As electrician of the Consolidated Electric Light Company, 127 and 129 Front street, Brooklyn.

3483 32 Q. State whether you are acquainted with Alexander Welsh.

A. I am.

33 Q. State whether you were present this morning at the time he gave his testimony in this case.

A. I was.

34 Q. State whether you saw the specimens of carbon produced by him and put in evidence as exhibits in this case.

A. I did.

35 Q. State, if you please, whether you saw those specimens of carbon made, and of what they were made.

A. I saw them made, they were made of blotting paper.

36 Q. State whether Mr. Welsh's statement of the facts of the preparation of the blotting paper, of its carbonization, and of its tests, accords with your own knowledge of the facts of such preparation, carbonization and tests of said carbons.

A. It does; all except to the test which I did not see performed.

37 Q. State what, if any, experience you have had in making carbons of paper for incandescent electric lighting.

A. I have made paper-carbon loops for incandescent lighting from a number of different kinds of paper a great many times.

38 Q. State when and where you first made such loops.

A. A number of times during the year 1880, at 97 Fulton street, New York city, also at 65 Henry street, Brooklyn, during the year 1882.

39 Q. When you made such carbons at 97 Fulton street, in the year 1880, was that before you made the acquaintance of Mr. Welsh?

A. It was.

40 Q. How long before?

A. About two years.

3484 41 Q. How did you make such loops of carbon? Please describe how you carbonized, and name the different kinds of paper you used in such carbonization.

A. I have made carbon loops from card and bristol board, writing and brown wrapping paper, drawing and blotting paper. I have made them of various forms, in loops or circles, crosses, stars, and a variety of forms. The form I preferred was made by cutting a circular disk with a steel punch from blotting paper, and with a smaller-sized punch cutting another circular disk out of the first disk, thus leaving a narrow circle of paper. In carbonizing, I took a thin sheet or plate of battery carbon, placed a number of these circles upon it, leaving the central portion in them to prevent distortion. I placed on these another plate of carbon, then on that plate more circles, and so on, finishing the pile with a plate of carbon, the whole was then bound strongly together with wire and placed in a black-lead crucible and surrounded and covered by finely powdered carbon. The crucible was then set in a blacksmith's forge, a thick piece of sheet *of* iron lain on top of the crucible, and a fire built all around it and over it. The heat was gradually raised to a bright red, and maintained at that temperature for a long time. The crucible was then allowed to cool, after which, the carbons were taken from it.

42 Q. What use did you make of the carbons you have described in your last answer?

A. I used them for incandescent conductors in electric lamps.

43 Q. In the lamp known as the Sawyer and Man lamp?

A. Yes.

44 Q. Was this during the time that you were assistant electrician with Mr. Sawyer?

A. It was.

45 Q. How long were these carbons continued in a state of incandescence?

3485 A. I have had them run all the way from ten hours to thirty-six hours.

46 Q. And then did they fracture in the lamp?

A. They generally broke close to one of the retaining clamps.

47 Q. State, if you know, why they broke.

A. The interior parts of the lamp were too rigid and did not give quick enough when a current of electricity was suddenly turned on the lamp.

48 Q. Do you wish to be understood as saying that the disruption of the carbon was due to the construction of the machinery of the lamp, or was it due to any imperfection in the carbon?

A. It was due to imperfections in the mechanism of the lamp.

49 Q. Are any of these carbons to which you have referred as being used for illuminating conductors in the lamps made of blotting paper?

A. They were most all made of blotting paper.

50 Q. Previous to the carbonization of the blotting paper was it subjected to a treatment of any kind, or was it carbonized in its natural state?

A. It was carbonized in its natural state.

51 Q. After it was carbonized was it subjected to any treatment, and if yea, what treatment was it subjected to?

A. They were all treated in a hydrocarbon, either a gas or fluid, but generally in ordinary illuminating gas. They were treated by bringing them to incandescence by means of a current of electricity while surrounded by the hydrocarbon. The effect of this treatment was to render them exceedingly dense and hard, so much so that I usually finished them with a file and emery paper.

52 Q. Please to produce any specimens you may have of carbonized blotting paper made by you in the year 1880, previous to their treatment and use as illuminating conductors in the lamps, as you have stated.

A. I now produce two of the U loops and two circles of
3486 carbons made of blotting paper, made during 1880 while I
was with Sawyer as assistant electrician.

Specimens of carbon produced by the witness offered in evidence and marked, Knowles Exhibit Paper Carbon.

53 Q. In preparing these carbons to put in the lamps, what, if anything, did you do to them to make the circuit complete?

A. The carbons were placed in a pair of clamps, and the portion between the clamps on the under side was broken away, they were then treated as before described, smoothed, the ends plated with copper, and they were inserted in the clamps of the lamp, and the lamp sealed and charged with pure nitrogen gas.

54 Q. Are these specimens of carbon of the same size and form as those you used in the lamps of 1880, as you have stated?

A. They are.

55 Q. And they were made in the same way, are the same in every respect, as I understand you, excepting that they have not been treated with an electric current in the pressure of a hydrocarbon gas or liquid; is that correct?

A. Yes; they are.

So much of the foregoing testimony as relates to experiments made in 1880, is objected to as immaterial, and not included in the decision in the reopening of this case.

56 X Q. What were you doing between the time of your employment by the Eastern Electric Manufacturing Company, and the time you entered the employment of the Consolidated Electric Light Company?

A. I was employed as an assistant engineer on the East River bridge, and from thence I went into the employ of the American Electric Light Company, and on the consolidation of that company with the Eastern Electric Light Company, went into the employ of the Consolidated Electric Light Company.

3487 57 X Q. When you left the employment of the Eastern Electric Manufacturing Company were your relations friendly with Mr. W. E. Sawyer?

A. Reasonably so; I have not met him for eight or nine months.

58 X Q. How has he been since?

A. I have not seen him since and have no unfriendly feelings towards him whatever.

Redirect:

59 Q. During the time while Mr. Sawyer was writing the book, Edison Exhibit Sawyer Book, what were his habits, temperate or intemperate, in other words, drunk or sober, most of the time?

A. During the daytime, while I was with him, he was under the influence of liquor the larger portion of the time.

E. R. KNOWLES.

Subscribed and sworn to before me this 23rd day of November, 1882.

J. EDGAR BULL,
Notary Public, N. Y. Co., N. Y.

3488

EXHIBITS.

Agreement between W. E. Sawyer and Albon Man.

Memorandum of agreement between Wm. E. Sawyer, of the first part, and Albon Man, of the second part.

The party of the first part has made certain inventions and obtained certain patents having reference to the distribution, regulation, production and use of electricity, and especially its use for electric lighting and the forms of burners or lamps, and the media, menstru-m or bath, in which light is produced to prevent oxidation, combustion and — and is engaged in experiments in these matters to render the same practical, has agreed to sell and convey to the party of the second part*y* fifty-five one-hundredths parts of all his said inventions and patents and discoveries of and concerning the use, distribution, regulation and production of electric currents, especially as relating to electric lighting and all other matters and things effecting the same, for the sum of $2,500, to be paid to the party of the second part within two months as he may require it—he to procure all necessary patents at his own expense. Man to have ten days to complete his arrangements for associates with him, and $150 to be paid to Sawyer meantime for experiment under the agreement with and between these parties dated February 15, 1878. When all is completed and signed, Sawyer to go on with his experiments and take out his patents, and whenever Man and his associates are ready, a joint stock company to be formed and all inventions and patents to be assigned to it and the stock to go, fifty-five one-hundredths to Man and his associates, and forty-five one-hundredths to Sawyer.

3489 This has no reference to Sawyer's patent electric engine or telegraphs, but does to and includes inventions and discoveries made in aid of electric lighting or other uses of electricity under the experiments above referred to. Dated March 19, 1878.

W. E. SAWYER.
ALBON MAN.

Witness:
WM. H. ALLEN.

Recorded in Liber A 28, p. 117, April 4, 1882.

3490 *Agreement between W. E. Sawyer and Albon Man.*

NEW YORK, *May* 11, 1882.

Whereas, on the 19th day of March, 1878, an agreement was made between the parties hereto, in which reference for particulars is hereby made; and

Whereas, contrary to the expectations of the parties, the plans originally proposed by the party of the first part did not prove practically successful, and the party of the second part then came in and made certain suggestions which were generally adopted, and has, from time to time, made suggestions in relation to the subject-matters of said agreement, which have been adopted, and through which suggestions it is believed that success has been achieved; and

Whereas, the parties hereto are unable to distinguish which of them is the author of different parts of the inventions hereinafter referred to:

Therefore, it is hereby agreed by and between William Edward Sawyer, party of the first part, and Albon Man, party of the second part, in modification of their previous agreement, as follows:

That instead of the letters patent being taken out in the name of the party of the first part solely, that they shall be taken out in the names of both parties hereto, and the interest to be held by said parties in the same shall be to the party of the first part .45, and to the party of the second part .55. In other respects the agreement of March 18, 1878, referred to, shall stand, except that the party of the second part is considered to have accepted, and does hereby accept the inventions mentioned in said agreement and those inven-

tions jointly made by himself and the party of the first part, to wit, .55 of the same, for the sum of $2,500, of which sum the
3491 party of the first part hereby acknowledges the receipt of $1,372.75; the balance, viz., $1,127.25, to be paid to the party of the first part, from time to time, as he may call for the same, to cover the expenses of letters patent about to be applied for in the United States, and to meet his personal expenses.

Certain inventions, covered by letters patent in the United States, as follows: "Electric engineering and lighting apparatus and system," No. 194,111, dated August 14, 1877; "electric candles," No. 194,500, dated August 21, 1877; "electric lighting apparatus," No. 194,563, dated August 28, 1877; and "electric engineering and lighting system," No. 196,834, dated November 6, 1877; having been assigned to the extent of $\frac{3}{5}$ thereof to James Flanagan, and the party of the first part claiming that he has the right, as he stated at the time of making the agreement of March 19, to withdraw the same from the said Flanagan and obtain a reassignment thereof within one year from about the 15th of February last, the party of the first part hereby agrees to assign to the party of the second part the remaining $\frac{2}{5}$ of said patents, which he now holds, and within the time limited by his agreement with said Flanagan, to redeem from him the other $\frac{3}{5}$, and assign the same to the company to be formed by the party of the second part for the purpose of holding and operating under all the patents obtained and to be obtained, which are referred to in this agreement and in the agreement of March 19, 1878.

The inventions herein referred to, which are jointly to be patented by the parties hereto, are to be considered as though they had been the sole inventions of the party of the first part under the agreement of March 19, 1878, and a joint stock company is to be formed and all the patents obtained and to be obtained, as proposed in said agreement, are to be assigned to the said company when formed, including the $\frac{2}{5}$ interest in the four Flanagan patents hereinbefore enumerated and agreed to be assigned to the party of the
3492 second part, and the stock of the company is to be distributed as set forth in said agreement.

The joint inventions of the parties hereto being at present as follows:

Electric lamp,
Regulators for electric lamps, and
Electric lighting system,

and other apparatus and inventions now under consideration. It is fully agreed that the party of the first part shall devote his time and attention exclusively to perfecting the same and to the procurement of United States letters patent upon the same, the expenses of procuring said patents to be borne by him; but after the proposed company is formed, which shall be with all reasonable dispatch after the joint patent on the lamp is obtained, the company is to bear the expenses of all new patents and new inventions.

And the said Sawyer hereby agrees to assign to said company any rights remaining to him in any of his telegraphic inventions, in so far as their application to the purpose of electric lighting is concerned.

W. E. SAWYER.
ALBON MAN.

Witness:
R. M. STRATTON.

Recorded in Liber A 28, p. 118, April 4, 1882.

3493 *Assignment: W. E. Sawyer to Albon Man.*

For and in consideration of one dollar, to me in hand paid by Albon Man, of Brooklyn, New York, and for other good and valuable considerations passing from the said Albon Man to me, the receipt whereof is hereby admitted, I, William E. Sawyer, of the city of New York, have sold, assigned and set over to the said Albon Man, and hereby do sell, assign, transfer, convey and set over unto him, his heirs, executors and assigns forever, two-fifths of each of the following letters patent issued by the United States of America to me, namely, letters patent for "electric engineering and lighting apparatus and system," No. 194,111, dated August 14th, 1877; letters patent for "electric candles," No. 194,500, dated August 21, 1877; letters patent for "electric lighting apparatus," No. 194,563, dated August 28, 1877; and letters patent for "electric engineering and lighting system," No. 196,834, dated November 6, 1877; together with a two-fifth interest in the inventions covered by the said letters patent, or intended to be, with all modifications reissues and extensions thereof, made or to be made, had, obtained or granted to me, my executors, administrators, heirs or assigns. And I do hereby covenant to and with the said Albon Man, his heirs, executors, administrators and assigns, as follows, viz: 1st. That I am the sole and absolute owner at the time of this conveyance of the two-fifth interest in the before-mentioned letters patent, four in number, and have good right and authority to sell and convey the same in manner aforesaid. 2d. That said two-fifth interest in each and every of the four letters patent hereinbefore mentioned, hereby conveyed, or intended to be, is wholly unincumbered and free from all manner of charges, liens, mortgages, conveyances and grants of what nature and kind soever, and solely vested in me at the time of this conveyance. 3d. That I, my heirs, executors or administrators, at the reasonable request of the said Albon Man, his executors, administrators,
3494 heirs, or assigns, and at his or their cost and expense, will
make any other assignment or conveyance for the better assuring the title of the said two-fifths interest in the said letters patent in him, them or either of them, which by him, them or his, or their counsel learned in the law shall be reasonably advised, devised or required; and further, that for the better protection of my said assignee and grantee, his heirs, executors, administrators and assigns, I, my heirs, executors and administrators shall and will, at his or their expense, make any explanations for reissue of any of said patents from time to time, and for modifications thereof, and

for extension thereof, which he, they or his or their counsel learned in the law may advise or request, and assign and convey all such reissues (to the extent of the two-fifths interest hereby granted), modifications and extensions to said Man, his heirs, executors, administrators and assigns.

4th. I do hereby covenant for myself, my executors and administrators, to warrant and defend the title of the said Albon Man, his heirs, executors, administrators and assigns, in and to the said two-fifths interest in the said letters patent hereby granted or intended to be, against all persons claiming or to claim the same by, through or under me in any manner whatsoever.

In witness whereof, I have hereto set my hand and seal this 14th day of May, one thousand eight hundred and seventy-eight.

W. E. SAWYER. [SEAL.]

Sealed and delivered in presence of—
WM. SAWYER.

3495 STATE OF NEW YORK,
City and County of New York, } *ss:*

On this 14th of May, 1878, before me personally came William E. Sawyer, to me well and personally known, and known to me to be the same person described in and who executed the foregoing instrument, and acknowledged to me that he executed the same.

J. C. CROKER,
Notary Public, N. Y. Co.

County clerk's certificate appended.
Recorded in Liber S 22, p. 494, May 16, 1878.

3496 *Assignment: Sawyer and Man to Electro-Dynamic Light Co.*

Whereas, William E. Sawyer, of Brooklyn, N. Y., and Albon Man, of New York, N. Y., did obtain letters patent of the United States of America for certain improvements in electric lighting systems, which letters patent bear date the 25th day of June eighteen hundred and seventy-eight, and numbered 205,303;

And whereas, the Electro-Dynamic Light Company, a corporation formed under the laws of the State of New York, is desirous of acquiring an interest therein:

Now this indenture witnesseth, that for and in consideration of the issuing to us of stock and scrip of said company, and of the sum of one dollar to us, the said Sawyer and Man, in hand paid, the receipt of which is hereby acknowledged, we have assigned, sold and set over, and do hereby assign, sell and set over unto the said The Electro-Dynamic Light Company all the right, title and interest which we have in said invention, as secured to us by said letters patent, the same to be held and enjoyed by the said The Electro-Dynamic Light Company for its own use and behoof, and for the use and behoof of its legal representatives, to the full end of the term for which said letters patent are granted, as fully and entirely as the same would have been held and enjoyed by us if this assignment and sale had not been made, together with all renewals thereo and improvements thereon.

In testimony whereof we hereunto set our hands and affix our seals this 15th day of June, eighteen hundred and seventy-eight.

W. E. SAWYER. [SEAL.]
ALBON MAN. [SEAL.]

Sealed and delivered in presence of—
WILL. MAN.

Recorded in Liber C 24, page 300, May 29, 1879.

3497 *Assignment: Sawyer and Man to Electro-Dynamic Light Co.*

Whereas, William E. Sawyer and Albon Man did obtain letters patent of the United States of America for certain improvements in electric lamps, which letters patent bear date the 18th day of June, eighteen hundred and seventy-eight, and numbered 205,144.

And whereas, the Electro-Dynamic Light Company, a corporation formed under the laws of the State of New York, is desirous of acquiring an interest therein.

Now, this indenture witnesseth, that for and in consideration of the issuing to us of stock and scrip of the said company and of the sum of one dollar to us, the said Sawyer and Man, in hand paid, the receipt of which is hereby acknowledged, we have assigned, sold and set over, and do hereby assign, sell and set over unto the said The Electro-Dynamic Light Company, all right, title and interest which we have in the said invention, as secured to us by said letters patent.

The same to be held and enjoyed by the said The Electro-Dynamic Light Company for its own use and behoof, and for the use and behoof of its legal representatives to the full end of the term for which said letters patent are granted, as fully and entirely as the same would have been held and enjoyed by us if this assignment and sale had not been made, together with all renewals thereof and improvements thereof.

In testimony whereof we hereunto set our hands and affix our seals this 15th day of July, eighteen hundred and seventy-eight.

W. E. SAWYER. [SEAL.]
ALBON MAN. [SEAL.]

Sealed and delivered in presence of—
WILL. MAN.

Recorded in Liber C 24, page 299, May 29th, 1879.

3498 *Agreement: Sawyer and Man to Electro-Dynamic Light Co.*

Whereas, William E. Sawyer, of New York, and Albon Man, of Brooklyn, New York, did obtain letters patent of the United States of America for certain improvements in regulators for electric lights, which letters patent bear date the 25th day of June, eighteen hundred and seventy-eight, and numbered 205,305.

And whereas, the Electro-Dynamic Light Company, a corporation formed under the laws of the State of New York, is desirous of acquiring an interest therein.

Now this indenture witnesseth, that for and in consideration of the issuing to us of stock and scrip of the said company and of the sum of one dollar to us, the said Sawyer and Man, in hand paid, the receipt of which is hereby acknowledged, we have assigned, sold and set over, and do hereby assign, sell and set over, unto the said The Electro-Dynamic Light Company all the right, title and interest which we have in the said invention, as secured to us by said letters patent.

The same to be held and enjoyed by the said The Electro-Dynamic Light Company for its own use and behoof, and for the use and behoof of its legal representatives, to the full end of the term for which said letters patent are granted, as fully and entirely as the same would have been held and enjoyed by us if this assignment and sale had not been made, together with all renewals thereof or improvements ther-n.

In testimony wher-*h*f we hereunto set our hands and affix our seals this 15th day of July, eighteen hundred and seventy-eight.

W. E. SAWYER. [SEAL.]
ALBON MAN. [SEAL.]

Sealed and delivered in presence of—

WILL. MAN.

Recorded in Liber C 24, page 301, May 29th, 1879.

3499 *Assignment: A. Man to Electro-Dynamic Light Co.*

Whereas, I Albon Man, of the city of New York, have heretofore become interested with William E. Sawyer in various patents and inventions having general reference to the subject of producing light by means of electric currents and to the producing and conducting of such currents; now, in consideration of one dollar to me paid by the Electro-Dynamic Light Company, I do hereby sell, assign, transfer and set over to the said company, its successors and assigns, absolutely, certain agreements, and all my right, title and interest thereunder and therein, and all rights to accrue therefrom to me, which were made by me with the said William E. Sawyer, and which are dated respectively, February 15, 1878, March 19th, 1878, March 25, 1878, and May 11, 1878, together with the right to receive, take and hold any letters patent of the United States, or interest in or under any such letters patent, and all interests in improvements in electric apparatus, systems or lights in the said agreements referred to, as fully as the same are secured to me under the said agreements, I hereby relinquish in favor of said company, all my right, title and interest of every kind under the said agreements, for the United States of America.

In witness whereof I have hereunto set my hand and seal the fifteenth day of July, one thousand eight hundred and seventy-eight.

ALBON MAN.

Sealed and delivered in presence of—

WILL. MAN.

Recorded in Liber A 28, page 121, April 4th, 1882.

3500 *Assignment: Sawyer and Man to Electro-Dynamic Light Co.*

Whereas, we, William Edward Sawyer, of the city, county and State of New York, and Albon Man, of Brooklyn, county of Kings and State aforesaid, have made the following-entitled invention, viz:

Firstly. Certain improvements in "electric lighting apparatus and circuits."

Secondly. Certain improvements in "carbons for electric light" and in the treatment thereof;

—for which we are about to apply for letters patent of the United States; and whereas, the "Electro-Dynamic Light Company," a corporation created and existing under and by virtue of the laws of the State of New York, have purchased of us all our right, title and interest in and to said inventions, and any and all letters patent of the United States which may hereafter be granted for the same, and has paid us for the said inventions the sum of one dollar and given us other good and sufficient consideration for the same, the receipt of which we hereby acknowledge and with which we hereby declare ourselves satisfied, contented and paid; Now, therefore, upon consideration aforesaid, we the said William Edward Sawyer and Albon Man, have and do hereby sell, assign and convey to the said company the whole of our right, title and interest in and to said inventions and any and all United States letters patent which may hereafter be granted for the same, for the said company to have, hold and enjoy for its own use and behoof, and for the use and behoof of its legal representatives, as fully and entirely as we would have held and enjoyed the same had this assignment and sale not been made, for the whole term for which said letters patent may be granted, including any extensions thereof, and through the whole of the United States and territories thereof, and we do hereby covenant, for ourselves and our legal representatives, that we are 3501 now the sole owners of said inventions, and have good right and lawful authority to make and execute this conveyance in manner aforesaid, and that we will at any and all proper and reasonable times make and execute any and all proper papers that may be necessary to apply for and obtain letters patent of the United States for said inventions, and any and all proper papers that may be necessary to vest the title thereof in said corporation.

In witness whereof, we have hereunto set our hands and seals this the 14th day of October, 1878.

W. E. SAWYER. [SEAL.]
ALBON MAN. [SEAL.]

Witness:
WILLIAM H. BROADNAX.
AMOS BROADNAX.

Recorded in Liber H 23, p. 448, Oct. 22, 1878.

3502 *Assignment: W. E. Sawyer to Electro-Dynamic Light Co.*

Whereas, I, William Edward Sawyer, of the city, county and State of New York, have made the following-entitled invention, viz:

A new and useful electric meter, for which I am about to apply for letters patent of the United States;

And whereas, the Electro-Dynamic Light Company, a corporation created and existing under and by virtue of the laws of the State of New York, has purchased of me all my right, title and interest in and to said invention, and any and all letters patent of the United States, which may be hereafter granted for the same, and has paid me for the said invention the sum of one dollar, and given me other good and sufficient consideration for the same, the receipt of which is hereby acknowledged, and with which I hereby declare myself satisfied, contented and paid;

Now, therefore, upon consideration aforesaid, I, the said William Edward Sawyer, have and do hereby sell, assign and convey to the said company the whole of my right, title and interest in and to said invention, and any and all letters patent of the United States, which may hereafter be granted for the same. For the said company to have, hold and enjoy for its own use and behoof, and for the use and behoof of its legal representatives as fully and entirely as I would have held and enjoyed the same, had this assignment and sale not been made, for the whole term for which said letters patent may be granted, and through all the renewals and extensions thereof, throughout the whole of the United States and the territories thereof.

And I do hereby covenant for myself and my legal representatives, with said company that I am now the sole owner of said invention and have good right and lawful authority to make
3503 and execute this conveyance in manner and form as aforesaid. And that I will at any and all proper and reasonable times, make and execute any and all proper papers that may be necessary to apply for and obtain letters patent of the United States for s-id invention, and any and all proper papers that may be necessary to vest the title thereto in said company.

[SEAL.] In witness whereof, I have hereunto set my hand and seal in presence of the subscribing witness.

W. E. SAWYER.

Witness:
AMOS BROADNAX.

Dated October 16th, 1878.
Recorded in Liber H 23, page 449, Oct. 22d, 1878.

3504 *Assignment: Sawyer and Man to Electro-Dynamic Light Co.*

Whereas, we, William Edward Sawyer of New York city, and Albon Man of the city of Brooklyn, have invented certain new and useful improvements in electric lamps, for which we, on the fourth day of November, 1878, made application for letters patent of the United States in due form of law:

And whereas, the Electro-Dynamic Light Company, a corporation duly created and organized under and by virtue of the laws of the State of New York, and having its principal place of business at No. 94 Walker street, in the city of New York, has purchased of us all our right, title and interest in and to said invention, and has paid us therefor the sum of one dollar, and given us other good and sufficient consideration for the same, the receipt of which we hereby acknowledge, and with which we hereby declare ourselves satisfied, contented and paid;

Now, therefore, for the consideration aforesaid, we, the said Sawyer and Man, have, and we do hereby assign, transfer and convey to the said Electro-Dynamic Light Company all our right, title and interest in and to said invention, and in and to any and all letters patent of the United States, which may be granted or obtained for the same, in and for the whole of the United States and the territories thereof, for the whole of the term of said letters patent, and through all the renewals and extensions thereof, for the said company to have, hold and enjoy for its own use and behoof and for the use and behoof of its legal representatives as full- and entirely as we would have held and enjoyed the same had this assignment and sale not been made.

And we, the said Sawyer and Man, do hereby covenant with the said company that previous to, and at the time of selling said invention to said company, as aforesaid, we were the sole owners of said invention described, illustrated and claimed in 3505 said application for a patent, and that we have now good right and lawful authority to make this assignment, and convey the whole of the title to said invention and letters patent, hereby conveyed, or intended so to be, in manner as aforesaid; and that we will, at any and all reasonable times, make, execute and deliver, at the cost of said company, any and all papers or instruments of writing necessary in the law to obtain any reissue or extension of said letters patent, and vest the title thereof in said company.

In witness whereof, we have hereunto set our hands and seals this sixth day of November, 1878.

W. E. SAWYER.
ALBON MAN.

In presence of the subscribing witness—
AMOS BROADNAX.

Recorded in Liber K 25, page 170, November 12th, 1878.

3506 *Assignment: W. E. Sawyer to Electro-Dynamic Light Co.*

Whereas, I, William Edward Sawyer, of the city, county and State of New York, have invented certain improvements in "Electric lighting apparatus," for which I filed an application for letters patent of the United States, December 2d, 1878.

And have also invented certain improvements in electric lamps, for which I also filed an application for letters patent of the United States, December 2, 1878.

And have also invented a certain improved dynamo-electric machine, for which I have prepared an application for letters patent of the United States, dated December 16, 1878.

And have also invented certain other improvements in electric lamps, for which I filed an application for letters patent of the United States November 30th, 1878.

And have also invented a certain improved thermo-lamp, for which I filed an application for letters patent of the United States November 25th, 1878.

And have also invented certain other improvements in electric lighting apparatus, for which I filed an application for letters patent of the United States November 19th, 1878.

And have also invented certain other improvements in electric lamps, for which I filed an application for letters patent of the United States November 19th, 1878.

And whereas, the Electro-Dynamic Light Company, a corporation created and organized under and by virtue of the laws of the State of New York, have purchased of me all my right, title 3507 and interest in and to said inventions, and any and all letters patent of the United States that may be granted for the same, and have paid me therefor the sum of one dollar, and given me other good and sufficient consideration for the same, the receipt of which I hereby acknowledge, and with which I hereby declare myself satisfied, contented and paid.

I, the said William Edward Sawyer, have sold, and do hereby assign, transfer and convey to the said Electro-Dynamic Light Company all my right, title and interest in and to each and all of said inventions; and each and all letters patent which may be granted for said inventions, upon said applications, or any renewals or amendments thereof, for the said company to have, hold and enjoy for its own use and behoof, and the use and behoof of its successors and assigns to the full end of the term for which said letters patent may be granted, and through all the renewals and extensions thereof, and I do hereby authorize and request the Commissioner of Patents to issue said letters patent, applied for as aforesaid, to the Electro-Dynamic Light Company as the assignee of all my right, title and interest in and to the same as aforesaid.

Witness my hand and seal this 9th day of December, 1878.

W. E. SAWYER.

Witness:

EDWIN L. MYERS.

Recorded in Liber Z 55, page 55, March 14th, 1879.

3508 *Assignment: Sawyer and Man to Electro-Dynamic Light Co.*

Whereas we, William Edward Sawyer, of the city and county of New York, in the State of New York, and Albon Man, of Brooklyn, county of Kings, and State *of* aforesaid, have invented certain improvements in electric lighting apparatus and circuits, for which we filed an application for letters patent of the United States, November 22d, 1878.

And have also invented certain new and useful improvements in carbons for electric lights, for which we also filed an application for letters patent, November 29th, 1878.

And have also invented certain new and useful improvements in electric commutators, for which we filed an application for letters patent of the United States, December 5th, 1878.

And have also invented certain new and useful improvements in electric switches, for which we filed an application for letters patents of the United States, December 5th, 1878.

And, whereas, the Electro-Dynamic Light Company, a corporation created and organized under and by virtue of the laws of the State of New York, have purchased of us all our right, title and interest in and to said inventions, and any and all letters patent of the United States that may be granted for the same; and have paid us therefor the sum of one dollar, and given us other good and sufficient consideration for the same, the receipt of which we hereby acknowledge, and with which we hereby declare ourselves satisfied, contented and paid.

We, the said William Edward Sawyer and Albon Man, have sold and do hereby assign, transfer and convey to the said Electro-Dynamic Light Company, all our right, title and interest in 3509 and to each and all of said inventions, and each and all letters patent, which may be granted for said inventions upon said applications, or any renewals or amendments thereof, for the said company, to have, hold and enjoy for its own use and behoof, and the use and behoof of its successors or assigns, to the full end of the term for which said letters patent may be granted, and through all the renewals and extensions thereof. And we do hereby authorize and request the Commissioner of Patents to issue said letters patent applied for as aforesaid to the Electro-Dynamic Light Company as the assignee of all our right, title and interest in and to the same, as aforesaid.

In witness whereof, we have hereunto set our hands and seals this the ninth day of December, 1878, in the presence of the subscribing witness.

[SEAL.] W. E. SAWYER.
[SEAL.] ALBON MAN.

Witness:
EDWARD L. MYERS.

Recorded in Liber U 23, page 456, March 14, 1879.

3510 *Assignment: W. E. Sawyer to Electro-Dynamic Light Co.*

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the records of this office of an assignment from William Edward Sawyer to the Electro-Dynamic Light Company, recorded in Liber Q 24, page 10, and said record has been carefully compared with the original, and is a correct transcript thereof.

In testimony whereof I, E. M. Marble, Commissioner of Patents, have caused the seal of the Patent Office to be affixed this 12th day of December, in the year of our Lord one thousand eight hundred and eighty-two, and of the Independence of the United States the one hundred and seventh.

[SEAL.] E. M. MARBLE,
Commissioner.

Whereas I, William E. Sawyer, of the city, county and State of New York, have invented certain new and useful improvements in electric lamps for which I have applied for letters patent of the United States April 23, 1879; and for which letters patent of the United States was allowed June 28, 1879, as appears by a notice of the Commissioner of Patents dated the day and year last aforesaid.

And, whereas, the Electro-Dynamic Light Company of New York, have purchased of me all my right, title and interest in and to said invention, and in and to the letters patent allowed for the 3511 same as aforesaid; and in and to any and all letters patent of the United States which may be hereafter granted, issued, reissued or extended for said invention, as described in said application for said patent, and has paid me therefor the sum of one dollar, lawful money of the United States, and has given me other good and sufficient considerations for the same, the receipt of which I hereby acknowledge, and with which I hereby declare myself satisfied, contented and paid. I, the said William E. Sawyer, for the consideration aforesaid, do hereby assign, transfer and convey to the said Electro-Dynamic Light Company the whole of my right, title and interest in and to said invention, and any and all letters patent of the United States, which may be hereafter granted, issued, reissued or extended for said invention. For the said company to have, hold and enjoy for its own use and behoof, and the use and behoof of its legal representatives, to the full end of the term for which the same may be granted, issued, reissued or extended, the same as I would have held and enjoyed the same, had this assignment and sale not been made.

And I, the said William E. Sawyer, do hereby covenant, with the said Electro-Dynamic Light Company, that I am now the sole owner of said invention; and to any and all letters patent of the United States which may be granted for the same, and that I have good right and lawful authority to make and execute this conveyance in manner and form as aforesaid.

In witness whereof, I have hereunto set my hand and seal this thirtieth day of July, 1879.

[SEAL.] WILLIAM EDWARD SAWYER.

Witnesses:
AMBROSE E. BEARDSLEY.
WILLIAM L. DURANT.

Recorded, September 1st, 1879. Examined: M. McK.; E. H.

3512 Whereas, William Edward Sawyer, of the city, county and State of New York, and Albon Man, of Brooklyn, in the county of Kings and State of New York, have now obtained certain letters patent of the United States, dated and numbered as follows: Letters patent No. 210,151, dated November 19th, 1878, granted to William Edward Sawyer, as sole inventor, for electric meter; letters patent No. 210,152, dated November 19th, 1878, granted to William Edward Sawyer and Albon Man, as joint inventors, for switch for electric lights; letters patent No. 210,809, dated December 10th, 1878, granted to William Edward Sawyer and Albon Man as joint inventors, for improved electric lamp; letters patent No. 211,262, dated January 7th, 1879, as joint inventors, for carbon for electric lights; and

Whereas, the said William Edward Sawyer and Albon Man have heretofore, by certain instruments in writing, covenanted and agreed with the Electric-Dynamic Light Company, for the consideration therein mentioned, *do* convey to said company the whole of the title to said letters patent and inventions:

Now, therefore, in fulfillment of said agreements and covenants, and for the consideration therein mentioned, and for the further consideration of one dollar to them in hand paid by said company, the receipt of which is hereby acknowledged, and with which the said Sawyer and Man declare themselves satisfied, contented and paid, the said Sawyer and Man do hereby assign, transfer and convey to the said Electro-Dynamic Light Company, a corporation duly created and organized under and by virtue of the laws of the State of New York, the whole of the title to each and all of said letters patent and inventions. The said Sawyer, as sole inventor and owner of patent No. 210,151, and the said Sawyer and Man, as joint inventors and owners of all the rest of said patents, for the whole of the United States and the territories thereof, for the whole of the term for which the said letters patent are granted or may be
3513 granted by reason of any extension or renewal thereof, for the said company, its successors and assigns, to have and to hold for its and their own use and behoof as fully and entirely as the said Sawyer and Man might or could have held and enjoyed the same had this conveyance not been made.

In witness whereof, the said William Edward Sawyer and Albon

Man have hereunto set their hands and seals this the third day of February, 1879.

WILLIAM EDWARD SAWYER.
ALBON MAN.

Signed, sealed and delivered in presence of
EDWIN L. MEYERS.

Recorded in Liber C 24, page 302, May 29th, 1879.

3514 To all to whom these presents shall come or may concern, Greeting:

Know ye, that I, William E. Sawyer, of the city of New York, for and in consideration of the sum of forty-nine thousand dollars, lawful money of the United States of America, to me in hand paid by the Electro-Dynamic Light Company, of the same city, by hand of Albon Man, Hough McCulluck, James P. Kernochan, Lawrence Myers, Jacob Hays and Wm. H. Hays, the receipt whereof is hereby acknowledged, have remised, released, and forever discharged, and by these presents do for myself, my heirs, executors and administrators, remise, release, and forever discharge the said company, its officers and trustees, and other heirs, executors and administrators, of and from all and all manner of action and actions, cause and causes of actions, suits, debts, dues, sums of money, accounts, reckonings, bonds, bills, specialties, covenants, contracts, controversies, agreements, promises, variances, trespasses, damages, judgments, extents, executions, claims and demands whatsoever, in law or in equity, which against the said company, its officers or trustees, I ever had, now have, or which I or my heirs, executors or administrators, hereafter can, shall or may have, for, upon, or by reason of any matter, cause or thing whatsoever, from the beginning of the world to the day of the date of these presents, except a claim against said company, not yet adjusted, for services in August, 1878, not exceeding $250 in amount, and $100 and interest due me for stock sold Horace Little, for which said company received payment, and which latter claim I have assigned to Albon Man.

In witness whereof, I have hereunto set my hand and seal the 21st day of May, in the year of our Lord, one thousand eight hundred and seventy-nine.

W. E. SAWYER. [SEAL.]

Sealed and delivered in presence of—

—— ——.

3515 State of New York, City and County of New York, } ss:

On this 21st day of May, 1879, before me personally came William E. Sawyer, to me well known to be the same person described in, and who executed the within instrument, and acknowledged to me that he had executed the same.

ALBON MAN,
Notary Public, Kings County, N. Y.

Certificate of appointment filed in clerk's office of city and county of New York.

Recorded in Liber A 28, page 121, April 4, 1882.

3516 Whereas I, William E. Sawyer, of the city, county, and State of New York, having invented certain new and useful improvements in electric lamps, for which I have applied for letters patent of the United States April 23d, 1879; and for which letters patent of the United States was allowed June 28th, 1879, as appears by a notice of the Commissioner of Patents dated the day and year last aforesaid;

And whereas, the Electro-Dynamic Light Company of New York has purchased of me all my right, title and interest in and to said invention, and in and to the letters patent allowed for the same as aforesaid, and in and to any and all letters patent of the United States which may be hereafter granted, issued, reissued or extended for said invention, as described in said application for said patent, and has paid me therefor the sum of one dollar, lawful money of the United States, and has given me other good and sufficient consideration for the same, the receipt of which I hereby acknowledge, and with which I hereby declare myself satisfied, content and paid. I, the said William E. Sawyer, for the consideration aforesaid, do hereby assign, transfer and convey to the said Electro-Dynamic Light Company the whole of my right, title and interest in and to said invention, and any and all letters patent of the United States which may be hereafter granted, issued, reissued or extended for said invention. For the said company to have, hold and enjoy for its own use and behoof, and the use and behoof of its legal representatives to the full end of the term for which the same may be granted, issued, reissued or extended, the same as I would have held and enjoyed the same had this assignment and sale not been made.

And I, the said William E. Sawyer, do hereby covenant with the said Electro-Dynamic Light Company that I am now the sole owner of said invention, and to any and all letters patent of the United States which may be granted for the same, and that I have
3517 good right and lawful authority to make and execute this conveyance in manner and form as aforesaid.

In witness whereof, I have hereunto set my hand and seal this 30th day of July, 1879.

[SEAL.] WM. EDWARD SAWYER.

Witnesses:
AMBROSE E. BEARDLY.
WM. L. DURANT.

Recorded in Liber Q 24, p. 10, Sept. 2, 1879.

In consideration of the sum of five dollars to us in hand paid, we hereby assign, sell and set over to the Electro-Dynamic Light Company of New York our entire right, title and interest in and to an improvement in electric lights, as set forth in an application this day prepared and executed by us preparatory to applying for letters patent therefor, and we hereby request the Commissioner of Patents to issue the said patent to the aforesaid company as our assignee.

WM. EDWARD SAWYER.
ALBON MAN.

Witnesses:
WM. H. CHURCH.
WM. D. BALDWIN.

Recorded in Liber W 24, p. 380, Jan. 9th, 1880.
Ex'd: J. A. W.; M. McK.

3518 COMPLAINANT'S EXHIBIT PATENT OFFICE PROCEEDINGS NO. 5.

Oral Testimony in Interference. May 11, 1886. T. G., Ex'r.

CONSOLIDATED ELECTRIC LIGHT CO.
vs. } H, 3553.
EDISON ELECTRIC LIGHT CO. *et al.*

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed have been carefully compared with the files of this office and are true copies of certain papers in the matter of the interference Sawyer and Man *vs.* Thomas A. Edison, for improvement in electric lights.

In testimony whereof I, M. V. Montgomery, Commissioner of Patents, have caused the seal of the Patent Office to be [SEAL.] affixed this 22d day of June, in the year of our Lord one thousand eight hundred and eighty-five, and of the Independence of the United States, the one hundred and ninth.

M. V. MONTGOMERY,
Commissioner.

3519 In the United States Patent Office.

SAWYER AND MAN
vs. } Electric Lights.
EDISON.

To Amos Broadnax, Esq., attorney for Sawyer and Man:

Please take notice that, on Friday, April 13, 1883, at 10 o'clock, a. m., at No. 65 Fifth avenue, New York city, I shall proceed to take the testimony of Francis R. Upton, William Holzer and others, as witnesses in behalf of Mr. Edison, in the above-named interference.

The examination will be continued from day to day until completed. You are invited to be present and cross-examine.

RICHARD N. DYER,
For Edison.

Service acknowledged this 10th day of April, 1883.

AMOS BROADNAX,
Per W. H. BROADNAX.

U. S. Patent Office, May 7, 1883.

3520 In the United States Patent Office.

SAWYER AND MAN }
vs. } Interference. Electric Lights.
EDISON. }

In pursuance of the annexed notice, the parties to the above interference attended before me this 14th day of April, 1883, by attorney, as follows: Sawyer and Man by Amos Broadnax, counsel, and Thomas A. Edison by George W. Dyer, Esq., counsel.

By consent the further taking of testimony is postponed until Wednesday, April 18th, at 10 a. m.

WM. H. MEADOWCROFT,
Notary Public, New York Co.

3521 Pursuant to adjournment the taking of testimony was continued the 18th day of April, 1883.

Present: Amos Broadnax, counsel for Sawyer and Man; Geo. W. Dyer, counsel for Edison.

FRANCIS R. UPTON, a witness produced on behalf of Edison, being duly sworn, testifies as follows in answer to questions proposed by GEO. W. DYER, counsel for Edison:

1 Q. You have already testified in this case, haven't you?

A. Yes.

2 Q. Do you know Alexander Welsh, who has testified in this case as a witness for Sawyer and Man?

A. Yes.

3 Q. When did you first become acquainted with him?

A. I first met him in the fall of 1880.

4 Q. Under what circumstances?

A. He was employed in the lamp factory, and I came in contact with him in my visits to that place; the Edison lamp factory at Menlo Park was referred to.

5 Q. How long did Welsh work at the lamp factory at Menlo Park?

A. Until about February, 1882.

6 Q. What was his employment when he first worked at the lamp factory?

A. My impression is he was employed in exhausting the lamps.

7 Q. Do you know how long it was after that, he began to work at carbonizing?

A. He commenced carbonizing about February, 1881.

8 Q. Did he commence then to learn the business of carbonizing?

3522 A. He had some slight acquaintance of the methods used from seeing the process carried on. When he commenced at this time, he was instructed specially in this branch and gave his whole time to it.

9 Q. Were his instructions confined to Mr. Edison's methods of carbonizing?

A. As far as I know they were.

10 Q. Was there any time he was given full charge of the carbonizing, and if so, about what time was that?

A. From the time he was employed in carbonizing until he was discharged, he was given full charge of the carbonizing.

11 Q. Do you remember the time when he was thus employed in the carbonizing?

A. From February, 1881, till February, 1882, is my recollection.

12 Q. Why was Alexander Welsh discharged?

A. Because we had lost confidence in him.

13 Q. For what reason?

A. When he was placed in charge of the carbonizing it was expressly mentioned that he should report experiments truthfully. We were satisfied he was not doing so; this lack of truthfulness had become a by-word in our factory.

14 Q. Since he was discharged what has been his attitude towards the Edison Electric Light Co. and the interests of Mr. Edison?

A. Most of the time active opposition.

15 Q. What instances, if any, can you give of active opposition?

A. It has come to my knowledge several times that he was employed in trying to get workmen in the Edison interests away to other companies.

16 Q. Mr. Welsh in his testimony says that you made promises which you failed to fulfil, which led in consequence to a very bad feeling between us; this was an answer to X Q. 105. Have you anything to say in regard to this statement of Mr. Welsh?

3523 A. I have absolutely no recollection of any unfilled promises to Mr. Welsh. I had no bad feeling towards him, except that I had been provoked by finding out how grossly he had abused the opportunities that were given him.

17 Q. Mr. Welsh says in his redirect testimony, in answer to questions 116 and 117, that he has since been solicited to return to the employ of Mr. Edison by yourself. Have you anything to say as to that?

A. After his discharge from the lamp factory I was desirous of preventing him from carrying information gained by him at the employ of the lamp factory to opposition companies. I recommended him to the superintendent of the Isolated Company as a bright man, at the same time cautioning him regarding his habit of untruthfulness.

18 Q. Do you know Robert White, a witness, who has testified in this case in behalf of Sawyer and Man?

A. I do.

19 Q. Did he work at the lamp factory at Menlo Park, and if so, in what capacity?

A. He worked there as fireman in carbonizing.

20 Q. About what time did he leave the lamp factory and under what circumstances?

A. He was discharged at the same time as Welsh.

21 Q. Why was he discharged?

A. Because we did not think it prudent to discharge Welsh and leave his intimate friend behind.

22 Q. Mr. Welsh testifies that he made certain exhib-s of paper carbon on a morning in July, 1881, between about 7.15 and a quarter to 8, and that it was necessary to complete them at that hour because the train left at eight (8) for New York, and Robert White testifies that you were present during a portion of the time when such exhibits were being made. What recollection have you as to the facts thus testified about?

A. I have no distinct recollection of being present at the time mentioned. I am very positive that there was no train at eight for New York.

3524 24 Q. What hour nearest that time did the train run?

A. At 7.30, within a very few minutes; the next train after was 9.20.

24½ Q. Robert White testifies that in that carbonization you threw water upon the carbonizing box to hasten the cooling of it. What do you say to that statement?

A. I do not recollect doing anything of the kind.

25 Q. He testifies further that you then carried away the specimens of carbonized paper for the purposes, Mr. Welsh informed him, of giving them to Mr. Chas. Batchelor, at the depot. What have you to say to that statement?

A. I can't recollect so doing.

26 Q. Do you remember the fact that at the time Mr. Batchelor testified in this case, in July, 1881, he produced specimens of carbonized paper purporting to have been made in the manner described by Mr. Man and Mr. Sawyer in their previous testimony in this case?

A. I have been informed that he did so.

27 Q. Have you any knowledge or information who made those exhibits produced by Mr. Batchelor, and where they were made and during what time of the day?

A. I have always understood that he (Mr. Batchelor) made them himself, assisted by Mr. Atcheson, the night before he testified regarding them, and that they were made in the laboratory at Menlo Park.

28 Q. Was the laboratory a distinct building from the lamp factory, and, if so, about what distance from it?

A. It was entirely distinct and separated from the lamp factory by a distance of about 1,500 feet. The lamp factory was at the foot of the hill, the laboratory on top. Men employed in one were not allowed in the other, except on business.

3525 29 Q. Were you present during the time when Mr. Alexander Welsh gave his evidence in this case?

A. I was most of the time.

30 Q. Were you present when Alexander Welsh produced and put in evidence samples of carbonized paper purporting to have been made in accordance with descriptions in the former testimony of Mr. Man and Mr. Sawyer?

A. I was.

31 Q. Did you examine such specimens at the time sufficiently to form an opinion upon them?

A. I did.

32 Q. What opinion did you then form of them, as adapted to practical use, in incandescent electric lamps?

A. I formed a very decided opinion that for practical use in incandescent electric lamps they would prove an utter failure. First, in manufacturing lamps the breakage in clamping such loops would be so great as to preclude their use in competition with materials now ordinarily used. Secondly, owing to the irregularity of the carbon they, if it were possible to bring them to incandescence, would be so irregular as to shorten their life very materially. Third, owing to their extreme lack of elasticity it would be almost impossible to transport lamps if such could be made.

33 Q. In the first reason given in the previous answer, what would cause the breakage in clamping, referred to in that answer?

A. In clamping carbons it is necessary to handle them and to hold them firmly. From my experience, I should judge there would be great liability of breakage in either of these operations. The cause of it would be the friable nature of the carbon. I scarcely dared touch the exhibits for fear of breaking them.

FRANCIS R. UPTON.

By consent the further taking of testimony was postponed to Thursday, April 19th, at 10 a. m.

3526 THURSDAY, *April 19th.*

Parties met pursuant to adjournment. Same counsel being present, and PHILIP S. DYER, being duly sworn, is produced as a witness in behalf of Thomas A. Edison, and answers to the questions propounded to him as follows:

1 Q. Please give your name, age, residence and occupation.

A. Name, Philip S. Dyer; age, 26; residence, East Newark, N. J.; employed as book-keeper for the Edison lamp factory.

2 Q. How long have you been in the employ of the Edison lamp factory as book-keeper?

A. Since January 1st, 1881.

3 Q. Do you know Alexander Welsh, who has testified as a witness in this case in behalf of Sawyer and Man?

A. Yes.

4 Q. Was he at any time in the employ of the Edison Lamp Company at Menlo Park?

A. Yes, sir.

5 Q. When did he enter such employ?

A. About October 1st, 1880.

6 Q. When did he take charge of carbonizing?

A. About the latter part of January, 1881.

7 Q. When did he leave the employ of the Edison Lamp Company?

A. Latter part of January, 1882; discharged.

8 Q. Why was he discharged, if you know?

A. Considered untrustworthy and unreliable.

9 Q. Do you know what his reputation for veracity was among the employees of the company?

A. Very bad.

10 Q. Do you know Robert White who testified as a witness in this case for Sawyer and Man?

A. I do.

11 Q. Do you know when he was employed by the Edison Lamp Company at Menlo Park?

A. Yes, sir.

3527 12 Q. What date was it?

A. Middle of April, 1881.

13 Q. When did he leave the employ of the Edison Lamp Company and why?

A. In the latter part of January, 1882; discharged because he was considered unreliable and a friend of Alexander Welsh.

14 Q. What do you know about Mr. Alexander Welsh having attempted to entice away men from the Edison Lamp Company after he had been discharged by them?

A. I know of a conversation he had with one man and know of a telegram he sent to another man, and that man told me Welsh was trying to get him.

Answer objected to as mere hearsay.

Cross-examination by Amos Broadnax, counsel for Sawyer and Man:

15 X Q. What was in the telegram?

A. Welsh wanted this man to meet him at Brooklyn on a certain night.

16 X Q. What was the man's name?

A. Robert McKune.

17 X Q. When was that?

A. I think in the fall of 1882

18 X Q. What time in the fall of 1882 was it?

A. I can't say definitely.

19 X Q. Please to repeat the words of the telegram.

A. As near as I can remember "Meet me in Brooklyn this evening;" I can't remember where the place was.

20 X Q. And you inferred from the language of that telegram that Mr. Welsh was trying to induce the man McKune to leave the employ of the Edison Lamp Company, as I understand it?

3528 A. I inferred that from the telegram after what McKune told me that Welsh had been trying to get him to go over there previous to that time.

21 X Q. What did McKune tell you, please to repeat his words as near as you can?

A. That Welsh had sent word to him several times to meet him.

22 X Q. To meet him for what purpose?

A. Relative to taking a position in the company that Welsh was with.

23 X Q. Did McKune meet him?

A. Not to my knowledge.

24 X Q. How did McKune come to make this statement to you that Welsh was trying to get him to leave the employ of the Edison Lamp Co.?

A. On account of my giving him the telegram, and friendly relations between us, he being about my age. All the telegrams came to my office by telephone.

25 X Q. What was Mr. McKune's duties in the Edison lamp factory?

A. Cutting bamboo fibres for use in the Edison lamp.

26 X Q. Can't you fix the time a little more definitely when you received this telegram for Mr. McKune?

A. No, sir.

27 X Q. Did you ever know Mr. Welsh to tell a falsehood?

A. Yes, sir.

29 X Q. What did he lie about?

A. Everything.

29½ X Q. Lied all the time?

A. Yes, sir; pretty near all the time.

30 X Q. Can't you mention something he lied about?

A. Yes, sir.

31 X Q. Please do so.

A. He lied to me one time about owning a horse. He lied to me several times about his accounts.

32 X Q. Did he swear to these lies, any of them?

A. No, sir.

3529 33 X Q. How do you fix the dates of the time that Mr. Welsh went in the employ of the Edison Lamp Company and the time that he left the employ of that company?

A. From records now in the hands of the Edison Lamp Company.

34 X Q. Do you refer to the time books of the Edison Lamp Co.?

A. Yes, sir.

35 X Q. Who kept those books at the time you say Mr. Welsh went in the employ of that company?

A. The assistant in the office at Menlo Park, John Randolph.

36 X Q. Did you examine that book before you came here to give testimony yourself?

A. I examined that book first when I went in the employ of the Edison Lamp Company in 1881.

37 X Q. When did you last examine it upon this question of fixing time when Mr. Welsh went in the employ of the Edison Lamp Company and when he left that employ?

A. I examined the book last which contains the memorandum of his entering the employ of the Edison Lamp Co. last week, not with any idea of testifying here.

38 X Q. How large is that book?

A. Larger than a sheet of legal-cap paper.

39 X Q. How thick and how much larger?

A. The cover of the book is 9x14, and 1¾ inches thick.

40 X Q. If you can do so, please to produce the book?

A. I do produce the book.

41 X Q. Please to take this book and read from it all the entries you can find in it respecting the time credited to Alexander Welsh.

3530 A. I do so. (Witness reads from page 166.)

Alexander Welsh.

1880.					
Oct. 7th.	By 68 hours	7	....		$4 76
" "	To check			$4 76	
" 14.	By 60 hours		....		4 20
" "	To check			4 20	
" 21.	By 75 hours		....		5 25
" "	To check			5 25	
" 28.	By 90 hours		....		6 30
" "	To check			6 30	
Nov. 4.	By 69 hours	8⅓	....		5 75
" "	To check			5 75	

42 X Q. Is that all you find in the book that goes to show the time when Mr. Welsh entered the employ of the Edison Lamp Company, and when he left it?

A. That is all I find in that book to show when he entered the Edison Lamp Company's employ.

43 X Q. How does that account show that Mr. Welsh did not enter the employ of the Edison Lamp Company before October 1st, 1880?

A. The first entry of his name and the first account that we had with him and the first knowledge of a man by the name of Alexander Welsh.

44 X Q. Was this book kept by the Edison Lamp Company or by Thomas A. Edison?

A. Strictly speaking, it was kept by the employees of T. A. Edison, but the Edison Lamp Company paid for the man's services keeping the account.

45 X Q. Do you know of your own knowledge that Alexander Welsh was not in the employ of Thomas A. Edison or the Edison Lamp Company previous to Oct. 1st, 1880?

A. No, sir.

46 X Q. Is your statement that Alexander Welsh went in the employ of the Edison Lamp Company first on October 1st, 1880, based upon the entry in this book you have already quoted?

A. Not wholly.

3531 47 X Q. What other fact or circumstance, is your statement to that fact based upon?

A. Conversations with Welsh and other employees of the Edison Lamp Co.

48 X Q. Please to repeat what conversation you may have had with Mr. Welsh upon that subject.

A. Conversation was general; it was a curiosity to know what time Welsh went to work for the Edison Lamp Company.

49 X Q. Can you swear to anything that Mr. Welsh said that enables you to fix that date?

A. A conversation that I remember having one time with Welsh about the rights of the older employees of the lamp company. Welsh only being there a few months previous to my going there our rights were about equal.

50 X Q. Is that all?

A. Yes; I remember Welsh saying that he was three or four months before I. I also remember Mr. Holzer the superintendent saying so, and others.

Redirect examination by Geo. W. Dyer:

51 R. D. Q. This book that you testified about; what is written on the outside of the book?

A. "Time book."

52 R. D. Q. What is printed on the back of the book?

A. "T. A. Edison."

53 R. D. Q. After you went into the employ of the Edison Lamp Company were regular books first started for that company?

A. Yes, sir.

54 R. D. Q. By whom and under whose directions?

A. By Mr. Wm. Carman under the directions, I suppose, of Mr. Edison. Mr. Carman started the books, and then I kept them afterwards.

55 R. D. Q. Was this account of Mr. Welsh that you have quoted transferred to the company's books?

A. It was.

3532 56 R. D. Q. And charged against the Edison Lamp Company?

A. Yes, sir.

57 R. D. Q. Was that the earliest account in which Mr. Alexander Welsh's name appears on the books of the Edison Lamp Company?

A. Yes, sir.

58 R. D. Q. Do you know how the morning trains from Menlo Park to New York ran in July, 1881?

A. Yes, sir.

59 R. D. Q. What were the hours?

A. 6.65 first; 7.21, 9.21 and 11.21

Recross-examination by Mr. Broadnax:

60 R. X Q. What is printed on the side of this book about which you have testified?

A. "Platina."

PHILIP S. DYER.

(En'd: J. A. W. M. McK.)

3533 State of New York, }
County of New York, } *ss:*

I, J. Edgar Bull, a notary public within and for the county of New York, do hereby certify that the exhibits referred to in the annexed sheets were duly marked by me and were offered in evidence on the 11th day of October, 1882, by George W. Dyer, Esq., on behalf of Thomas A. Edison, that Amos Broadnax, Esq., was present as counsel for Sawyer and Man, that I am not connected by blood or marriage with either of said parties, nor interested directly, or indirectly, in the matter in controversy.

In testimony whereof I have hereunto set my hand [SEAL.] and affixed my seal of office this 16th day of February, 1883.

J. EDGAR BULL,
Notary Public, N. Y. Co., N. Y.

3534 & 3535

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *June* 2, 1882.

In Re Interference SAWYER AND MAN *v.* EDISON. } Before the Examiner of Interferences.

Subject-matter: Electric lamps or lights.

Sawyer and Man, care of A. Broadnax, 8 and 10 Pine street, N. Y. city;
Thomas A. Edison, care of Geo. W. Dyer, Washington, D. C.:

Please find below a communication from the examiner in charge of interference, in regard to the above-cited case.

An appeal may be taken from the decision of the examiner within twenty days, (see § 4904, Revised Statutes).

Very respectfully,

E. M. MARBLE,
Commissioner of Patents.

3536 Room No. 1.

In the matter of the interference above referred to, upon which a hearing was appointed for the 7th day of May, 1883, the question of priority of invention has been decided in favor of Sawyer and Man.

J. B. CHURCH,
Examiner of Interferences.

(Endorsement: 7768; office to Sawyer and Man and Edison in interference decided in favor of Sawyer and Man June 2, 1883.)

3537 In the United States Patent Office.

SAWYER AND MAN *vs.* EDISON. } Before the Examiner of Interferences.

Application of Sawyer and Man, filed January 9, 1880.

Application of Edison, filed December 11, 1879.

The invention involved in this controversy is:
"The incandescent conductor for an electric lamp, formed of carbonized paper."

A decision was rendered in this case by this tribunal on the 20th of January, 1882, but, on motion in behalf of Edison, accompanied by certain affidavits and other evidence, the Commissioner reopened the case, with leave to take new testimony. The case has now been considered in connection with the testimony before filed and that introduced under the order of the Commissioner.

It appears from testimony on both sides that carbonized paper has certain qualities which are generally considered very desirable, if not indispensable, for an incandescent conductor, but it also has defects which if not cured, cause its destruction in such a brief period as to render it of no practical value in the system of electric lighting. It is found that carbonized paper if used as a conductor in the open air, or in such a vacuum as can be obtained by ordinary apparatus, has a life of only a few minutes. The two parties to this interference have discovered methods of using this paper so as to utilize its desirable qualities and lengthen its life to such an extent as to make a practical operative incandescent electric lamp instead of obtaining mere momentary flashes of light as were given 3538 in their first experiments. For those reasons we do not regard the use of paper carbon abstractly as within the issue, which must be construed to be paper carbon embodied in an operative combination. Though the methods employed for producing this effect are dissimilar in some respects, yet the paper carbon is the basis of the system, and the party who first invented some manner of practically applying the paper carbon so as to adapt it to use is entitled to an award upon the issue involved herein.

Sawyer and Man made experiments in March, 1878, in which paper carbons were used, and perceiving the difficulties, numerous methods of obviating them were resorted to. During that spring the resistance of the paper carbon was made more uniform by treating it with powdered plumbago and with a hydrocarbon vapor or liquid, and oxygen was excluded from the chamber containing the incandescent conductor either by creating a partial vacuum therein or by filling the chamber with a gas (preferably nitrogen).

These experiments were contiuued until the following autumn or winter, and the light of a lamp containing the paper carbon was extended from a few minutes to some hours. Such is the testimony of all the witnesses examined on this point.

It is urged by the opposing party that Sawyer and Man no longer employed a paper carbon, but that it was so modified by the treatment as to become a different composition, and so be removed from the controversy. To this it may be replied that the paper carbon still exhibited its desirable qualities, while its defects were modified to such an extent as to produce a decided improvement in electric lighting. The principle was the same, though the improvements from a failure brought success. A product may receive additions which remove certain of its defects and yet retain the valuable properties and capacities of the original, and then, because it is an improvement, it is none the less within the scope of the basic product. (See Goodyear Dental Vulcanite Company *vs.* Evans, 3 Fisher, page 390.)

3539 Many other considerations besides durability of the incandescent conductor enter into the question of the commercial success of the electric light, and it is not thought necessary to determine in this case whether either of the parties has produced such a light, but simply to ascertain which first employed paper carbon in an operative lamp in such a manner as to demonstrate its practicability as an incandescent conductor. No precise limit of time for the duration of the conductor can be fixed upon, but generally it may be said that an existence of a few moments would not satisfy the conditions required of a conductor, while an existence of some hours would. According to the testimony presented, Sawyer and Man had succeeded in employing paper carbons in such a manner that they lasted some hours at least as early as the autumn of 1878. The life of the carbons varied, but the majority of them burned from five to twenty hours.

It is argued, however, that certain newspaper articles and a book written by Sawyer to show that the experiments conducted by Sawyer and Man were unsuccessful and abandoned. As the case was reopened on account of this evidence, it is deemed advisable to give it special attention. In an article to the New York Herald the following paragraph occurs:

"If you care to settle the question of priority of invention upon the horseshoe lamp as between Mr. Edison and myself, you may inspect one of those lamps which broke down a- No. 94 Walker street about a year ago, and, after many experiments, was so far condemned that Mr. Man and I concluded we would not waste money enough on it to pay for a patent. This lamp is at present just exactly as it was when removed from the bracket, hermetically sealed in a glass globe filled with nitrogen gas, and in just exactly the same condition it was a year ago. To avoid any question I placed said abandoned institution in the hand of Messrs. Arnoux and Hochhausen, number 2 Howard street, yesterday (Monday) morning at nine o'clock."

3540 This letter bears date December 23, 1879. Of the three newspaper articles it is the only one which bears on the question of abandonment by Sawyer and Man. What lamp is this which is referred to?

From the fact that it was made at Walker street, and at about the same time, and with the one now in controversy, the inference is sought to be drawn that it is identical with the one now in question. But it is thought that other facts point more strongly the other way. It is nowhere stated in the article that it was a paper-carbon lamp. The letter says that Sawyer and Man did not think the lamp therein referred to worth patenting, while the testimony of Broadnax shows that they did wish to patent the paper-carbon lamp. As before stated, the letter is dated December 23, 1879, and then refers to that lamp as an abandoned institution, but an application for a patent was executed for the paper-carbon lamp about two weeks thereafter.

The burden of proof is upon Edison to identify the lamp mentioned in the letter with the paper-carbon lamp, but it is not thought he has sustained this point.

In the book introduced in evidence, denominated Electric Lighting, Sawyer, a chapter is devoted to incandescent carbons, and the following sentence occurs:

"The carbonization of live willow twigs, with a view to obtaining a suitable bent carbon by Sawyer and Man, and the carbonization of paper and bamboo by Edison substantially close the account of incandescent carbon."

The book was published in 1881, and Sawyer and Man's application herein involved was before the office. It would be difficult to fathom Sawyer's exact motives in mentioning the fact that Edison had carbonized paper, without at the same time adverting to his own efforts in the same direction. It may be, that knowing 3541 his claim was on file in the Patent Office, he preferred to rest upon that, without publishing it to the world, and by so doing obtain a patent without the expenses of a conflict with rival inventors. Indeed, it seems very plausible that both the letters and the book were intended to throw Edison of his guard, so that Sawyer and Man's patent might be first secured.

At any rate, such an explanation is more consistent with his other acts, and the testimony in the case, than the theory advanced by the other side, that he regarded his former efforts as unsuccessful experiments.

If, however, it be admitted that the articles in the newspapers refer to the paper-carbon lamp, and that Sawyer's derogatory expressions indicate that the experiments made by Sawyer and Man were unsuccessful, and were abandoned, then it becomes necessary to weight this evidence against the other evidence to a contrary effect.

And we find that a large preponderance of the evidence contradicts most positively the implication of abandonment deduced from these publications. Furthermore, it is shown that at the date of these publications, Sawyer was hostile to the company which was working this invention.

After an examination of the entire record, it must be held that Sawyer and Man reduced this invention to practice at least as early as the autumn of 1878.

The testimony in behalf of Edison shows that carbon from paper was made by him in 1876, but it was for other purposes than electric lighting. He, however, seems to have been aware of its quality of high resistance for small surfaces.

Experiments were made by Edison and his assistants relating to incandescent electric lamps in the autumn of 1877 and 1878, and amongst the almost innumerable materials tested it appears that carbonized paper was included. It is in evidence that in the first attempt at making an incandescent lamp Edison wished to put a hard-carbon piece into the globe, but as great difficulty was 3542 experienced in making the carbon small enough, he suggested to his assistant that he should cut the carbon from carbonized paper, of which they had a quantity on hand (Batchelor, answer to Q. 10).

This 1877 test was unsatisfactory, as the carbon could only be made to last a few minutes (Edison answers to X QQ. 104, 163, 153. Batchelor answer to Q. 37).

He then tried boron and silicon, and in 1878 made a second attempt with paper carbons, but this was equally unsatisfactory, as he could not get the paper carbon to stand. He then gave up paper carbon and sought for some more durable material. Platinum was selected, and he testifies that between January, 1879, and the autumn of that year he was "engaged night and day" on experiments with platinum as a conductor (answer to X Q. 242.)

The trouble with the paper carbons was that they would not last, being quickly oxidized in the partial vacuum which he then attained. In the autumn of 1879, however, while experimenting in another direction, he obtained a much more perfect vacuum, and it then occurred to him that perhaps the paper carbon would stand in such a vacuum. Following up this idea, he commenced experiments again with the paper carbon, and they ended in success, as he succeeded in making a lamp which would burn some hours.

The autumn of 1879 may, therefore, be fixed upon as the date of Edison's reduction to practice.

It is quite clear that the former attempts had been discontinued because of unsatisfactory results, and that he had abandoned the idea of employing paper carbons; hence the earlier efforts cannot be regarded save as abortive experiments which are of no avail in this contest.

Indeed, Edison himself stated that it was not until the autumn of 1879 that he reached the conviction that electric lighting could be successfully accomplished by the employment of carbonized paper as a conductor, for it was only then that he learned
3543 what were the proper conditions. (See Edison's answer to X Q. 259.) The earliest date of invention which can be accorded Edison is the autumn of 1879.

In the argument in behalf of Sawyer and Man reference is made to a motion filed before the first hearing for the suppression of certain testimony in behalf Edison, on the ground that it is inconsistent with the preliminary statement as first filed.

Edison was allowed to amend this statement, and the motion to suppress the testimony was denied, after due consideration, and no reason is now seen for changing the former action. It is also contended that the newspaper articles and book are not competent evidence, but whatever opinion this tribunal may have on this point will not be expressed, as the matter is regarded as having been practically passed upon in the decision of the Commissioner reopening the case.

Sawyer and Man must be adjudged to be the prior inventors.

J. B. CHURCH, *Ex.*

Frank F. Brown, asst. exam'r.
June 2, 1883.

(Endorsement: 7768; 62; Sawyer and Man *vs.* Edison; decision; recorded; vol. 14, p. 432; June 2nd, 1883.)

3544 *Index.*

Interference. No. 7768.

SAWYER AND MAN
vs.
EDISON.

Subject-matter: Electric lamps or lights.

1	Sept.	25,	'80.	Declaration.
2	Oct.	"	"	State. of S. and Man.
3	"	"	"	" " Edison.
4	"	"	"	Office letters.
5	Nov.	5,	"	Preliminary statement of Man.
6	"	11,	"	" " " Edison.
7	"	11,	"	Notice of hearing.
8	"	20,	"	Stipulation.
9	"	22,	"	Office letter.
10	"	23,	"	" "
11	Dec.	9,	"	" "
12	Jan.	26,	'81.	Motion by S. and M.
13	Feb.	14,	"	Office letter.
14	"	16,	"	Request of S. and M.
15	"	23,	"	Office letter.
16	"	26,	"	Motion by Sawyer and Man.
17	M'ch	2,	"	Office letter.
18	Ap'l	18,	"	Stipulation.
19	"	"	"	Office letter.
20	May	20,	"	Stipulation.
21	"	"	"	Office letter.
22	June	20,	"	Stipulation.
23	"	21,	"	Motion by Edison.
24	"	20,	"	Office letter.
25	"	21,	"	" "
26				
27	"	29,	"	Stipulation.

3545

28	"	"	"	Office letter.
29	Aug.	8,	"	Stipulation.
30	"	9,	"	Office letter.
31	Sep.	27,	"	Stipulation.
32	"	"	"	H'g p'p'd to Nov. 2, '81.
33	Oct.	20,	"	Stipulation.
34	"	21,	"	Office letter.
35	Nov.	29,	"	Record for Edison.
36	"	"	"	Test'y and exhibits for Edison.
37	Dec.	5,	"	Office letter.

38	Dec.	12,	'81.	Request of S. and M.
39	"	13,	"	Office letter.
40	"	23,	"	Test'y for Sawyer and Man.
41	"	"	"	Record for Sawyer and Man.
42	"	"	"	Brief for Sawyer and Man.
43	Jan.	19,	'82.	Office letter.
44	"	20,	"	Decision.
45	"	"	"	Notice of decision.
46	Feb.	9,	"	Office letter.
47	July	31,	"	" "
48	Aug.	7,	"	Stipulation.
49	"	8,	"	Office letter.
50	Sep.	30,	"	Stipulation.
51	"	"	"	Office letter.
52	Nov.	27,	"	Stipulation.
53	"	28,	"	H'g p'p'd Jan. 5, '83.
54	Dec.	16,	"	Stipulation.
55	"	17,	"	H'g p'p'd Feb. 5, '83.
56	Feb.	9,	'83.	Stipulation.
57	"	10,	"	Office letter.
58	"	17,	"	Test'y for Edison.
59	"	27,	"	Stipulation.
60	"	28,	"	Office letter.
61	Mar.	17,	"	Office letter.
62	June	2,	"	Decision.
63	"	2,	"	Notice of decision.

3546 Complainant's Exhibit Patent Office Proceedings No. 9.

Edison's appeal to examiner-in-chief, May 11, 1886. T. G., ex'r.

Consolidated Electric Light Co.
vs. } G, 3553.
Edison Electric Light Co. *et al.*

Department of the Interior,
United States Patent Office.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the files of this office of the file-wrapper and contents in the matter of the appeal to the examiners-in-chief of Thomas A. Edison, filed June 21, 1883, number 79851 for improvement in electric lamps.

In testimony whereof, I, M. V. Montgomery, Commissioner of Patents, have caused the seal of the patent office to be affixed, this 19th day of June, in the year of our Lord one thousand eight hundred and eighty-five and of the Independence of the United States the one hundred and ninth.

M. V. MONTGOMERY,
Commissioner.

3547 SAWYER AND MAN *vs.* EDISON. } Interference. Electric Lamps.

Appeal to the examiners-in-chief.

To the Hon. Commissioner of Patents:

In this case, I respectfully appeal to the board of examiners-in-chief, from the decision of the examiner of interferences, who, on June 2, 1883, awarded priority of invention to Sawyer and Man, and assign the following

Reasons of Appeal.

1. The examiner of interferences erred in awarding priority of invention to Sawyer and Man.
2. The examiner of interferences erred in not awarding priority of invention to Edison.
3. He also erred in holding that the "built-up" carbon conductor of Sawyer and Man was the paper-carbon conductor in issue.
4. He also erred in holding that the lamp of Sawyer and Man, referred to in Sawyer's newspaper letters, was not the kind of lamp in issue.
5. He also erred in holding that the statements in Sawyer's book were designedly untrue, and intended to deceive.

An oral hearing is requested.

THOMAS A. EDISON,
By GEO. W. DYER, *Attorney.*

Washington, D. C., June 21, 1883.

(Endorsement: 7985; interference; 1; Sawyer and Man *vs.* Edison; appeal to board; Thomas A. Edison; reasons of appeal; filed June 21, 1883; *In re* Interference Wm. E. Sawyer and A. Man. *vs.* Thomas A. Edison. U. S. Patent Office June 21, 1883.)

3548 Room No. 3.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *June* 23, 1883.

Thomas A. Edison, care Geo. W. Dyer, attorney, present; Wm. E. Sawyer and A. Man, care Amos Broadnax, attorney, No. 57 Broadway, New York city, N. Y.

SIR: The appeal from decision of the examiner o- interferences in the case of Sawyer and Man *vs.* Edison; subject-matter "electric lamps or lights," will be heard by the examiners-in-chief. at 1 p. m., on Wednesday, July 18, 1883.

Very respectfully,
E. M. MARBLE,
Commissioner of Patents.

(Endorsement: 7985; 2; Wm. E. Sawyer and A. Man. *v.* Thomas A. Edison; "copy" notice of hear——

3549
No. 7985.

United States Patent Office, July 28, 1883.

Before the examiners-in-chief.

On appeal.

In the matter of the interference between the application of William E. Sawyer and Albon Man, filed January 9, 1880, and the application of Thomas A. Edison, filed December 11, 1879.

Improvement in Electric Lamps or Lights.

The matter in contest is embraced in the claim of Edison, as follows:

"The incandescent conductor for an electric lamp formed of carbonized paper."

Edison applied December 11, 1879, and after referring to his former patent for an electric lamp, wherein a filament of carbon is shown enclosed in a glass bulb, and the atmosphere removed, etc., he sets forth his invention to be an improvement in the process of making the carbon, and sets forth the improved character of the carbon so made of paper, and the advantages of its high resistance and small volume, over slight resistance and greater bulk.

His whole specification is devoted to this single paper carbon, and that is made the gist of his claim.

Now let us see when he first conceived of this specific device for this specific object, and see if he followed it up by experiment with reasonable diligence until he reduced it to practice and made his application.

The evidence shows conclusively that he commenced experimenting with paper to form carbon for various uses and purposes, in his electrical labors, experiments and inventions, which are of public notoriety and knowledge, in 1876, and discovered and had full knowledge of its property for great electrical resistance, which would qualify it for the precise purpose for which he afterwards
employed it on his theory set forth in his specification, for
3550 incandescent light. In 1877, he more particularly devoted
his inventive thoughts and labors to producing an electric lamp or light, of the incandescent class, which should be able to "compete with gas, and be a commercial success." Following up his theory, he, amongst other things, employed a paper carbon pure and simple, in a lamp which is now before us, Edison's Exhibit First Incandescent Lamp; he had discovered and knew as well then as now, that to be able to hold this slight filament of high resisting carbon against the destructive effects of the atmosphere in the presence of electricity, he must have as nearly a perfect vacuum as possible. He did the best he could to secure one; and so far succeeded that he was enabled to fully demonstrate the correctness of his theory, and the adaptability and practicability of the paper carbon. He also knew that such carbon would make suitable con-

ductors in incandescent electric lamps (see X Ans. 397, page 140, printed testimony, and Ans. 372–3, page 86).

What he required to perfect, not the carbon, but the lamp, was more perfect means to exhaust the air from the lamp, and a more perfect seal to keep it out when once expelled.

The first came to his hand in a foreign invention, the mercury air pump, with which he could exhaust the lamp to the "millionth of an atmosphere."

The second defect in the lamp he obviated by employing platinum wires fused in the glass which formed nearly a perfect seal. When this was done the lamp was perfected as now patented to him, and the paper carbons that he had formerly invented and reduced to practice in his 1877 lamp, now before us, came into use and have been put into thousands of these lamps and successfully used, without any change, addition or improvement whatever.

So far then as this paper carbon in contest is concerned, Edison conceived of it in 1876, and experimented with it for an electric lamp in 1877, and in September of that year put it to a practical test in a lamp, and afterwards experimented further in 1878, and kept on testing and perfecting his lamp, and fully reduced the perfected thing to practice, and put it on the market, and publicly exhibited it in 1879. 3551

We see no possible ground for charging lack of diligence from conception to complete perfection, and application, and giving to the public.

Certainly Sawyer and Man cannot successfully challenge him, since he came first to the office.

Now, as regards Sawyer and Man. They applied January 9, 1880, and set forth and claimed:

"1. Incandescing arcs for electric lights.
"2. Incandescing arcs of carbon.
"3. Incandescing arcs of carbonized paper.
"4. Incandescing arc of carbonized fibrous or textile material."

In their specification they say that their "improved burner consists in an arch-shape piece of carbon shown as 'A' in their drawing."

They lay no stress at all upon the character of this carbon, except as to this arch form, saying that they have tried carbonized paper covered with powdered plumbago, wood, carbon or charcoal, and ordinary gas carbon.

All was fish coming to their net, any kind of carbon, if in the form of an arch, came within their supposed invention and claims, and certainly the carbonized paper and plumbago was not the "paper carbon" pure and simple of Edison.

A substitute specification was afterwards filed by their attorney, in which is repeated the declaration that their "improvement consists in the employment of an incandescent arc of carbon," etc., and more fully sets forth the "advantages of the arched form," and say they have used such burners in the presence of nitrogen and hydrogen gas in vacuum chambers, etc., and they claim: 3552

1. An incandescing arc, of carbonized fibrous textile material, and of an arch or horseshoe shape.

2. The combination of such a shaped carbon and a transparent, hermetically sealed chamber from which oxygen, etc., are excluded.

3. Like combination with addition of transparent, hermetically sealed chamber, from which oxygen, etc., are excluded.

"4. The combination, substantially as hereinbefore set forth, of an electric circuit, an incandescent arc of carbonized paper included in and forming part of said circuit, and a transparent, hermetically sealed chamber, in which the arc is enclosed."

All of these claims were rejected, except the 4th,—the examiner holding that there was no patentable novelty in the form, etc.

This 4th claim was put in interference with Edison's first.

But there is nothing in their specification to show that they considered themselves the inventors of anything, except this form, as regards paper carbon, they merely say that they have "tried" "paper and plumbago" together with various other substances. They lay no stress at all upon the paper-plumbago carbon as being in any way different or superior to the other carbon tried. They claim any and all carbon in that shape. There is then no good basis in their specification for making any such claim as that made by Edison.

At most they set forth a claim to use paper carbon alternately, and as the equivalent of any other carbon in the specific form, and for the purpose set forth.

3553 Now, when we come to look at their proofs, we find the same thing in regard to their trying paper with other substances in making carbons, and experimenting with electric incandescent lamps.

Everywhere it is the same thing—using paper indiscriminately with other things, such as "fibrous and textile material," embraced in their first claim.

In fact, Sawyer swears that "what Man did not do in the way of carbonizing different things can't be imagined."

There is nothing to show that they considered paper superior to any of the other things. Indeed upon the theory upon which they were working, and in the lamp which they brought forth, it had no special value. It was employed rather as a vehicle to carry the real carbon. It was a skeleton upon which they built up their comparatively large and hard carbon, the thing which they had to "treat" by burning it electrically in the presence of hydrocarbons, to secure a deposit upon it of "hard condensed carbon," suitable for their theory of low resistance and greater quantity of electrical current (Man's testimony, ans. 17 and 18; Church, ans. 39; Wm. E. Sawyer, fol. 268, ans. 5, p. 67, and ans. 6; Church, X ans. 92 and 94, p. 100; Man's, p. 103, folio 411).

Sawyer fully recognizes the difference between Edison's theory, on which he reduced his lamp—having this attenuated paper carbon pure and simple—to practical and commercial success; and the theory upon which he and Man were working, while they tried paper-plumbago carbons treated to secure additional bulk of carbon.

He says: "Mr. Man's idea and mine upon the question of resistance began to differ. That is to say, my theory that the most perfect electric lamp would be one in which the incandescent conductor had the highest resistance and the least transverse mass (the theory on which Edison worked out his invention) was gradually abandoned by myself, while largely retained by Mr. Man; my present theory being that the most perfect electric lamp is
3554 one in which the incandescent conductor has not only the least transverse mass, but the least resistance; I soon began to reduce the resistance of my carbons to as low as an ohm; at present I make them only ¼ ohm, therefore I would treat the carbons so as to obtain a heavy deposit." (X ans. 42), and he adds that "Mr. Man reduced the resistance in his carbons from 50 to 75 per cent. by the treatment referred to." That is the "Sawyer and Man treatment," which was patented to them.

They commenced their experiments with paper and other things in the spring of 1878.

Sawyer says Man took pieces of blotting paper, rubbing and pounding graphite into them until they were full, and carbonized by electrical currents in the presence of illuminating gas. Mr. Man also packed blotting paper in powdered gas-retort carbon, and carbonized in an iron box heated in a range.

These were "treated" in the presence of hydrocarbon and tried in a lamp. The experiment was not satisfactory to Sawyer, at least. He says his own idea was that a "harder carbon would be better than those thin, fragile paper carbons, but Mr. Man preferred the paper," etc.

And the question is asked him by his own attorney, "After you had the paper carbons made, state whether you treated them electrically in the presence of hydrocarbon, for the purpose of consolidating and enlarging them," and he answers, "I did." (See also Man's testimony, ans. 17, p. 7. where he speaks of their thus "perfecting the carbon by a deposit of carbon from the gas," etc., "over the whole carbon," etc.

In regard to these experiments in 1878, Sawyer says, that certain carbons shown in a drawing produced, were "positively used, were sealed up and run; the great trouble with them was when we raised the temperature till we could get a bright light, they would break; for this reason I preferred the harder carbon, we finally made them hard enough by treating them in hydrocarbon gas by the Sawyer-Man process." (Ans. 16.)

3555 "Untreated by the Sawyer-Man process, would last from one second to ten minutes, if run up to a good bright light."

In the fall of 1878, it seems that Mr. Man resumed experiments in making carbons from various substances, Sawyer taking no active part, except in testing them, and then it was that Sawyer says, "What Mr. Man did not do in carbonizing different things, can't be imagined," as before stated, but so far as paper is concerned, Sawyer is asked again by his own attorney, "Please state whether or not you began and perfected the invention of the paper-carbon burners, while you and Mr. Man were at 43 Centre street," and he answers, "Yes, sir." (Q. and ans. 22.) The experiments in Centre street were the same we have been considering.

It seems that some lamps were made in the fall of 1878, or fore part of 1879, on their theory, in which prepared paper carbons treated by the Sawyer-Man process were made to do duty, and that some of them burned 100 hours, but the majority broke in 5 hours, and nineteen-twentieths of them in 20 hours. (Sawyers X ans. 94.)

One of these lamps in its broken condition is made an exhibit, and seems to have had a French carbon treated by such process. (See Man's testimony; p. 103, fol. 411.)

In regard to the treated paper carbon made and used by Sawyer and Man, Mr. Edison in his expert testimony says, in answer to Q. 54, p. 31:

"I do not see that the treating of a paper carbon by a hydrocarbon gas, to deposit hard-carbon, improves the paper carbon. If the paper carbon was originally bad, it will always remain so. If it is coated by a deposit of hard carbon the light is radiated then from a hard carbon and not from a paper carbon. If the paper carbon is to have a deposit of this hard carbon placed over it and within it, it doesn't matter whether the paper carbon is good, 3556 bad or indifferent, or is any other form of carbon, or even a metal. The incandescing conductor of the lamp becomes really and truly a hard-carbon conductor, as the major portion of the current passes through the hard carbon, and all the light is radiated from it. If a paper carbon is dipped in different hydrocarbons several times, and recarbonized each time, a deposit of hard carbon takes place on the surface as well as within the paper. The use of a hydrocarbon for depositing hard carbon by electrical incandescence, is only a method for rendering a useless carbon available in an electric lamp."

And again, ans. 59, he says: "The source of light would be a hard gas carbon and not the paper carbon."

It seems to us from a consideration of all they pretend to disclose in their application to the office, and of the testimony before us, that all that Sawyer and Man ever did in the way of using paper in forming carbon for electric light purposes was as a convenient vehicle to carry this true hard carbon built upon it, as set forth, and it seems to us from their own presentation of the case, that in the way they have used, and propose to use paper carbons, as treated by their patented process, any other carbon, or, as suggested in their specification, any carbon from a "fibrous or textile material" or other substance equally convenient as to form with paper, would do just as well. They do not claim in the specification, nor does it appear in evidence, that they have invented and given to the public anything new and useful in the way of carbons beyond what has already been patented to them as a process for building up.

Indeed, when we come to consider this patent No. 211,262, January 7, 1879, in connection with Sawyer's publications, we shall find ample reasons for this holding.

They made their application for this patent October 15, 1878, right after their experiments, as detailed by Sawyer, and in 3557 their specification they say their invention consists "in electrically heating the illuminating part of an electric lamp while surrounded by a carbon liquid, and a new article of manufacture, consisting of an improved illuminating conductor for electric action; and a novel process of preparing the illuminating part of an electric lamp, consisting of first heating the same by means of the electric current while immersed in a carbon liquid, and of subsequently, when the globe containing it is charged with nitrogen gas, and before the flow of such gas through the lamp has ceased, and before the lamp is sealed, heating its illuminating part by means of the electric current to draw out impurities."

And they set forth *in extenso* the defects of ordinary carbons, and especially dwell upon the "dissociate character of all obtainable carbons," a characteristic specially of paper carbons, and they speak of "gas-retort carbon, and that molded from powdered material," but aver that "neither are suitable for incandescent lights, as they lack hardness, density and homogen-ity."

But treated by their process, these defects are cured and when heated they glow with uniform brilliancy.

And they aver that "they have found a pencil of carbon immersed in hydrocarbon liquid and heated to an extremely high temperature by the voltaic current is not of itself attacked, but decomposing the surrounding matter (?), the carbon of which enters and fills up its pores to an extent impossible, except with matter in a very attenuated state, and deposits a perfectly homogeneous layer, generally of a bright gray color, upon the exterior surface," etc.

"Carbon pencils may be cut from this deposit, or the original pencil with its coating may be used in the lamps."

Not a word is said about paper carbon as possessing any quality making it superior to other carbon for treatment by this process, though it was evident that it was during the experiments 3558 made by them in 1878, as narrated, that they hit upon this process and its results. Beyond this we do not think that they themselves supposed any discovery or invention in relation to carbons for incandescent light was made during their experiments, and this is in perfect keeping with Sawyer's publications put in evidence. See his statements in regard to such patented process, p. 69 of his book on electric lighting, and p. 72, when he concedes to Edison the "carbonizing of paper" and bamboo for incandescent purposes.

As to the effect of these publications by Sawyer, as evidence, the Commissioner of Patents, in his decision upon a motion to open the case to introduce it thus expresses himself:

"On the particular point now under consideration, however, said letters have force. In his letter of December 24, 1879, Sawyer says: 'If you care to settle the question of priority of invention upon the horseshoe lamp, as between Mr. Edison and myself, you may inspect one of those lamps which broke down at No. 94 Walker street, about a year ago, and after many experiments was so far condemned by Mr. Man, and I concluded we would not waste enough money on it to pay for a patent.'

"Again he says: 'To avoid any questions, I placed said abandoned institution in the hands of Messrs. Arnoux and Hochhausen, No. 2 Howard street, yesterday, (Monday) morning at 9 o'clock.' In his letter of January 4th, he says: 'Notwithstanding the assertion that one of Mr. Edison's electric lamps has been running for 240 hours, I still assert, and am prepared to back up my assertion, that Mr. Edison cannot run one of his lamps up to the light of a single gas jet (to be more definite, let us call it twelve candle power) for more than three hours.'

3559 "His letter of January 6, 1880, does not seem to have anything material in it, except to show that it is one of a series of letters written by Sawyer at that time.

"The quotations above given have a tendency, at least, to show whatever has been done by Sawyer and Man prior to the time said letters were written, in relation to the invention herein claimed, was simply experimental, and that their experiments had fallen short of success. Sawyer not only says that their efforts had proven ineffective, and were considered by both himself and Man as worthless, but that the abandoned institution had been placed in the hands of parties where it could be found. In his second letter he very forcibly denies the truthfulness of statements made as to the operativeness of Mr. Edison's lamps. Notwithstanding these letters were written and published as above stated, on the 9th of January, 1880, an application executed by Sawyer and Man, describing and claiming the invention in question, was filed in this office.

"In a work published by Mr. Sawyer, and received at this office on March 12, 1881, Mr. Sawyer says, on page 72: 'The carbonizing of live willow twigs, with a view of obtaining a suitable bent carbon, by Sawyer and Man, and the carbonizing of paper and bamboo by Edison, substantially close the account of incandescent carbons.'

"On page 78 he says: 'The filament originally used by Mr. Edison was prepared by cutting card-board into the desired shape, and carbonizing the same by placing the loops thus formed in layers within an iron box with intervening layers of tissue paper, closing the box to exclude oxygen, and raising the whole to red heat in a furnace.'

"Taking all these statements of Mr. Sawyer together, without further explanation, I am compelled to reach the conclusion
3560 that the experiments made by himself and Man were not successful, and that they did not have the invention complete on December 24, 1879.

"The statements contained in his book seem to ascribe this particular invention to Mr. Edison, although this book was published a year after the application of Sawyer and Man was made."

We find nothing in the testimony touching these experiments and publications to explain away the force of these admissions, and conclude with the Commissioner as to the effect thereof.

An attempt is made on the part of Sawyer and Man to destroy its validity by showing that Sawyer made such publications after he had parted with all interest in this invention, and its reliability, by showing that he was bitterly hostile to Man, and the parties with whom he was associated in the ownership of Sawyer's invention.

We find no satisfactory evidence to show that Sawyer or anybody else supposed that he alone, or with Man, had made any invention "of paper carbon," or that any mention of such invention is to be found in any contract or assignment made by him.

As to the other matter, it is possible that Sawyer had good cause for such feeling, and the fact that he was so hostile may possibly reflect as strongly on one party as the other.

Besides, it does not follow that such feeling would affect the truth and veracity of the party entertaining it, especially on a matter of such open and common notoriety as were the transactions and facts embraced in such publications, all of which were susceptible of being easily controverted if not true.

If, therefore, Mr. Man, or others interested, considered such statements untrue, and their rights injured, it was open to them to at least meet them by counter-statements of what they deemed a more correct setting forth of facts.

3561 But nothing of this kind appears to have been attempted in the lifetime of Mr. Sawyer, but on the contrary, they put him on the stand and made him the principal witness, and gave him credit, and can hardly be permitted to come in now and impeach his credibility, or destroy his character for truth and veracity.

For if we are asked to disbelieve his published statements on account of his hostile feelings, how can we be asked to credit him in his statements of other facts when he is a party to the issue, and presumably interested?

Giving credit, then, to Sawyer and Man for all that they claim of invention in their specification herein, and for all that they aver that they did in the way of experimenting with paper carbon in 1878, and after, and admitting that they made a successful incandescent lamp on their theory in 1879, or even in 1878, in which they used a paper carbon alternately with French and other carbon pencils, treated by their process, and built up and consolidated, and made large and hard, as was deemed essential by them, we find no sufficient evidence to show that they ever conceived of reducing to successful practice the paper carbon pure and simple, set forth and claimed by Edison, and made the subject of this interference.

In fact, from Mr. Sawyer's own testimony, it would appear that such paper carbon would be of little or no value in an incandescent lamp of their construction, and not practicable until "treated" to consolidate and harden.

We must therefore find Edison to be the original and first inventor of the thing in controversy, and find priority in his favor, reversing the decision of the examiner of interferences.

(Signed) R. L. B. CLARKE,
(Signed) H. H. BATES,
Examiners-in-chief.

(Endorsement: 7985; 3; William E. Sawyer and Albon Man *vs.* Thomas A. Edison; electric lamps or lights; decision of the examiners-in-chief, July 28, 1883; recorded vol. 18½, p. 15.)

3562 Room No. 3.

All communications should be addressed to "The Commissioner of Patents, Washington, D. C."

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., ——, 188-.

Wm. E. Sawyer and Albon Man, care Amos Broadnax, attorney, No. 57 Broadway, New York, N. Y.; Thomas A. Edison, care Geo. W. Dyer, attorney, present.

SIR-: You are hereby informed that the case of interference between Sawyer and Man *vs.* Edison, subject-matter, electric lamps or lights, has been heard by the examiners-in-chief, on appeal, and the decision of the examiner in charge of interferences is reversed, and the question of priority of invention is decided in favor of Thomas A. Edison.

An appeal may be taken from this decision within thirty days from the date of this notice.

Copies of this decision will be furnished at the usual rates.

Very respectfully, E. M. MARBLE,
Commissioner of Patents.

(Endorsement: 7985; 6; Wm. E. Sawyer and Albon Man *vs.* Thomas A. Edison; "copy;" notice of decision, July 28, 1883.)

3563 1883.

Appeal to the examiners-in-chief. Emory.

No. —.
Thomas A. Edison,
Of ——,
County of ——,
State of ——.
Electric lamps.
Rec'd June 21st, 1883.
3 petition- " "
Cert. dep.
Cash $10. June 21st, 1883.
Geo. W. Dyer, present.

3564 1883.

Contents.

Application papers:
1. Reasons of appeal filed June 21st, '83.
2. Hearing, Wednesday, July 18, '83.
3. Decision of the examiner of interference reversed July 28th,

1883, and priority found in Thos. A. Edison. Notice of decision sent July 28th, 1883.

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Title: Improvement in —.
Ex'd: H. M. H.
I. M. F.

3565 COMPLAINANT'S EXHIBIT PATENT OFFICE PROCEEDINGS No. 10.

File-wrapper and Contents in the Matter of the Appeal of Sawyer and Man. May 11, 1886. T. G., Ex.

CONSOLIDATED ELECTRIC LIGHT CO.
vs.
EDISON ELECTRIC LIGHT CO. *et al.*
} H, 3553.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the files of this office of the file-wrapper and contents in the matter of the appeal to the Commissioner filed by William Edward Sawyer and Albon Man, August 3, 1883, for improvement in carbon for electric lighting.

In testimony whereof I, M. V. Montgomery, Commissioner of Patents, have caused the seal of the Patent Office to be affixed this 19th day of June, in the year of our Lord one thousand eight hundred and eighty-five, and of the Independence of the United States the one hundred and ninth.

[SEAL.]

M. V. MONTGOMERY,
Commissioner.

3566 New York, *April* 13, 1882.

Honorable Commissioner of Patents, Washington, D. C.

Dear Sir: Having received no acknowledgment of my communication of the other day respecting the pending interference matter between Sawyer and Man and Thomas A. Edison, I repeat that I have affidavits to submit concerning such interference of the most important and fundamental character, and desire to and will forward such affidavits upon receiving the necessary information.

Resp't'y, W. E. SAWYER.

New York, *April* 11, 1882.

Commissioner of Patents, Washington, D. C.

Sir: Before any decision is rendered in reference to the interference case between Sawyer and Man and Thos. A. Edison upon electric lamps under present proceedings, I desire to submit affidavits additional and highly important and fundamental and most importantly influencing this case. Will you please acquaint me when to proceed?

Resp'y, W. E. SAWYER.

Copy.

3567 Department of the Interior,
United States Patent Office,
Washington, D. C., *April* 19, 1882.

In the Matter of the Interference between Sawyer and Man and Edison. } Before the Commissioner.

In reply to your letter of the 13th inst., stating that you desired to file affidavits of the most important character in the above case, you are hereby notified to forward the affidavits referred to immediately.

Respectfully,
(Signed) M. SEATON,
Chief Clerk for Commissioner.

W. E. Sawyer, 61 Broadway, New York city.

(Endorsement: Office to W. E. Sawyer, Edison *v.* Sawyer and Man.)

3568 In the United States Patent Office.

William Edward Sawyer and Albon Man
vs.
Thomas A. Edison.
} Interference—Carbon for Electric Lighting.

In the above-entitled interference on behalf of Sawyer and Man an appeal is hereby taken from the decision of the board of examiners-in-chief, awarding priority of invention to Edison to the honorable Commissioner of Patents in person.

This appeal is taken for the reason that the board of examiners-in-chief erred in awarding priority of invention to Edison and also in not awarding priority of invention to Sawyer and Man.

And for the further reason that said decision is contrary to the evidence and is erroneous in law, and these appellants pray that the honorable Commissioner of Patents will set an early day for the hearing of this appeal and that they may have an oral hearing herein.

I herewith enclose my cheque for twenty dollars, the fee required by law upon this appeal.

Respectfully submitted.

AMOS BROADNAX,
Attorney for Sawyer and Man.

Dated August 2nd, 1883.

(Endorsement: Patent Office, Aug. 3, 1883, U. S. A.)

3569 (Duplicate.)

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Aug. 7th*, 1883.

In the Matter of the Interference between SAWYER AND MAN and EDISON. } On Appeal to the Com'r.

SIR: You are hereby informed that a hearing on the above appeal from the action of the examiners-in-chief is fixed for Friday, September 7th, at 1 o'clock p. m.

By direction of the Commissioner:

Very respectfully, SCHUYLER DURYEE,
Chief Clerk.

Sawyer and Man, care Amos Broadnax, New York city; Thomas A. Edison, care R. N. Dyer, present.

(Endorsement: Office to Sawyer and Man and Edison. Notice of hearing, Aug. 7, 1883.)

3570 Duplicate.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Aug.* 28, '83.

In the Matter of the Interference
of SAWYER AND MAN
vs.
EDISON. } On Appeal to the Commissioner.

SIR: You are hereby informed that the time for the hearing on the above appeal is changed from 1 p. m. to 10 a. m. on the day heretofore fixed, Friday, Sept. 7th, 1883.

By direction of the Commissioner.

Very respectfully, SCHUYLER DURYEE,
Chief Clerk.

Sawyer and Man, care Amos Broadnax, N. Y. city.
Thomas A. Edison, care R. N. Dyer, present.

(Endorsement: Office to Sawyer and Man and Edison; notice of hearing, Aug. 28, 1883.)

3571 (Duplicate.)

Department of the Interior,
United States Patent Office,
Washington, D. C., *Oct.* 8, 1883.

In the Matter of the Interference of
Sawyer and Man
vs.
Edison.
On Appeal to the Commissioner.

Sir: You are hereby informed on the above appeal that the decision of the examiners-in-chief awarding priority of invention to Edison is overruled.

By direction of the Commissioner.

Very respectfully, SCHUYLER DURYEE,
Chief Clerk.

Sawyer and Man, care Amos Broadnax, New York.
Thomas A. Edison, care Geo. W. Dyer, present.

(Endorsement: Office to Sawyer and Man and Edison; notice of Commissioner's decision; Oct. 8, 1883.)

3572 United States Patent Office.

Sawyer and Man
v.
Edison.
Electric Lamps.

Appeal from the examiners-in-chief.

Application of Sawyer and Man filed Jan. 9, 1880.

Application of T. A. Edison filed Dec. 11, 1879.

Mr. A. Broadnax for Sawyer and Man.
Messrs. L. Hill and N. R. Garden of counsel.
Mr. G. W. Dyer for Edison.
Hon. Roscoe Conkling of counsel.

The invention in controversy is defined as follows:

"The incandescent conductor for an electric lamp formed of carbonized paper."

Priority of invention was awarded to Edison by the examiners-in-chief, and from their decision appeal is taken to the Commissioner in person by Sawyer and Man, alleging that said decision is erroneous both in fact and law.

Before proceeding to a consideration of the question of priority of invention, it is necessary that certain other questions should be determined which were referred to by the examiners-in-chief in their decision, and urged by counsel for Edison in their arguments at the hearing.

They are as follows:

First. Are the inventions claimed by the respective parties substantially the same?

Second. Are Sawyer and Man joint inventors of the subject-matter in controversy?

A negative answer to either of these questions would necessarily require a dissolution of the interference. 3573 If the inventions made and claimed by these parties are not substantially the same invention, a decision in favor of either would be of no effect; and if Sawyer and Man are not joint inventors of the subject-matter claimed by them, their application was improperly filed, and there is in fact but one applicant properly before the office claiming the invention.

The application of the respective parties disclose the invention—one specifically and the other in connection with carbons formed of other substances. The interference, therefore, was properly declared, because an interference exists where two applicants are claiming substantially the same invention, and where an applicant claims an invention described and claimed in an unexpired patent. For a proper determination of the first question it will be necessary to examine the record of the case, or at least so much of it as may be necessary to ascertain the inventions claimed by the respective parties. Edison in his application describes his carbon and its manufacture as follows:

"I make use of paper of the desired thickness as free as possible from foreign substances or adulterations and for this purpose I prefer and use bristol-board. With suitable instruments, such as a punch and die, I cut out a narrow strip of this paper, preferably in the form of an elliptical bow or an arc of a circle, the ends of the strip being by preference wider than the other portions.

"A number of these pieces of paper are laid flatwise in the bottom of a mold, preferably of wrought iron, and there is laid on them a light weight in the form of a flat piece of gas-retort carbon or other device that will not be distorted by the heat. If several of these are laid one on the other in the mold a piece of tissue paper is interposed between each one and the next.

"A cover is used to close the mold, and the mold is raised very gradually to a temperature of about six hundred degrees 3574 Fahr. This allows the volatile portions of the paper to pass away, and at the same time the mold retains the paper in its proper shape and the paper is prevented from curling up or becoming distorted, as it would be likely to do if the heat were applied suddenly or the light weight dispensed with.

"The mold is now placed in a furnace and heated almost to a white heat and then removed and allowed to cool gradually. The carbon filaments will be found to be smaller than the card-board blanks, and to be sufficiently strong and flexible for handling. The ends of the carbon are to be secured to the metallic conductors in any convenient manner.

"The carbon filaments prepared as aforesaid are very uniform in their resistance to the electric current, and I make them thin and of a sufficient length to offer a great resistance to the passage of the current."

Sawyer and Man do not describe in their specification the process of making their paper carbon, but refer to a paper carbon, and in their fourth clause specifically claim it. Resort must, therefore, be had to the testimony taken in their behalf to show what their paper carbon is.

Albon Man on this point testified as follows:

"4 Q. State, if you please, how you made the carbons, and of what form they were after they were made.

"A. We made the carbons in two different ways—or three. The first were carbonized by the heat of the electric current, the paper being fastened between two conductors and filled with plumbago in some cases and in some cases with mineral salts. The first experiment was in the open air, subsequent experiments in a reservoir of hydrocarbon gas and probably, although not positively, in a reservoir of hydrogen, also in a reservoir of nitrogen, the reservoir being of glass and sealed up, the metallic conductors to which the 3575 paper was affixed passing through to the interior of the reservoir in which the gases were contained. Another method of manufacture was to place the paper in an iron box in powdered gas carbon, close the box and heat the whole in fire. The form- of the papers were various; some of them simple straight strips of paper, some of them were strips of paper cut into an arch form and inserted edgewise between the metal conductors; some of them were bent in an arch form and inserted flatwise between the conductors. 'A,' in drawing Figs. 1, 2 and 3 of the application for patent, represents the form where the paper was cut into an arch. Where the paper was straight without being cut into arch form it was sometimes tied to the conductors with wire and sometimes inserted in slits in the top of the conductors and packed with powder carbon to make connection with the conductor, sometimes fastened between clamps formed by binding screws passing through the heads of the metal conductors." (Sawyer and Man's Record, pages 3 and 4.)

"12 Q. Please to describe now what, if any, preparation you gave to the paper before carbonizing it.

"A. Before carbonizing the first time we filled the paper sometimes with a solution of white loaf sugar and sometimes with Canada balsam, and after carbonizing the first time we soaked the carbon produced in the solution of loaf sugar sometimes, and sometimes in Canada balsam, and recarbonized it; repeating operation several times in some instances; in other cases we did not treat the paper at all before carbonization; this was in the preparation of the carbon which was made in the furnaces, in the preparation of the carbon made with the electric current, in order to make the paper a conductor we coated it with graphite or plumbago and sometimes soaked it in solutions of different metallic salts and dried it; the latter process did not seem to work well; paper filled with plumbago worked the best." (*Ibid.*, page 5.)

3576 "17 Q. Please to state what further treatment you gave the carbon before you put it into the lamp.

"A. After it was placed between the metal conductors, we put it in a sealed reservoir of hydrocarbon gas or a reservoir through which hydrocarbon gas was passing; the reservoir being of glass so that we could observe what was going on; we then turned on the current of electricity gradually and heated up the carbon while it was in the bath, first to about a good white heat, and afterwards to high incandescence; continuing it so long as to perfect the carbon by rendering it uniform in resistance by deposit of carbon from the gas which went on under these conditions. At the point or points of highest resistance first and subsequently over the whole carbon." (*Ibid.*, page 7.)

Other witnesses called in behalf of Sawyer and Man testified on this point substantially to the same effect.

Edison uses his carbon in a glass bulb from which the air has been exhausted by a pump to the millionth of an atmosphere. Sawyer and Man use their carbon in a similar bulb from which the air has been expelled by the introduction of nitrogen or hydrogen gas. Both carbons are used in substantially the same way and for the same purpose. It is urged in behalf of Edison that because Sawyer and Man treat the paper before it is carbonized, and subject the carbon after it has been formed to the treatment of hydrocarbon gas, as stated by Mr. Man, it is no longer an incandescent conductor for an electric lamp formed of carbonized paper, but a compound conductor, and that the paper carbon is simply a frame work upon which a coating of carbon is deposited, and that the original character of the paper carbon is entirely changed.

On behalf of Sawyer and Man it is urged that notwithstanding the treatment to which the paper and carbon are subjected, the carbon is still one formed of carbonized paper. The only witness who testified understandingly as to the effect which the deposit of carbon had upon the paper carbon, was Mr. Batchelor, a witness called in behalf of Edison.

3577 "158 X Q. What experience, if any, have you had in treating paper carbon electrically in the presence of hydrocarbon gas?

"A. I have had considerable experience in treating carbonized paper used as an incandescent conductor in hydrocarbon vapor in connection with the paper-carbon loops of Edison's electric lamp.

"159 X Q. What effect does such treatment have upon the paper-carbon burner?

"A. It deposits carbon from the hydrocarbon on the surface of the incandescent conductor.

"160 X Q. Doesn't it fill up the interstices and consolidate the carbon, making it finer and more compact?

"A. It probably does fill up the little interstices on the surface, but I do not think it makes the paper carbon any more compact. It adds to that by coating on the surface. I have frequently broken these conductors that have been treated in the vapor of the hydrocarbon, and, under a powerful microscope, have found that the fracture of the paper carbon showed no greater density, and the deposited carbon sticking to it in the shape of small needles stuck endwise on it." (Edison's Record, pages 179 and 180.)

Other witnesses testify as to the manner in which the conductor performs its function after being treated in a hydrocarbon vapor, but not as to the effect which such treatment has upon the paper carbon.

From Mr. Batchelor's statement it will be seen that the paper carbon is not affected by such treatment except by the coating of carbon which it receives. In all other respects it remains the same.

The invention, as claimed, is broadly to the incandescent conductor for an electric lamp, formed of carbonized paper. The claim is without limitation, and was intended to cover, I think, any kind of a conductor for an electric lamp formed of carbonized paper.

3578 Can it be truthfully said that the conductor made and claimed by Sawyer and Man is not a paper carbon? Before its treatment in hydrocarbon vapor it certainly is. Does that treatment change its entire character? Is the desk at which I sit not a wooden desk, because covered with a coating of varnish? Is the paper on which I write not paper, because sizing was used in the manufacture to give it body and finish? Are the doors which lead into this room not wooden doors, because there is a coating of paint on them? The desk and the doors are undoubtedly improved by the coatings of varnish and paint, because made more durable in any atmosphere, and under any conditions, but they are used in the same manner as if the coatings were not on them and are known by the same name.

So with Sawyer and Man's carbon; it is undoubtedly changed somewhat by a coating of carbon deposited thereon; but it is nevertheless, I think, a paper carbon. The carbons when prepared by either of the parties in the manner described by them become incandescent conductors when placed in a lamp from which the oxygen has been removed, either by exhaustion by a pump, or by expulsion by hydrogen or nitrogen gas. Neither will operate unless the oxygen is removed, and both will when it is. In other words, each of the carbons become- an incandescent conductor under substantially the same conditions. They are, therefore, substantially the same, and must be so held. If counsel for Edison considered them otherwise, they should have moved a dissolution of the interference after the testimony was originally concluded, and not a reopening of the case for the taking of further testimony.

At all events such motion should have been made before the case was fully submitted on the merits a second time to the examiner of interferences for decision on the question of priority of invention. The idea that the invention claimed by Sawyer and Man does not fall within the issue was clearly an afterthought conceived after the decision by the examiner of interferences on the question of priority in favor of Sawyer and Man.

3579 In relation to the second question Sawyer testifies that he first suggested the making of carbons from paper. Man testifies that he does not know whether Sawyer or himself first suggested it. The first experiment following the suggestion by whomsoever made was an attempt to pass an electric current through a piece of paper which had been marked with a lead pencil. That experiment was not attended with much success, but subsequently it was found that by rubbing the paper with plumbago the current could be passed through and the paper carbonized. Carbonization of paper, however, was not new, and hence whether it was carbonized in that or any other way, so far as this issue is concerned, is immaterial.

After the experiments of Sawyer and Man to carbonize paper by electric currents, the plan was adopted and subsequently followed, which is set forth in the testimony of Mr. Man above quoted.

In their efforts to carbonize paper, the testimony of Man and Sawyer, as well as other witnesses, shows that both the parties were engaged in devising ways and means to secure a perfect carbon from paper, very likely each of them made suggestions which were adopted; they were working together for a common end and object, viz: the carbonization of paper, which was finally accomplished in the manner described by Mr. Man.

Where two or more parties thus unite their efforts to accomplish a particular object, and by such efforts that object is secured, I think it must be held that the product obtained, if any is obtained, is the joint product of both. There is no doubt in my mind that Sawyer and Man should be considered joint inventors of the incandescent conductor made by them.

The case, therefore, recurs on the question of priority of invention.

From the testimony it appears that Edison, in 1876, made certain experiments in the carbonization of paper and in determining the resistance of such carbons.

3580 The history of Edison's experiments in electric lighting by incandescent paper carbon is fully and succinctly stated by Mr. Batchelor, a witness called in his behalf, who testified that he had had general charge of all of Edison's experiments during the last eight or nine years. His testimony is as follows:

"37 Q. Please to give a summary, in a connected way, mentioning dates, as far as possible, of the progress of the invention of incandescent conductors for electric lights made of carbonized paper, from the beginning up to the completion of the commercial lamp."

"A. The history of electric lighting by incandescence with paper carbon by Mr. Edison, so far as I know it, is as follows: In the summer of 1877 he used strips of paper carbonized as an incandescent conductor *in vacuo*, and the lamp in which they were used is now in evidence, and marked 'Exhibit Edison's First Incandescent Lamp.' I should have said here that I remember Edison, within a day or two previous to this lamp being made, using carbonized paper as an incandescent conductor between two electrodes of a battery, but in the open air. The next experiment, or series of experiments, that I call to mind are the ones which I have before spoken of as being made in August or September, 1878. At this time my whole time and attention began to be devoted to develop-

ment of his system of incandescent electric lighting. These paper carbons were made by coating thin papers with lamp-black and tar and rolling up tightly into a rod, drying and carbonizing the same in a suitable furnace. Some of these paper carbons were put in between the two electrodes in an electric circuit, and raised to incandescence in a vacuum. At this time carbons made of paper were not the only things that we tried as incandescent conductors in a vacuum. We made experiments with hard carbons, wood
3581 carbons, and some metal, such as platinum, nickel and iron.

It had early been decided by Mr. Edison that the requisite material for his incandescent lamp should have a great resistance combined with the least possible surface, and I remember well that at this time and previous we used to expect that we should be able to get a substance for an incandescent conductor that would give us at least 500 ohms resistance. The result of this latter series of experiments *in vacuo* had shown us that in order to get a high-resistance lamp from carbon in any form it would have to be cut in an exceedingly fine filament. The paper carbons which we tried were larger than we should have to use if we wanted a higher resistance. With the vacuum we then got, and which we considered at that time to be good, the carbons lasted at the most from ten to fifteen minutes in a state of incandescence. The experiments on platinum led us to hope that it might be easier to get a high resistance from that metal than from carbon. From the date of the finishing of these experiments, which, I believe, was toward the latter end of October, '78, Mr. Edison turned his attention to lamps in which the incandescent conductors were formed of metal and alloys of metal. During the last part of the year '78, and up to October, 1879, I made, at Mr. Edison's request, a very large number of lamps having platinum and platinum-iriduum composing the incandescent conductor. A great many of these lamps had their conductors coated with insulating material in order to be able to wind them up close and get them into as small a space as possible, in order to offer the least radiating surface. Mr. Edison very frequently sat down at my table and worked for hours helping me on these experiments. Our conversation frequently was directed to getting the highest resistance in the least possible space. I remember once or twice during these conversations, early in 1879, he remarked how easy it would be to
3582 get this resistance if carbon were only stable. During the time that I was experimenting on these lamps he had been very busy experimenting to perfect the different apparatus composing his electric lighting system as a whole. I had also worked on these matters, but as our lamp was an exceedingly difficult job the majority of my time, both night and day, with the exception of a week or two in which I devoted some time to telephones, was spent on the lamp. He had succeeded in making a more perfect dynamo machine In testing the lamps with platinum conductors he had been continually improving the apparatus for exhausting the globes. In October, 1879, when he had got a very perfect vacuum for his lamp, he suggested the use again of carbonized paper as a conductor,

and accordingly he had me cut a fine filament of paper which we carbonized and put in a globe. This filament, I believe, was cut straight from paper and bent round previous to putting in the carbonizing chamber. I do not remember what we did with this lamp afterward. But within a day or so of that I cut a loop from paper similar in shape to the one now in Edison's commercial incandescent electric lamp. At the same time that these were being tried I also made lamps of loops of carbonized thread, carbonized flax, fine filaments of lamp-black and tar rolled up and baked, and also threads which had been treated with lamp-black and tar previous to carbonization. All these things we used about the same time as incandescent conductors in electric lamps, the most satisfactory at the time being the carbonized-paper loop which I had cut by hand. We immediately after this made a steel mould in which these loops could be cut quickly, and after a few experiments in the carbonization of them, in order to get their resistance as near as possible alike after carbonization, we made a number of these filaments and used them at an exhibition in Mr. Edison's house, about the second or third of December, 1879. When the first 3583 lamp was made, which had a fine filamentary carbonized-paper conductor from which the light was given, which was about October 22, 1879, then I believe we had a system of electric lighting that was complete and could compete with gas, and we proceeded as expeditiously as possible to exhibit it as such." (Edison's Record, p. 153.)

Mr. Edison testifies to his experiments in the carbonization of paper in 1876, to his experiments in 1877, with the lamp known as Edison's First Incandescent Lamp, to his experiments in 1878, when paper carbons were laid aside, and to his later experiments in 1879, in substance the same as Mr. Batchelor. On direct examination he was asked (Edison's Record, p. 12):

"24 Q. When did you produce electric lamps with incandescent paper carbon conductors in vacuum bulbs hermetically closed, so as to be a commercially complete lamp, capable of entering into competition with gas light?

"A. I made such a lamp about October 22, 1879, which had the characteristics of high resistance, small radiating surface, and sufficient stability and economy to allow of competition with gas."

On cross-examination he testifies as follows:

"259 X Q. State, if you please, when it was that you first reached the conviction that electric lighting could be successfully accomplished by carbonized paper *in vacuo*.

"A. In September or October, 1879; that it could be accomplished by the use of carbonized paper in high and stable *vacuo*, which were the proper conditions. (*Ibid.*, p. 66.)

"396 X Q. When did you ascertain whether or not the conductor could be made small enough and burn under the proper conditions?

"A. I ascertained and obtained the proper conditions to allow of the conductor being made small enough some time in October, 1879. This was when it was placed in high vacuum." 3584 (*Ibid.*, p. 140.)

October, 1879, therefore, must be taken as the earliest date upon which Edison can be said to have had this invention. The invention in controversy is not simply a paper carbon, but an incandescent conductor for an electric lamp, resulting from the use of a paper carbon under certain conditions. The conditions under which he could use such a carbon for that purpose, according to his own statements, and those of the witnesses who had general supervision and management of all his experiments in electric lighting, but did not ascertain until that time.

Sawyer and Man, as appears from the testimony commenced their experiments in electric lighting at No. 43 Centre street, in the city of New York, some time in February, 1878; their operations were continued at that place until the latter part of May, or first June, of the same year. At about the latter date they removed to the corner of Centre and Howard streets, where their operations were continued until the latter part of September of that year; from thence they removed to No. 94 Walker street, near the corner of Elm, where their operations were continued from that time until the following May. Their experiments and demonstrations covered a period of about fifteen months.

Albon Man, one of the parties to this record, testifies as follows:

"13 Q. State, if you please, when it was that you first used the carbon burners you have been describing in the sealed electric lamp.

"A. In March, 1878.

"14 Q. Can you state at what time in March, 1878?

"A. Between the 1st and 15th; I can't give the date." (Sawyer and Man's Record, p. 6.)

"18 Q. Please to state what part or parts of the invention and experiments were made, of which you have been testifying, previous to the 15th of March, 1878, and state what was done after
3585 that, and down to the months of October or November, 1878,
in the order as near as you can, of its being done?

"A. We prepared the paper carbon, first electrically, and subsequently by carbonization in the furnace, in March, 1878; and from that time on to May continued our experiments with it, we treated it during this period in the hydrocarbon bath, improved it by soaking in sugar, etc., and recarbonization. In September, 1878, we commenced the use of the oils, in connection with the electric current, in the preparation of carbon. In October, 1878, we carbonized the complete paper circles or washers, and also straight pencils of paper, with better success than before, that is, having better appliances for the work. I think the first lamps we exhibited with paper were in October, 1878; we had others before that, but did not exhibit them; we first had an electric lamp fitted with a carbon burner, made of paper, in March, 1878." (*Ibid*, p. 8.)

Referring to the experiments made by Sawyer and Man at their rooms on Centre street, Mr. Man testifies as follows:

"74^8 X Q. What was the most satisfactory experiment you made at that place?

"A. With paper carbonized in the furnace.

“ 74^9 X Q. How long did the carbonized-paper conductor last in this experiment?

“A. Until we took down the lamps, taking the carbon out practically uninjured. I can't say exactly how long. We were trying everything we could think of at that time. We ran the lamps for a time, and took them down to examine the carbon to see the effect, and to see if we had got the lamps sealed; we took them down often—daily, or every two or three days.

“ 75 X Q. What was the form of paper carbon in this instance?

“A. That of a flat arch.” (*Ibid.*, pp. 18 and 19.)

3586 “ 83 X Q. What kind of paper was that carbon conductor made from?

“A. White blotting paper.

“ 84 X Q. Single, or of several thicknesses?

“A. I should think several thicknesses pressed together.

“ 85 X Q. Was that conductor coated with powdered carbon?

“A. No, sir; the paper was carbonized in box in furnace; was thicker after carbonization than we wanted; was worked down with emery paper after being worked in shape with knife and filing. This refers to paper shaped after carbonization. The burners shaped before carbonization were simply cut in shape with knife or scissors, and were ready for use after carbonization except rubbing them down on the emery paper.

“ 86 X Q. Do you remember positively this carbon conductor was in a state of incandescence for fifteen minutes?

“A. Yes, I should think for a couple of hours at a time (*ibid.*, page 20).

“ 49 X Q. How many lamps were you in the habit of running upon the same circuit?

“A. Largest number I think was eight. Usually ran but one.

“ 50 X Q. How long did you ever run eight lights continuously at that shop?

“A. I should think probably a week.

“ 51 X Q. Night and day right along?

“A. No, we ran none continuously for a week; but ran them for several hours continuously; we were troubled for power (*ibid.*, page 13):

“ 113 R. D. Q. State, if you recollect, how long you continued a paper carbonized burner in a state of incandescence at any one time.

“A. All day, and until late in the evening. This at the corner of Walker and Elm.

3587 “ 114 R. D. Q. And what its condition when you turned off the current?

“A. Same as when we put it on, except possibly improved.

“ 115 R. D. Q. When was that?

“A. That particular one I should say was in the month of December, 1878.

“ 116 R. D. Q. And was that carbonized-paper burner made in the same way that those were made at No. 43 Centre street?

“A. Yes, same as that in which some were made at No. 43 Centre street. There were other trials much before this, in October, but we only ran them during the day (*ibid.*, page 24)."

William H. Church, a witness sworn in behalf of Sawyer and Man, testifies as follows:

"41 Q. Please to state when it was that you first saw the paper carbons used in the lamp—not experimentally, but in the lamp as perfected.

"A. In Sept., 1878 (*ibid.*, page 31).

"1 X Q. I call your attention to the lamps referred to in your 41st and 42d answers, being the lamps you say you saw perfected and in use in September, 1878, from that time on during the winter. How many different lamps did you see at that time at the places named?

"A. Quite a number; it would be difficult to give the number of separate distinct lamps; sometimes the same lamp was taken down and put up again and again; but for a guess I should say 25 or 30 probably. But this is a guess.

"2 X Q. How many different lamps can you state from recollection that you saw at that time at the places named?

"A. They put up one lot of lamps in which there were six or eight
of a kind. Then another lot varying from that of about as
3588 many more or perhaps a dozen. Then still another form of
as many more, say a dozen. Each of these lamps—some at
least—were taken down and refilled again, or perhaps two or three times, to observe their working. There was still another kind I think of, being four different lots. But the last did not have a paper carbon, but a straight pencil. Mr. Sawyer called it the feeder lamp." (*Ibid.*, pp. 31 and 32.)

"43 X Q. How many lamps did you see in circuit run by this 4-horse-power engine?

"A. I should think 6; might have been 7 or 8. Don't think more than 7 or 8. Have watched 6 lights very often.

"44 X Q. How long did you see these 6 lights burning continuously at one time?

"A. Two hours and a half. Usually watched them about an hour. Seen the current turned in gradually from the light of a very small taper up to a full incandescent light—the best incandescent light, by all odds, I have ever seen. * * *

"46 X Q. Do you know when this type of lamps was produced?

"A. My wife was taken ill last November, and died 11th of December (1878); it was after the 16th of December I came to New York. Then I think I saw this lamp for the first time.

"48 X Q. How many of these lamps did you see in a circuit together?

"A. About the same number, *i. e.*, about half a dozen, more or less." (*Ibid.* pp. 38 and 39.)

William Sawyer, a witness called on behalf of Sawyer and Man, testifies as follows:

"51 Q. State how long you saw any one of the carbons made of carbonized paper illuminating continuously at the corner of Walker and Elm streets, as near as you can recollect?

3589 "A. My answer is about as before. We ran them from day to day.

"52 Q. Did you take occasion to examine them after they had thus been illuminated?

"A. Yes; some seemed as perfect as when they went in, others were fractured.

"53 Q. How many lamps did you have in circuit in Elm and Walker?

"A. The highest number I think was eight.

"57 Q. State, if you know, how many of those lamps were filled with carbonized-paper burners?

"A. Can't say positively, but think all were furnished with such burners.

"58 Q. Did you put carbonized-paper burners in the lamps yourself?

"A. Yes.

"59 Q. In Centre as well as Walker street?

"A. Yes; I made them all." (*Ibid.* pp. 49 and 50.)

William E. Sawyer, one of the parties to this record, testifies as follows:

"3 Q. The subject-matter of this interference as given by the Patent Office is: the incandescent conductor for an electric lamp formed of carbonized paper; please state whether or not you, in conjunction with Albon Man, have at any time made and used such a conductor?

"A. We have a great many times.

"4 Q. State, as near as you can recollect, when it was that you and Mr. Man made such a conductor?

"A. Almost immediately after we went to 43 Centre street; should think about 6th or 7th March, 1878; might have been a little earlier or later.

"18 Q. State as near as you can recollect, how long the best of the carbon papers you made at 43 Centre street would last in the lamp when raised to a temperature high enough to give a good, bright light, after having been treated by the Sawyer-Man process?

3590 "A. Run at a power of about 25 candles they would last from 5 to 100 hours; once in a while we would get a lamp so perfect in every respect that it would seem to undergo no change after a long use; but generally they would fracture in from 5 to 20 hours run at that temperature; the difference in the duration of the burners was due to both imperfections in the lamp and in the carbon; where the fracture alone occurs it must be due either to imperfection in the carbon, or the effect of unequal expansions; when consumption occurs it is due to the imperfect charging of the lamp." (*Ibid.* pp. 65 and 70.)

I have thus given sufficient of the testimony of the respective parties to this contest to show what they did respectively, and when they did it.

Edison completed the invention and reduced it to practice on or about October 22, 1879. Sawyer and Man had the invention in a rude form as early as March, 1878, and completed as early as September or October of the same year. The question here is not when was the invention so completed as to compete commercially with gas, but when was it completed as an operating invention?

It may be that it will never prove to be equal to gas commercially, but that will not prove it is not a complete and perfected invention. An invention is complete when the thought conceived is embodied in some practical and operative form.

It may never prove to be profitsble because of other ways devised for accomplishing the same end. This invention was complete in a legal sense when either of the parties to this controversy had devised means by which to demonstrate its practicability. This was done, not when they with a conductor formed of carbonized paper had produced a light which would continue for a few minutes, but when they with such conductor had produced one which would last for hours, days and even weeks. Such a light with such conductor was first produced by Sawyer and Man.

3591 It was sought to be shown on the part of Edison that all that was done by Sawyer and Man amounted to no more than experiments leading toward a completed invention, but never reaching the goal, and that such experiments were afterward abandoned. In support of this proposition attention was called to certain letters alleged to have been written by Mr. Sawyer and published in the New York Herald, and also to a book put forth under his name and shown to have been written by him. If it had not been conclusively shown that Sawyer and Man had perfected their invention and reduced it to practice more than a year prior to the time either of these letters were written, and more than two years before the book was published, some weight might be attached them, but such proof having been adduced, the publications, in any view which might be taken of them amount to nothing.

When this case was before me in July, 1882, on a motion to reopen it to take further testimony, I stated in my decision—"Taking all the statements of Mr. Sawyer together without further explanation—I am compelled to reach the conclusion that the experiments made by himself and Man were not successful, and that they did not have the invention complete on December 24, 1879." On a full and careful reading of the testimony the "further explanation" mentioned has been fully supplied. Before the writing of these letters and publications the invention of Sawyer and Man had passed beyond the tentative domain of experiment, and had reached the solid ground of completion by practical demonstration. If it be conceded, therefore, that Mr. Sawyer wrote the letters attributed to him, and published the book put forth in his name, they cannot be allowed, either singly or together, to work an abandonment of the invention of Sawyer and Man. This invention was the product of their joint efforts, and could not be abandoned by either separately and alone. Mr. Sawyer could not by any act or by
3592 any word prejudice the rights of Mr. Man without the consent of the latter. I do not think, however, that it was the intention of Mr. Sawyer to abandon the invention, but, feeling

piqued and annoyed by the success of Mr. Edison, he published his letters for the purpose of calling attention to his own and the joint inventions of Sawyer and Man. At the time said letters were written and the book published he was inimical to the owners of this invention, and his habits for sobriety were not good, to say the least. Under such conditions it is not strange he should have written and published what under other *other* circumstances he would not have uttered.

In view of the facts disclosed in the testimony regularly taken in this case, I do not consider any of the statement made by him in his letter or book of any importance, and hence dismissed them from consideration. Neither do I consider, for the foregoing reasons, the question of where the title of the invention was of the time said letters were published of any moment of the decision in this case. The question here is not as to who at that time or now owns the invention of either of the parties, but which of the parties to this record first made the invention. I think it is fully and clearly shown that Sawyer and Man were the first inventors of the "incandescent conductor for an electric lamp formed of carbonized paper."

The decision of the examiners-in-chief awarding priority of invention to Edison is therefore overruled, and priority of invention of the matter in controversy is awarded to Sawyer and Man.

E. M. MARBLE,
Commissioner.

October 8, 1883.

(Endorsement: U. S. Patent Office; Commissioner's decision; Sawyer and Man *vs.* Edison; October 8, 1883; recorded vol. 25, page 41.)

3593 (Duplicate.)

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Oct.* 19, 1883.

In the Matter of the Interference of SAWYER AND MAN *vs.* EDISON. } Appeal to the Secretary of the Interior.

SIR: In compliance with rule 2 of the rules governing appeals to the Secretary of the Interior, you are hereby informed that the Commissioner has submitted his report to the Secretary in answer to the appeal of Thomas A. Edison.

By direction of the Commissioner.

Very respectfully, SCHUYLER DURYEE,
Chief Clerk.

T. A. Edison, care Geo. W. Dyer, present; Sawyer and Man, care Amos Broadnax, No. 8 Pine St., N. Y. city.

(Endorsement: Office to Sawyer and Man *vs.* Edison; notice of Commissioner's report to Secretary; Oct. 19, 1883.)

3594 Interference.

SAWYER AND MAN
vs.
EDISON.
} Electric Lamps.

Before the honorable Secretary of the Interior.

Brief for Edison in Support of His Appeal.

In this case reliance will be had upon the arguments submitted in behalf of Edison before the Commissioner of Patents, which arguments will be found in the printed briefs of Hon. Roscoe Conkling and of George W. Dyer filed herewith and made a part of this brief.

These arguments will also be relied upon as to the errors in law and fact in the decision of the Commissioner, and set out in this appeal herewith submitted.

ROSCOE CONKLING,
GEORGE W. DYER,
For Edison.

October 29, 1883.

3595 *Copy of Appeal.*

Interference.

SAWYER AND MAN
v.
EDISON.
} Electric Lamps.

To the honorable Secretary of the Interior:

In the above-entitled interference I respectfully appeal to your honor *for* the decision of the Commissioner of Patents, who on October 8, 1883, awarded priority of invention to Sawyer and Man, and assign*ed* the following:

Reasons of Appeal.

The Commissioner erred in the following particulars:

As to Matter of Law.

1. In determining that if the inventions claimed by the respective parties are not "substantially the same," or if Sawyer and Man are not joint inventors, then the interference must necessarily be dissolved.

2. In determining that the conductors of the respective parties were "substantially the same" because both employed paper, and both papers were adapted for use in incandescent electric lamps, without taking into consideration the other essentials which in law enter into the comparison of two things asserted to be "substantially the same," viz., a similarity in the mode of operation, and in the result attained.

3596 Having found that Sawyer first suggested the use of paper for carbons for incandescent lamps, and that both Sawyer and Man participated in subsequent experiments in treating the paper after it was carbonized.

3. In determining that under such circumstances Sawyer and Man were joint inventors of carbon conductors made of paper.

Having found that Edison had made and used paper-carbon conductors for electric lamps, and had decided that carbon had the requisite qualities of high resistance and small mass necessary to develop his theory.

4. In determining that Edison did not, in fact, invent his paper-carbon conductors until such time subsequently, as he had ascertained from experiment the best size for his filaments, and had devised a better mode of creating a vacuum in his lamps.

5. In determining that Sawyer and Man did not make the invention when their lamp had a life of a few minutes, but did make it when their lamp had a life of a few hours.

6. In determining that the letters and book of Sawyer were not proof of an abandonment of the invention of Sawyer and Man, because there was proof that Sawyer and Man had completed the invention before the letters were written.

7. In determining in effect that one of the two joint inventors cannot abandon the common invention by public declarations known to and uncontradicted by the other inventor.

As to Matter of Fact.

The case finding on uncontradicted testimony that the paper conductors of Edison had a resistance of one hundred ohms, and those of Sawyer and Man a resistance of one-fourth of an ohm.

3597 1. In determining that these conductors were "substantially alike."

The case finding that Edison's conductors were simply carbonized paper, where the paper gave the high electrical resistance and the consequent light, and Sawyer and Man's conductors were paper carbons built up by hydrocarbon deposits, where the deposits alone caused the low resistance and alone gave the light.

2. In determining that these two conductors were "substantially alike."

3. In determining from the proofs that Sawyer and Man invented paper-carbon conductors for incandescent lamps in 1878.

4. In determining from the proofs that Edison invented paper-carbon conductors for incandescent lamps in 1879.

5. In determining that Sawyer and Man's paper carbons were perfected inventions.

6. In awarding priority of invention to Sawyer and Man contrary to the proofs in the case.

7. In not awarding priority of invention to Edison, in accordance with the proofs in the case.

In view of the pecuniary interests involved in this appeal the Secretary is respectfully requested to grant an oral hearing.

THOS. A. EDISON,
By GEO. W. DYER.

ROSCOE CONKLING.

Washington, D. C., October 17, 1883.

J. K. McC.

3598

DEPARTMENT OF THE INTERIOR,
WASHINGTON, *November 19th*, 1884.

The Commissioner of Patents.

SIR: In accordance with the principle established by the recent decision of the U. S. Supreme Court in Butterworth, Commissioner of Patents, *v.* The United States *ex rel.* Hoe *et al.*, the appeal of Thomas A. Edison to the Secretary, from the decision of the Commissioner of Patents, awarding priority of invention to Sawyer and Man, in the case of Sawyer and Man *vs.* Edison, is hereby dismissed for want of jurisdiction on the part of the Secretary of the Interior to hear and determine such appeal.

The papers in the case belonging to the files of your office are herewith returned.

Very respectfully, H. M. TELLER, *Secretary.*

(Endorsed: $\frac{588}{160}$; office of receiver; Com'r of Patents, Nov. 20, 1884; Sawyer and Man *vs.* Edison; Secretary's decision dated Nov. 19, 1884; recorded page 101.)

3599 (Duplicate.)

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Nov.* 24, 1884.

In the Matter of the Interference of SAWYER AND MAN *vs.* EDISON. } Appeal to the Secretary of the Interior.

SIR: You are hereby informed that the above appeal has been dismissed for want of jurisdiction on the part of the Secretary of the Interior to hear and determine such appeal.

By direction of the Commissioner.

Very respectfully, SCHUYLER DURYEE,
Chief Clerk.

Sawyer and Man, care Amos Broadnax, 10 Pine street, New York city; Thomas A. Edison, care Geo. W. Dyer, present.

(Endorsed: Sawyer and Man *vs.* Edison; notice of Secretary's decision; Nov. 24, 1884.)

3600 Interference.

SAWYER AND MAN
vs.
EDISON.
} Electric Lamps.

To the honorable Commissioner of Patents:

In the above interference, I move for a rehearing before your honor, and for a stay of issue of patent to Sawyer and Man during the pendency of this motion, and ask that your honor fix an early day for the hearing, and assign the following

Reasons in Support of Motion.

In this interference, priority of invention was awarded to Sawyer and Man by the examiner of interferences, and on appeal priority of invention was awarded to Edison by the board of examiners-in-chief, and on further appeal priority of invention was awarded to Sawyer and Man by the Commissioner.

An appeal was then taken by Edison to the Hon. Secretary of the Interior, and was fully argued before him.

He made no decision thereon in consequence of the mandamus proceedings in Gill *vs.* Scott which followed directly afterwards. The Secretary has now dismissed the appeal for want of jurisdiction, under the recent decision of the Supreme Court of the United States in Butterworth, Commissioner, *vs.* United States *ex rel.* Hoe *et al.*, so that all the papers are now before your honor.

After the decision of the Hon. Commissioner of Patents in this interference, Edison did not move for a rehearing and exhaust his remedies before the Commissioner because as the law was 3601 then construed a direct appeal lay to the Secretary which was accordingly taken, and Edison ought not thereby to be deprived of the benefit which would have resulted from a motion for rehearing by the fact that the Secretary had misconstrued the law.

The specific errors of the Commissioner are stated in the reasons of appeal, and the post-cript hereto appended, and reliance will be had upon these reasons in addition to those before presented.

GEO. W. DYER,
For Edison.

Mr. Amos Broadnax, attorney for Sawyer and Man, New York:

Take notice that the above motion will be filed on Monday, November 24, 1884, and heard at such a date as may be determined by the Hon. Commissioner of Patents.

GEO. W. DYER,
For Edison.

(Endorsed: Sawyer and Man *vs.* Edison; motion by Edison; U. S. Patent Office, Nov. 24, 1884. A copy of the within papers served on me 22d of Nov., 1884. Amos Broadnax, for Sawyer and Man.)

3602

Reasons of Appeal.

The Commissioner erred in the following particulars:

As to Matter of Law.

1. In determining that if the inventions claimed by the respective parties, are not "substantially the same," or, if Sawyer and Man are not joint inventors, then the interference must necessarily be dissolved.

2. In determining that the conductors of the respective parties were "substantially the same," because both employed paper, and both papers were adapted for use in incandescent electric lamps, without taking into consideration the other essentials which in law enter into the comparison of two things, asserted to be "substantially the same," viz., a similarity in the mode — operation, and in the result attained.

Having found that Sawyer first suggested the use of paper for carbons for incandescent lamps and that both Sawyer and Man participated in subsequent experiments in treating the paper after it was carbonized.

3. In determining that under such circumstances Sawyer and Man were joint inventors of carbon conductors made of paper.

Having found that Edison had made and used paper-carbon conductors for electric lamps, and had decided that carbon had the requisite qualities of high resist- and small mass necessary to develop his theory.

4. In determining that Edison did not, in fact, invent his paper-carbon conductors until such time subsequently as he had ascertained from experiment the best size for his filaments and had advised a better mode of creating a vacuum in his lamps.

5. In determining that Sawyer and Man did not make the
3603 invention when their lamp had a life of a few minutes, but
did make it when their lamp had a life of a few hours.

6. In determining that the letters and book of Sawyer were not proof of abandonment of the invention of Sawyer and Man, because there was proof that Sawyer and Man had completed the invention before the letters were written.

7. In determining, in effect, that one of two joint inventors cannot abandon the common invention by public declarations known to and uncontradicted by the other inventor.

As to Matter of Fact.

The case finding on uncontradicted testimony that the paper conductors of Edison had a resistance of one hundred ohms, and those of Saw-er and Man a resistance of one-fourth of an ohm.

1. In determining that these conductors were "substantially alike."

The case finding that Edison conductors were simply carbonized paper, where the paper gave the high electrical resistance and the consequent light, and Sawyer and Man's conductors were paper carbons built up by hydrocarbon deposits, where the deposits alone caused the low resistance, and alone gave the light.

2. In determining that these two conductors were "substantially alike."

3. In determining from the proof that Sawyer and Man invented paper-carbon conductors for incandescent lamps in 1878.

3604 4. In determining from the proofs that Edison invented paper-carbon conductors for incandescent lamps in 1879.

5. In determining that Sawyer and Man's paper carbons were perfected inventions.

6. In awarding priority of invention to Sawyer and Man contrary to the proofs in the case.

7. In not awarding priority of invention to Edison, in accordance with the proofs in the case.

As Additional Error of Law.

The issue having been declared by the Patent Office to be "the incandescent conductor for an electric lamp formed of carbonized paper;" and the Commissioner having found that such a conductor was first made, operated and used by Edison in a lamp from which the air had been exhausted with knowledge of its utility and value for incandescent lamps.

In determining that the specific invention in interference was not complete in a legal sense until the other parts and conditions of an incandescent lamp had been perfected, and a lamp produced which would last for hours, weeks and days.

As Additional Error of Fact.

If it be the law that the invention in interference was not complete until such time as it was embodied in a practical and commercial lamp, then the Commissioner erred in determining from the proofs that such a lamp was first made by Sawyer and Man.

3605 Duplicate.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Dec.* 26, 1884.

In the Matter of the Interference of SAWYER AND MAN *vs.* EDISON. } Motion for Rehearing.

SIR: You are hereby informed that a hearing on the above motion is fixed for Wednesday, December 31st, 1884, at 10 o'clock a. m.

By direction of the Commissioner.

Very respectfully, SCHUYLER DURYEE,
Chief Clerk.

Sawyer and Man, care Amos Broadnax, 10 Pine St., N. Y. city;
T. A. Edison, care Geo. W. Dyer, present.

(Endorsed: Sawyer and Man *vs.* Edison; notice of hearing; dated Dec. 26, 1884.)

3606 U. S. Patent Office.

EDISON
vs. } Motion for Rehearing.
SAWYER AND MAN.

Incandescent conductor.

Application of T. A. Edison, filed February 11, 1879.

Application of Sawyer and Man, filed Jan. 9, 1880.

Mr. J. C. Tomlinson and R. N. Dyer for Edison.
Mr. A. Broadnax for Sawyer and Man.

This interference was declared for the purpose of deciding which of the contesting parties is entitled to priority for the invention of

The incandescent conductor for an electric lamp formed of carbonized paper.

The examiner of interferences decided in favor of Sawyer and Man. The examiners-in-chief reversed that decision. Mr. Commissioner Marble on appeal reversed the decision of the examiners-in-chief and awarded priority of invention to Sawyer and Man. Edison then appealed to the Secretary of the Interior who heard the case, but, without deciding it, dismissed the appeal under the decision of the Supreme Court of the United States in Butterworth *vs.* Hoe, *et al.* (29 O. G. 615) the Secretary holding that in view of said decision he had no jurisdiction.

Edison now moves for a rehearing before the Commissioner, on the ground that the decision was against the law and weight of the evidence, and I am asked on an inspection of the record to grant a rehearing.

No additional evidence is produced or offered. If there be error, therefore, which can authorize or require the exercise of the jurisdiction invoked, it is apparent on the face of the record itself.

3607 I shall not attempt to consider at length the several points made by counsel, for after all the whole thing may be summed up in the single proposition heretofore mentioned—that the finding of Commissioner Marble is not sustained by the weight of the evidence and was contrary to law.

That the granting of a new trial was clearly within my jurisdiction I have no doubt. The question I am to pass upon is whether this is a proper case for the exercise of that jurisdiction.

The learned counsel for Edison have called my attention to the practice in the English courts in the matter of granting new trials, and have suggested that the importance of the case and the possibility that another trial might result in a more satisfactory finding and decision should induce me to grant a rehearing.

I am aware that the practice in the English courts has been very liberal, but as has been remarked by an eminent judge in this country (Justice Story), such practice has resulted, in a great many cases, in vexatious delays and great hindrances in the administration of justice. The English practice has not been adopted nor does it obtain in this country.

Mr. Justice Story in the case of Jenkins *vs.* Eldridge (3 Story, 299), in commenting upon the principle that should govern the granting of rehearings referred to the English practice in the following language:

"I am aware of the English practice on this subject. It has guards which do not and cannot exist here where the counsel and the client are brought into immediate and constant contact with each other. But such as is the practice in England, it is a source of almost infinite delays and inconveniences; and under a chancellor like Lord Eldon, whose mental constitution led him to cherish interminable doubts, and to court rehearings, it must be a source of irreparable mischief and sometimes of unmitigated ruin. I have no desire to introduce such a practice into this court, when a
3608 cause has been once fully argued in this court, and an appeal lies from its decree there is, ordinarily, no reason for a rehearing here upon the original evidence; and if such a practice is to be introduced, it must be by the will and judgment of some one who shall succeed me. If rehearings are to be had until the counsel on both sides are entirely satisfied, I fear that suits would become immortal, and the decision be postponed indefinitely."

I do not overlook the fact that Justice Story in the remarks I have quoted, refers to a review on appeal as a means of correcting errors; but it must also be borne in mind that this case has been heard three times, and that the Commissioner himself sat as a court of review for the correction of errors. It does not appear that he failed to consider every legal proposition submitted or to consider fully all the evidence in the case. In fact, he seems to have gone over the whole case exhaustively. It is urged that he was aware of the fact that an appeal could be prosecuted from his decision to the Secretary of the Interior, and that in view of this he possibly gave the case less careful consideration than he otherwise would. I do not think this proposition sound. If an appeal was authorized, the influence upon the Commissioner would have been exactly the reverse from that which is suggested it could not, in the nature of things, have been otherwise. And beyond that I cannot deem it possible that an officer charged with the exercise of important judicial functions would neglect or be indifferent to the discharge of his duties because the result of such indifference might or could be corrected by a reviewing tribunal. Nor do I admit that I am, by law or sound precedent, required to grant a rehearing in thise case because I might reach a different conclusion from that of my predecessors. From the examination I have given the case I am not clear that I would reach the same conclusion he did; but that fact does not authorize, much less require, that I should set aside his decision unless I am at the same time convinced that the
3609 evidence does not warrant the finding made by him, and that the decision is in fact against the clear weight of the evidence.

To restate the legal proposition, before I can properly set aside a decision of a former Commissioner and retry the case, I must be satisfied that the decision was clearly against the weight of the evidence and against the law.

Hunt *v.* Smith, 3 Rich., Eq. 465.
Jenkins *v.* Eldridge, 3 Story, 299.
Adams Eq., p. 396, 398.
Everet *v.* Buffalo Oil Co., 22 Fed. Rep., 253.
Powell on Appellate Proceedings, 258.

If the mere fact that a court might not, or probably would not, have reached the same conclusion that a jury has, or that a judge hearing a motion for a new trial might have found differently from that of another who heard the cause, is to be regarded as ground for a new trial in every case, there would be no end to litigation, for it must occur that there is enough of doubt involved in many, not to say most cases, to render it uncertain what the finding of a jury will be, and to render it unsafe in the administration of public justice to disturb a finding merely because the judge hearing the motion might differ from the judge who rendered the decision as to the weight of the evidence. I am not prepared to say that the decision of Commissioner Marble is clearly against the weight of the evidence, or that his finding is not warranted.

While the rule laid down in Gill *vs.* Scott (29 O. G., 949), that (quoting from the syllabus) "after a case has been heard and decided by the Commissioner, it is competent for either party to move for a new trial or rehearing on the record. When, however, the party fails to make such motion, but prosecutes an appeal, the prosecution of such appeal operates as a substantial waiver of the right to subsequently make such motion" does not control my
3610 action in this behalf, I adhere to the principle there enunciated; but since there is no longer an appeal to the Secretary of the Interior that rule becomes unimportant.

It is urged by counsel for Edison that he is deprived of a right, since the appeal was taken away, and that as the finding of Commissioner Marble becomes practically final, the motion to set aside his decision should be granted.

I do not think the point well taken. This determination is not final so far as the rights of these contestants are concerned. The courts are open, and have a broader and fuller jurisdiction than I possess. If there is error in the decision of my predecessor which works a hardship upon either of the parties to this controversy, there is another forum where his action can be reviewed.

I am constrained on the whole case to dismiss the petition and overrule the motion.

BENJ. BUTTERWORTH,
Commissioner.

February 14, 1885.

(Endorsed: Sawyer & Man *vs.* Edison; Commissioner's decision; dated Feb. 14, 1885; recorded vol. 27, p. 337.)

3611 Duplicate.

Department of the Interior,
United States Patent Office,
Washington, D. C., *Feb.* 16, 1885.

In the Matter of the Interference of Sawyer and Man *vs.* Edison. } Motion for Rehearing.

Sir: You are hereby informed that the above motion has been overruled by the Commissioner and the petition dismissed.

By direction of the Commissioner.

Very respectfully, SCHUYLER DURYEE,
Chief Clerk.

Sawyer and Man, care Amos Broadnax, 10 Pine street, N. Y; T. A. Edison, care Geo. W. Dyer, present.

(Endorsement: Sawyer and Man *v.* Edison: notice of Commissioner's decision, Feb. 16, 1885.)

3612 No. 10 Pine Street, N. Y., 24 *February*, 1885.

Dear Sir: I this morning received the annexed notice and copy of petition, and I thereupon immediately served upon Mr. Edison's attorney the following notice of motion to dismiss the petition:

"Please take notice that on the record in this case, and all the papers and proceedings herein, I will move before the Commissioner of Patents on the 27th day of February, 1885, at 11 o'clock in the forenoon of that day, or as soon thereafter as counsel may be heard, that the petition filed by Thomas A. Edison and served upon me this 24th day of February, 1885, and which is set for hearing on the 2nd day of March, 1885, at 11 o'clock, a. m., be dismissed."

I trust your honor will find time to hear this motion to dismiss; your honor has now been all over this case, is familiar with it and can dispose of this matter with very little labor to yourself and to the parties. The petition is in substance a renewal of the motion for a rehearing.

Every point raised has been adjudicated by Commissioner Marble, and your honor has just denied a motion to rehear the case after a very full argument. The petition is vexatious, and is manifestly entered for delay merely; and it is thought that it ought to be disposed of by your honor before you leave the office, which I presume will not be later than the fourth of March. It is unjust that our application should be tied up by this kind of repeated motion after a full and fair hearing and after an exhaustive consideration and adjudication upon all the points raised by the motion or petition.

I have noticed the motion to dismiss for Friday, the 27th
3613 instant, fearing that your honor may leave the office before
the 2d of March, and I will be present then and ask your honor to hear the motion, a copy of which I enclose.

Very respectfully, AMOS BROADNAX.

To Hon. Com'r of Patents, Washington. D. C.

3614 U. S. Patent Office.

In Re Interference SAWYER AND MAN v. EDISON. } Paper Carbons.

To Amos Broadnax, Esq., attorney for Sawyer and Man:

Take notice that on the petition hereto annexed and on all the papers and proceedings herein we shall move before the Commissioner of Patents on the 2nd day of March, 1885, at 11 a. m. on that day for the relief prayed for in the first, second and third prayers of such petition.

RICHARD N. DYER,
Att'y for Edison.

3615 United States Patent Office.

In Re Interference SAWYER AND MAN *vs.* EDISON. } Paper Carbons.

The petition of Thomas A. Edison, by Richard N. Dyer, his attorney, respectfully shows:

First. That heretofore, and on the 11th of December, 1879, your petitioner filed an application for letters patent for improvement in electric light, and that subsequently an interference was declared between said application and a certain application filed by Sawyer and Man, for an improvement in electric lamps, the issue being stated to be in the language of the claim of your petitioner "the incandescent conductor for an electric lamp formed of carbonized paper."

That subsequently the parties to such interference filed their preliminary statements according to the practice in such cases, and that thereafter testimony was taken by the respective parties, and the matter coming up for argument before the examiner of interferences, priority of invention was awarded to Sawyer and Man; on appeal by your petitioner to the board of examiners-in-chief priority of invention was awarded to your petitioner; and on further appeal to the Commissioner of Patents priority of invention was awarded to Sawyer and Man; that an appeal was then taken by your petitioner to the Secretary of the Interior, and after argument, but before decision, was dismissed by reason of the decision of the Supreme Court of the United States in the case of Hoe *et al. v.* The Commissioner of Patents, holding that he had no jurisdiction 3616 in the premises, and that the practice theretofore existing in taking such appeal was unauthorized and contrary to law.

That your petitioner then moved for a rehearing of the case before the Commissioner of Patents, which motion was denied.

All of which appears by the record and papers on file in the Patent Office herein.

Second. That as your petitioner is informed and believes at the time the interference herein was declared it was the rule and practice in the Patent Office that an interference should be declared between applications setting forth explicitly or by inference the same invention, the whole application in each case being considered, irrespective of the fact whether there were conflicting claims; that there was no conflict in the claims of the parties hereto as appears by their respective applications on file in the office, but the interference was based on the assumption that they described the same or similar inventions.

That in the preliminary statement filed herein by Sawyer and Man they swore that they made the invention in interference as defined by the issue, and their preliminary statement taken in connection with their application made it necessary the interference should proceed, and it was so held by the office on motion to dissolve the interference made by them.

Third. That after the testimony of the parties hereto was taken, as your petitioner is informed and believes, it appeared by the testimony of Sawyer and Man that the invention set out in the issue herein was never made by them, and that the statement of facts in their said preliminary statement was not only not supported by, but was in fact contrary to the evidence.

3617 Fourth. That the application as originally made by said Sawyer and Man does not in fact disclose or claim the invention in interference, and their application and preliminary statement, as explained by their evidence herein, shows that such invention was never made by them.

Fifth. That at the several hearings had herein, it has been insisted by your petitioner that the application of Sawyer and Man, as explained by the evidence, did not in fact disclose the invention in issue, and that no interference in fact existed between the parties hereto. That Commissioner Marble, in his decision awarding priority of invention to Sawyer and Man, intimated that he did not consider that question properly before him, but that it was one that should be or should have been presented on a formal motion to dissolve the interference.

Sixth. That since the decision herein, the said Sawyer and Man have amended their application by inserting as a claim therein the issue in interference, which claim, as your petitioner is informed, is in no way supported by the application or the evidence, wherefore your petitioner prays:

1st. That the judgment heretofore made awarding priority of invention to Sawyer and Man be vacated and set aside, upon the ground that the inventions of the parties as fully disclosed by their testimony in said interference do not in fact interfere.

2nd. That letters patent be issued to your petitioner upon his application, and embodying the claim in issue in this interference.

3rd. And that your petitioner have such other and further relief as may be just and equitable in the premises

4th. And in the meantime, and until the hearing and decision on this petition, that all proceedings on the part of Sawyer and Man be stayed.

RICH'D N. DYER,
Att'y for Thos. A. Edison.

3618 STATE OF NEW YORK, } ss:
City and County of New York, }

Richard N. Dyer, being duly sworn, deposes and says: That he is attorney for Thomas A. Edison, petitioner above named; that he has read the foregoing petition, and that the same is true to his own knowledge, his knowledge being based upon the papers and records filed in the Patent Office herein; that the reason such petition is not verified by Thomas A. Edison is, that he is now absent from the city of New York, on his way to Florida.

RICHARD N. DYER.

Subscribed and sworn before me this 21st day of February, 1885.

[L. S.] JOHN C. TOMLINSON,
Notary Public, N. Y. Co.

(Endorsement: Sawyer and Man *vs.* Edison. Motion by Sawyer and Man to dismiss Edison's motion for rehearing; U. S. Patent Office, February 26, 1885.)

3619 SAWYER AND MAN
vs.
EDISON.

It is hereby stipulated by and between the parties hereto that the hearing on the petition made by Edison be set down for hearing before acting Com'r Dyrenforth on the 12th day of March, 1885, at 9 a. m.

March 2, 1885.

RICHARD N. DYER,
Att'y for Edison.
AMOS BROADNAX,
Att'y for Sawyer and Man.

(Endorsed: Sawyer and Man *vs.* Edison; stipulation on motion. U. S. Patent Office, March 2, 1885.)

Duplicate.

3620 DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *March 3rd*, 1885.

In the Matter of the Interference of SAWYER AND MAN
v.
EDISON.
} Motion for Rehearing.

SIR: You are hereby informed that the hearing on the above motion has been continued, as per stipulation, to Thursday, March 12th, 1885, at 9 a. m.

By direction of the Commissioner.

Very respectfully, SCHUYLER DURYEE,
Chief Clerk.

Sawyer and Man, care Amos Broadnax, 10 Pine street, N. Y.; T. A. Edison, care R. N. Dyer, 65 Fifth Ave., N. Y.

282—286

(Endorsed: Sawyer and Man *vs.* Edison; notice of postponement March 3rd, 1885.)

3621 Duplicate.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *April 2d*, 1885.

In the Matter of the Interference of SAWYER AND MAN *vs.* EDISON. } Motion for Rehearing.

SIR: You are hereby informed that the above motion has been denied by the acting Commissioner.

By direction of the acting Commissioner.

Very respectfully, SCHUYLER DUYREE,
Chief Clerk.

Sawyer and Man, care Amos Broadnax, 10 Pine street, New York;
Thos. A. Edison, care R. N. Dyer, 65 Fifth avenue, New York.

(Endorsed: Sawyer and Man *vs.* Edison; notice of Commissioner's decision, April 2, 1885.)

3622 United States Patent Office.

SAWYER AND MAN *vs.* EDISON. } Incandescent Conductors. Motion for Rehearing.

Application of Sawyer and Man filed Jan. 9, 1880.

Application of Edison filed Feb. 11, 1879.

Mr. Amos Broadnax for Sawyer and Man.
Messrs. J. C. Tomlinson and R. N. Dyer for Edison.

This motion for a rehearing on behalf of Edison, after reciting the leading facts in the proceeding heretofore had, including the fact that Mr. Commissioner Marble duly decided against the petitioner on the issue defined in the interference, and the fact that Mr. Commissioner Butterworth duly heard and denied a motion for a rehearing, proceeds to set forth the grounds why a rehearing should now be granted. These grounds are substantially as follows: That the interference was based on the assumption that the two applications described the same invention, whereas the original application of Sawyer and Man did not disclose the invention in interference, and the testimony taken shows that said invention was never made by Sawyer and Man, as has always been insisted upon by and on behalf of Edison—that is to say, rehearing is asked on the general allegations that there never has been an interference between the inventions of the parties, and that Edison has always said so, but has never been listened to.

I need scarcely remind counsel that since the entire pro-
3623 ceedings, from the declaration of interference to the present time, have been based on the judgment of the office that there was an interference, a general denial of the correctness of that judgment is not ground of reviewing one's own decision, much less the decision of a predecessor. I may also call attention to the remark of Mr. Justice Field, in Giant Powder Co. *vs.* Vigorit Powder Co. (5 Fed. Rep., 197), as follows:

A new hearing should not be had simply to allow a rehash of old arguments, which seems to be pertinent to this case. And I may conclude by quoting the closing paragraph of the decision, dismissing the former petition for rehearing, in which I concur.

The courts are open, and have a broader and fuller jurisdiction than I possess. If there is error in the de*de*cision of my predecessor, which works a hardship upon either of the parties to this controversy, there is another forum where his action can be reviewed.

There must be an end of litigation over a case in this office, and as I think that this case reached that end at date of the decision last mentioned, I must decline to reopen it. The motion for rehearing is therefore declined.

R. G. DYRENFORTH,
Acting Commissioner.

April 2, 1885.

Ex'd: A. H.

(Endorsement: Sawyer and Man *vs.* Edison; Commissioner's decision; dated April 2, 1885; recorded vol. 27, p. 460.)

3624 United States Patent Office.

THOMAS A. EDISON *vs.* SAWYER AND MAN. } Interference. Electric Lighting.

Upon motion to rehear.

Brief for Sawyer and Man.

This interference is between an application of Thomas A. Edison for a patent for "the incandescent conductor of an electric lamp formed of carbonized paper," filed December 11, 1879, and an application of Sawyer and Man for a similar invention filed January 9, 1880. Five years have elapsed since these applications were filed.

The interference was declared September 23, 1880.

On January 29, 1881, a motion was made on behalf of Sawyer and Man to dissolve the interference upon the ground that the claims did not interfere. This motion was opposed by Edison and denied by the examiner in charge of the case on January 28, 1881; and the decision of the examiner denying the motion was affirmed by the Commissioner, February 15, 1881.

The testimony was thereupon taken by the respective parties and the case duly submitted for hearing, and on January 20, 1882, the examiner of interferences rendered his decision, awarding priority of invention to Sawyer and Man.

A motion was thereupon made on behalf of Mr. Edison to vacate the decision and for leave to put in further testimony. This motion having been duly heard by the Commissioner, was granted July 24, 1882.

Mr. Edison thereupon put in all the testimony he had to offer and the case was again submitted for hearing and, on June 2, 1883, priority of invention was again awarded to Sawyer and Man.

3625 Thereupon the case was appealed to the board of examiners-in-chief and they awarded priority of invention to Edison.

Whereupon the case was brought before the Commissioner in person upon appeal and after an exhaustive argument on both sides, lasting fully twelve hours, he reversed the decision of the board and again awarded priority of invention to Sawyer and Man.

I have made the brief recital of the proceedings in this case to show your honor how very fully the case has been considered. Indeed upon an examination of the several briefs in the case on behalf of the respective parties I do not see how it is possible to suggest any point or aspect of the case that has not been fully presented and considered. Indeed, the decision of the Commissioner itself is an exhaustive consideration of the salient points in the case and cites fully and fairly the testimony upon which the decision is grounded.

But the decision, of course, did not suit the Edison Electric Light Company; and thereupon an appeal was taken to the Secretary of the Interior, an appeal that we move to dismiss upon the ground that the Secretary had no jurisdiction to entertain it.

That motion was of course denied. Having the utmost confidence in our case we went to a hearing before the Secretary, where the case was fully argued. In the meantime the mandamus proceedings in Gill *vs.* Scott was taken, which resulted in the Secretary dismissing this and all similar appeals for want of jurisdiction. And now, upwards of fifteen months after the decision of Commissioner Marble (rendered October 8, 1883,) we are met with a motion for your honor to rehear the case upon the record precisely as it stood when considered by your predecessor.

If the proponents had a case for rehearing why did they not take it before Commissioner Marble? Why did they take an appeal, when in law there was none, instead of moving for a rehearing, about the legality of which there was no doubt? The truth
3626 is, they had no case for a rehearing before Commissioner Marble, and much less have they any case before your honor. The moving papers do not make a case for rehearing not even before the Commissioner who decided the case, and certainly much less before his successor.

The "reasons of appeal" to the Secretary of the Interior make the ground upon which this motion is based. The appeal was taken for the reason that the Commissioner erred in law upon certain points, and erred in fact upon certain other points; and this motion is grounded upon a copy of such "reasons of appeal."

Errors in judgment about the points considered are always grounds for appeal, but never for rehearing; the latter is granted because some point of law or evidence has been overlooked, or not fully presented and considered. But where it appears that the law and evidence have been fully considered a rehearing is never granted because the counsel for the unsuccessful party is of the opinion that the court erred in its judgment upon the evidence, or upon the law.

The moving papers in this case are not supported by any affidavit whatever, and they do not allege that there was a single material point in the case, either of law or fact, that was not fully presented and considered by the Commissioner deciding it. On the contrary, the moving papers actually show that every material point in the case was considered by the Commissioner and decided by him. The motion is grounded upon the mere opinion of counsel that the Commissioner erred in his judgment upon the fact and law considered and decided by him. There is no other ground for this motion in the moving papers.

The language of Mr. Justice Coxe in denying a motion to rehear in the case of Everest *v.* Buffalo Lubricating Oil Company, decided November 29, 1884 (22 Fed. Rep. 253), is exactly pertinent here:

> "If it could be shown that the court had mistaken the
> 3627 facts, or manifestly misapprehended the law, it might be
> sufficient for a rehearing. But the fact that the defendant and his counsel think the decision erroneous is not enough, for it unfortunately seldom occurs that the court and the counsel for the unsuccessful party are in perfect accord in their view regarding the case. For errors in judgment ample remedy is provided by appeal."

The proponents elected to take an appeal to the Secretary and thereby waived their rights to move for a rehearing. In the recent case of Gill *vs.* Scott (29 C. Gaz., 949) your honor, reviewing facts precisely similar to those presented in this case, held:

> "By taking the appeal direct to the appellate tribunal the applicant waived his right to file a motion for a new trial. The fact that it was subsequently determined that the appellate tribunal had no jurisdiction to hear and determine the cause in my judgment made no difference; the right was substantially waived when the party declined to avail himself of it."

The proponents elected to take an appeal to the Secretary because they really had no grounds for rehearing before Commissioner Marble, as appears by their reasons of appeal upon which they base this motion; and if they had no grounds for rehearing before Commissioner Marble, how much worse are they off before his successor? For surely the Commissioner is bound by the rules of his own office. The only ground- upon which he can rehear this case are those upon which new trials are granted in the United States courts: not a single one of which is presented in these motion papers. (See Rules of Practice, § 139.)

The grounds upon which new trials are granted in the Federal courts, and rehearings by succeeding Commissioners in this office, *is* very fully stated in the following authorities:

Wait's Practice, III, p. 405, and cases cited.
Brown *vs.* Wilde, 12 Johnson, 455.
Dodd *vs.* Cobb, Com'r Decis., p. 196, of 1876.
3628 Blanchard *vs.* Jacobs, 2 Blatch., 71.
Rowe *vs.* Matthews, 18 Fed. Rep., 132.
Schneider *vs.* Thill, 3 Fed. Rep., 95.
U. S. *vs.* Millinger, 7 " " 187.
Robinson *vs.* Railroad, 9 " " 877.
Greenwalt *vs.* Tucker, 10 " " 884.
Dudley *vs.* Sears, 16 " " 335.
Josselyn *vs.* Swezey, Com'r Dec., p. 15, of 1879.
Huttner *vs.* Knox, " " 281, "
Giant Co. *vs.* Vigorit Co., Com'r, 5 Fed. Rep., 201.
Jarvis *vs.* Hathaway, 3 Johns., 180.
Marriot *vs.* Fearing, 11 Fed. Rep., 947.

In Wait's Practice (vol. III, p. 405) the law is thus summarized:

"Although there may be cases in which the ends of justice demand that the court should possess the power to correct abuses committed by a panel of jurors, that power should be limited by reasonable rule. It must be an abuse; it must be such a verdict as evinces that it was the result of passion, prejudice, mistake or corruption; such a verdict as shocks the common judgment; or such as is without evidence to support it, or is so against the striking preponderance of evidence that a common exercise of judgment demands its reversal. * * * And the findings of fact by a referee, where there is a conflict of evidence, is as conclusive as the verdict of a jury."

In Blanchard's Gun Stock Turning Factory *vs.* Laban Jacobs (2 Blatch., 711) Judge Betts said (case of infringement of letters patent):

"The rule laid down in Ward *vs.* Centre (3 Johns., 572) that the verdict of a jury will not be set aside where there has been evidence on both sides of a question of fraud, and no misdirection as to law, is applied with like strictness in all cases of tort." (Jarvis *vs.* Hatheway, 3 Johns., 180.)

3629 In the late case of Rowe *vs.* Matthews (18 Fed. Rep., 133), decided Oct. 15, 1883, Judge Brown said:

"In their numerous exceptions counsel for defendants seem to have shared in a misapprehension which, judging from the number of motions of this character is a common one, that nothing more is necessary to entitle a party to a new trial than to show such errors as would be deemed sufficient by an appellate court to justify setting aside the verdict. Nothing could be more misleading than this idea. * * * Errors in the admission of testimony or in the instructions of the court, even though material, do not, as matter of law, necessitate a reversal of the proceedings. * * * Nothing is better calculated to demoralize the administration of justice, and to justify the popular belief in the uncertainty of the law, than the practice of granting new trials upon trivial grounds to give the defeated party another chance"

In denying a motion for rehearing in Marriot *vs.* Fearing (11 Fed. Rep., 846) Judge Wheeler said:

"There is nothing to indicate that the jury were actuated by either passion or prejudice. To grant a new trial would be merely to allow an appeal upon these questions of fact from that jury to another. That is not allowable by the rules of law or the practice of courts."

In Huttner *vs.* Knox (Com'r Decis., p. 281 of 1879) Com'r Paine held that, "a decision of a Commissioner rejecting a claim for want of patentability, on motion to dissolve an interference, cannot be reopened by his successor in office, under rule 45 (now 139) except in accordance with the principles which govern new trials; that a decision was against the evidence adduced on the hearing can only be asserted, as a valid ground for a rehearing, when either there was no evidence at all to support the decision, or the preponderance of evidence against it was clear and decided.

Giant Powder Co. *vs.* California Viogrit Powder Co. 5 Fed. Rep., 201.

3630 Mr. Justice Field said:

"A rehearing should not be granted for newly discovered evidence where the evidence could have been obtained by reasonable diligence on the first hearing, nor when it is merely cumulative to that previously received, nor when, if presented, it would not have changed the result. And as to errors of law they should be such as are clearly shown by considerations not previously presented. A new hearing should not be had simply to allow a rehash of old arguments. The proper remedy for errors of the court on points argued in the first hearing is to be sought by appeal, when the decree is one which can be received by an appellate tribunal. (See Tufts *vs.* Tufts, 3 M. and W., 426.) * * *

"Before concluding it may not be amiss to invite the attention of complainant's counsel to the language of Judge Story in the case of Jenkins *vs.* Eldridge, with respect to the earnestness with which counsel, in applying for rehearings, sometimes asseverate their convictions to the errors of the court; and to repeat what is there said: 'That if any judge should be so unstable in his views or so feeble in his judgment, as to yield to them, he would not only surrender his independence but betray his duty. However humble may be his own talents, he is compelled to treat every opinion of counsel, however exalted, which is not founded in the law and the facts of the case, as voiceless and valueless.' (3 Story, 303.) Nothing can be gained by the strong language expressed by counsel in presenting the petition as to the supposed errors of the court nor by the statements as to what may have been said of the decision by other counsel who have neither examined, studied, nor understood the case."

(Endorsement: United States Patent Office; Edison *vs.* Sawyer and Man; interference, electric lighting; motion to rehear; brief on behalf of Sawyer and Man; Broadnax and Bull, 10 Pine street, N. Y.)

3631 8 *x*. 1883. 83.

Appeal to the Commissioner of Patents. Emory.

No. —.
William Edward Sawyer and Albon Man,
Of ——,
County of ——,
State of ——.
Carbon for electric lighting.
Rec'd Aug. 3, 1883.
Petition, " " "
2. Cert. dep.
1. Cash, $20, Aug. 3, 1883.
3. Circular.
Amos Broadnax, 10 Pine street, New York city.

3632 1883.

Contents.

Application papers.
1. Notice of hearing sent Aug. 7, '83.
2. Decision Oct. 8, '83.
3. Notice of decision sent Oct. 8, '83.
4.
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6.
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9.
10.
11.
12.
13.
14.
15.
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17.
18.
19.
20.
Title: Improvement in —.

3633 In the United States Patent Office.

Application of WILLIAM E. SAWYER and ALBON MAN for a Patent for Improvement in Electric Lamps. Filed Jan. 9th, 1880. No. 547.

The fourth claim of this application having been in interference with an application of Thomas A. Edison for a patent for a similar invention, filed Dec. 11, 1879, case 187, and priority of invention having been finally awarded to Sawyer and Man, the appeal to the Secretary of the Interior having been dismissed for want of jurisdiction, the application is now presented for the further action of the office, and to that end the specification is hereby amended by adding to the claims now pending the following claim:

3.
A.
Erased Feb. 28, '85.

5th. The incandescent conductor for an electric lamp, formed of carbonized paper, substantially as set forth.

The foregoing claim being the single claim of the application of Edison, the office having made that claim the subject-matter of the interference aforesaid.

The 1st, 2d and 3d amended claims, filed May 17, 1880, on behalf of Sawyer and Man having been but once rejected by the primary examiner are now respectfully submitted for reconsideration—the undersigned being of the opinion that the reference cited does not anticipate the claim.

Respectfully submitted.

AMOS BROADNAX.

Dec. 4th, 1884.

(Endorsed: U. S. Patent Office, Dec. 4, 1884; division XVI; serial No. 547; paper No. 8; am'd't A; filed Dec. 4, 1884.)

3634 Serial No., 547.

Room 91.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Feb.* 19, 1885.

Application, "electric lamps or lights." Filed Jan. 9, 1880.

William E. Sawyer and Albon Man, care Amos Broadnax, 57 Broadway, New York city:

The interference with Edison having been decided in favor of applicants, this case has been reconsidered as requested by letter accompanying the amendment filed Dec. 4, 1884.

It appears that in the specification there are two terms used in a manner that renders it somewhat difficult to understand what ap-

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[Matter enclosed between rules erased in copy.]

plicants desire to express by the same; these terms are "arc" and "arch." The first seems to be intended as designating the light-giving portion of the lamp, irrespective of its form, and the second seems to be a generic description of the form of the light-giving portion of the lamp. While this is the probable intended meaning of these terms it is clear that the term "arc" is not a proper designation of the light-giving portion, and its use is calculated to confuse the reader; it is unquestionably a source of obscurity and ambiguity which should be removed by proper amendment. The number of the patent granted to applicants June 18, 1878, to which reference is made in the specification, is No. 205,144, and not 206,144 as given in the specification; this should be corrected. The word "cylindrical," on p. 2, line 15, should be changed to circular.

Claims 2 *x* 3 are held to be fully anticipated by English patent No. 3809 of 1872, Fig. 8.

C. J. KINTNER, *Examiner.*

JOS. LYON, 1*st Ass't.*

(Endorsed: Serial No. 547; paper No. 9; rej.; dated Feb. 19, 1885.)

3635 In the United States Patent Office.

Application of WILLIAM E. SAWYER and ALBON MAN for a Patent for Improvement in Electric Lamps. Filed January 9th, 1880. Serial No., 547.

Amend the substituted specification filed May 17th, 1880, as follows:

In line 18, page 1, strike out the figures 206,144 and in lieu thereof substitute the figures 205,144.

In line 15, page 2, strike out the word "cylindrical" and substitute the word "circular."

In line 2, from the bottom of page 1, strike out the word "arc" and substitute the word "arch."

In line 14, page 2, strike out the word "arc" and substitute the word conductor. In line 15, same page, strike out the word "preferably" and substitute the word made.

In line 18, page 2, strike out all after the word paper; and in line 19, same page, strike out all before the word "we" and in lieu thereof substitute the following: also wood, carbon, charcoal and the like.

In the first line of the first claim strike out the word "arc" and substitute the word conductor.

Strike out the 2 and 3 claims.

Respectfully submitted.

AMOS BROADNAX, *Att'y.*

Dated Feb. 19th, 1885.

(Endorsed: Serial No., 547; paper No. 10; U. S. Patent Office, Feb. 19, '85; am'd't filed Feb. 19, 1885; division XVII.)

3636 In the United States Patent Office.

Application of WILLIAM EDWARD SAWYER and ALBON MAN for a Patent for Improved Electric Lamps. Filed January 9, 1880. Serial No., 547.

The above-entitled application is hereby further amended as follows:

In line 20, page 2, strike out the word "arcs" and insert the words incandescing conductors.

In line 23, same page, strike out the word "arcs" and insert the words incandescing conductors.

Respectfully submitted.

AMOS BROADNAX, *Att'y.*

Dated Feb. 20, 1885.

(Endorsement: Serial No. 547; paper No. 11; am'd't. Filed Feb. 20, 1885. U. S. Patent Office, Feb. 20, 1885; division XVI.)

3637 Serial No., 547.

(Room 91.)

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Feb.* 20, 1885.

Application, electric lamps or lights. Filed Jan. 9, 1880.

William E. Sawyer and Albon Man, care Amos Broadnax, 57 Broadway, N. Y. city:

By the amendments filed Feb. 19, and Feb. 20, 1885, the objections heretofore urged have been removed, and as at present advised the case is now ready for issue; final action, however, must be suspended until March 2, 1885, in view of a possible interference with another pending application.

C. J. KINTNER, *Ex.*

JOS. LYONS, 1*st Ass't.*

(Endorsement: Serial No. 547; paper No. 12; letter dated February 20, 1885.)

3638 In the United States Patent Office.

In the Matter of the Application of SAWYER AND MAN for Electric Lamps. Filed Jan'y 9, 1880. } No. 547.

To the examiner in charge:

Your honor will find annexed an amendment in this case. My reasons for filing this amendment are, that the specification, as it now stands, is defective in not clearly pointing out the objects of the improvements described and the various modes of carrying them into effect.

It is for the purpose of making the specification more definite that this amendment has been prepared, and is now filed.

Respectfully, AMOS BROADNAX,
Attorney for Sawyer & Man.

Washington, D. C., February 28th, 1885.

3639 In the United States Patent Office.

In the Matter of the Application of SAWYER AND MAN for Electric Lamps. Filed Jan'y 9, 1880. } No. 547.

Amendment.

Amend the specification herein by erasing all after the words "granted to us June 18, 1878."

Last words of paragraph 2, page 1, down to the signatures of inventors and witnesses, and substitute in lieu thereof the following:

B. Our invention relates more especially to the incandescing conductor, its substance, its form and its combination with the other elements composing the lamp. Its object is to secure a cheap and effective apparatus and our improvement consists, first, of the combination in a lamp chamber, composed wholly of glass, as described in patent No. 205,144, of an incandescing conductor of carbon

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having the form of an arch or loop in the circuit, as the light-giv*en* medium, and also of an incandescing conductor composed of carbon made from a vegetable fibrous material in contradis-tion to a similar conductor made from mineral or gas carbon.

Substitute C, March 13, '85.

The accompanying drawings show all our improvements embodied in an apparatus or lamp, substantially like that represented in the patent above referred to, being the form in which we have practically used it, but some of our improvements may be used in connection with other forms of lamps with equally good effect.

Reference being had to said drawings:

Fig. 1 is a top view of the lamp.

Fig. 2 a side elevation thereof.

Fig. 3 a side view in elevation of the burner on an en-
3640 larged scale to show its details more clearly; and

Fig. 4 is a similar edge view.

[Matter enclosed between rules erased in copy.]

Substitute D, March 13, '85.

The lamp or apparatus embracing our improvements being constructed substantially as that described and illustrated in the patent above mentioned and constituting no part of the subject-matter hereinafter claimed, excepting as hereinafter stated, needs no particular description beyond what is necessary to point out the features of novelty constituting the improvements covered by the claims.

March 13, '85.
March 14, '85.

In the practice of our invention we have made use of carbonized paper and also wood carbon, [charcoal, and ordinary gas carbon.]* We have also used such conductors or burners of various shapes, such as pieces with their lower ends secured to their respective supports and having their upper ends united so as to form an inverted-Λ-shaped burner. We have also used conductors of varying contours, that is, with rectangular bends instead of curvilinear ones, but we prefer the arch shape.

Insert F, April 21, '85.
Erased March 14, '85.

In making these carbons from the fibrous material, our practice has been to cut the burner to the desired form before carbonization, and this we found to be much the best practice, although it is possible in some forms of burners made from paper or other sheets of fibrous material, to cut or form the burner after carbonization.

An important practical advantage which is secured by the arch form of incandescing carbon is that it permits the carbon to expand and contract under the varying temperature to which it is subjected, when the electric current is turned on or off, without altering the position of its fixed terminals. Thus the necessity for a special mechanical device to compensate for the expansion and contraction which has heretofore been necessary, is entirely dispensed with, and thus the lamp is materially simplified in its construction. Another advantage of the arch form is that the shadow cast by such burners is less than that produced by other forms of burners when fitted with the necessary devices to support them.

3641 & 3642

Another important advantage resulting from our construction of the lamp results from the fact that the wall forming the chamber of the lamp, through which the electrodes pass to the interior of

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[* Words enclosed in brackets erased in copy.]
[Matter enclosed between rules erased in copy.]

the lamp, is made wholly of glass, by which all danger of oxidation, leakage or short circuiting is avoided.

The advantages resulting from the manufacture of the carbon from vegetable, fibrous or textile material instead of mineral or gas carbon, are many; among them may be mentioned the convenience afforded for cutting and making the conductor in the desired form and size, the purity and quality of the carbon obtained, its susceptibility to tempering, both as to hardness and resistance, and its toughness and durability.

We have used such burners in closed or hermetically sealed transparent chambers, in a vacuum, in nitrogen gas, and in hydrogen gas; but we have obtained the best results in a vacuum, or an attenuated atmosphere of nitrogen gas, the great desideratum being to exclude oxygen or other gases capable of combining with carbon at high temperatures from the incandescing chamber, as is well understood.

The nature of our inventions and the operation of our improved lamp will be readily understood from the foregoing description and the following claims:

We claim as our joint invention:

I. An incandescing conductor for an electric lamp of carbonized fibrous or textile material, and of an arch or horseshoe shape, substantially as hereinbefore set forth.

II. The combination substantially as hereinbefore set forth, of
an electric circuit, and an incandescing conductor [arch]*
April 21, '85. of carbonized fibrous material included in, and
3643 forming part of said circuit, and a transparent
April 21, '85. hermetically sealed chamber, in which the conductor [arch]*
is enclosed.

III. The incandescing conductor for an electric lamp formed of carbonized paper substantially as described.

IV. An incandescing electric lamp consisting of the following elements in combination: First, an illuminating chamber made wholly of glass hermetically sealed and out of which all carbon-consuming gas has been exhausted or driven; second, an electric circuit conductor passing through the glass wall of said chamber
3, 13, '85. and hermetically sealed therein ‸ as described; third, an illu-
minating conductor in said circuit and forming
April 21, '85. part thereof within said chamber, consisting of
3, 13, '85. carbon ‸ made from a fibrous or textile material having the form of an arch or loop, sub-
stantially as described for the purpose specified.

Respectfully submitted.

AMOS BROADNAX,
Attorney for Sawyer and Man.

Washington, D. C., February 28th, 1885.

[* Words enclosed in brackets erased in copy.]

(Endorsement: Serial No. 547; paper No. 13; am'd't B; filed Feb'y 28, 1885; U. S. Patent Office, Feb'y 28, 1885; div. XVI.)

3644 Serial No., 547.

Room 91.

Department of the Interior,
United States Patent Office,
Washington, D. C., *March* 7, 1885.

Application, electric lamps or lights. Filed January 9, 1880.

William E. Sawyer and Albon Man, care Amos Broadnax, 57 Broadway, N. Y. city:

This case has been reconsidered with reference to the new specification filed February 28, 1885.

The new statement of invention which precedes the description, and which substantially agrees with the present fourth claim, is objectionable for the reason that said claim cannot be allowed in view of the prior state of the art. Arch-shaped pieces of carbon, as incandescent elements in electric lamps, are old, as shown in English patent, No. 3809, of 1872 (Fig. 8), and a lamp chamber composed wholly of glass and constructed in exactly *in* the manner described in claim 4 is old with applicants, as shown by their patent No. 205,144, June 18, 1878. The use of an old carbon arch in an old electric light chamber is not an invention. It is clear that the only invention presented in this case is the incandescing conductor made of carbonized paper, and the claims as well as the statement of invention should be strictly confined to this element and to novel combinations of the same with other elements. When such claims are presented no objection will be made to the use of generic terms since in the application as originally filed the incandescing conductor was described in the fourth claim, as made of "carbonized fibrous or textile material." Nor will objection be made to a more extended or more specific description of the manner of making and constructing the lamp shown, but in a case like 3645 this, where the art of electric lighting has greatly developed since the filing of this application, the limits of the invention to which applicants are entitled should be well defined by general and specific disclaimers of everything beyond the arch or carbonized paper, and the new combinations of the same with other elements.

Additional description is indeed desirable, but it should be based upon additional drawings made from the model filed in this case, and said model should be identified in a manner that will admit of no doubt.

Claim 4 stands rejected.

C. J. KINTNER, *Ex.*

JOS. LYONS, 1*st Ass't.*

(Endorsed: Serial No. 547; paper No. 14; rej.; dated Mar. 7, 1885.)

3646 In the United States Patent Office.

In the Matter of the Application of SAWYER AND MAN for Electric Lamps. Filed January 9, 1880. } No. 547.

Amendment.

In response to office letter of the 7th instant, this application is further amended by striking out all after the word "carbon" in line 7 of the statement of invention, page 1 of the amended specification, filed February 28, 1885, and by substituting in lieu thereof the following:

C. Made from a vegetable fibrous material in contradistinction to a similar conductor made from mineral or gas carbon, and also in the form of such conductor, so made from such vegetable carbon, and combined in the lighting circuit within the exhausted chamber of the lamp.

Amend also by striking out lines 5 to 11 inclusive, page 2 of said specification, and substitute the following:

D. Fig. 5 of the drawing shows a vertical section through the bottom of the lamp; in this figure *x* is a glass flange on the bottom of the lamp chamber, *y*, is a glass disk corresponding in size to the flange and is ground to the bottom thereof to form an air-tight joint, so that the entire wall of the chamber is formed of glass; the electrodes passing through the glass disk in the manner shown, to form the lighting circuit in the chamber; substantially as in said patent No. 205,144; the sealing of the electrodes, where they pass through the glass wall, is done with any suitable cement, or in any of the 3647 well-known methods of sealing glass upon metal electrodes previous to the filing of this application.

The electric connections of this lamp are made in the base thereof, substantially the same as in our patent No. 210,809, dated December 10, 1878, and the whole bottom is enclosed in a cup filled with wax or other suitable cement the same as in that patent. The cement sealing in this lamp being also applied in substantially the same way as in the patent last above mentioned.

Insert E, April 21, '85. }

3, 14, '85. And further amend by striking out the words "charcoal and ordinary gas carbon," in lines 13 and 14, page 3 of said specification, and in lieu thereof insert the words ["of different kinds."]*

Amend the 4th claim by inserting in line 8, after the word "carbon" the following: "Made from a vegetable fibrous or textile material."

[* Words enclosed in brackets erased in copy.]

And further amend said claim by inserting the words "as described" in line 6, after the word "therein."

The application is also amended by filing the additional drawing, Fig. 5, as suggested by the examiner's letter above mentioned.

Respectfully submitted.

AMOS BROADNAX,
Attorney for Sawyer and Man.

Washington, D. C., March 13, 1885.

(Endorsement: Serial No. 547, paper No. 15. *Adm*'t- C, D, filed March 13, 1885, United States Patent Office, March 13, 1885; division XVI.)

3648 In the United States Patent Office.

Application of WILLIAM E. SAWYER and ALBON MAN for a Patent for Improvement in Electric Lamps. Filed January 9th, 1880. } No. 547.

Amendment 1*st.*

On page 2, line 13, insert the word "and" after the word paper, and erase the words "of different kinds," inserted by amendment of March 13, 1885.

Amendment 2*d.*

Erase from lines 20, beginning with the words "In making," in line 21, page 2, and ending with word "carbonization" in line 26, inclusive.

Respectfully submitted.

AMOS BROADNAX.

(Endorsed: Serial No. 547, paper No. 16; amendment filed March 14, 1885; U. S. Patent Office, March 14, 1885; division XYI.)

3649 (Interferences.)

Room No. —.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *March* 14, 1881.

William E. Sawyer and Man, assignors to Electro-Dynamic Light Co., N. Y. city, care Amos Broadnax, 57 Broadway, N. Y. city:

Please find below a copy of a communication from the examiner concerning your application for a patent for improvement in electric lamps, No. 517, filed Jan. 9, 1880.

Very respectfully, R. G. DYRENFORTH,
Act'g Commissioner of Patents.

3650 Room No. 91.

Your case above referred to is adjudged to interfere with others hereafter specified, and the question of priority will be determined in conformity with the rules.

The statement demanded by rule 105 must be sealed up and filed on or before the — day of ——, 188–, with the subject of the invention and name of party filing it indorsed on the envelope. The subject-matter involved in the interference is, first, an incandescent electric lamp, consisting of an enclosing globe or receiver and a conducting strip, ribbon, or loop of carbonized paper attached to metallic conductors passing into the said receiver. Freeman's first claim in substance the same as applicant's second and fourth claims.

2nd. As an incandescent medium for electric lamps a strip, ribbon or filament of carbonized paper, Freeman's second claim in substance; applicant's first and third claims.

The opposing party to this interference is Walter K. Freeman of Brooklyn, Kings Co., N. Y., assignor to Chas. R. Flint of New York.

Freeman's attorneys of record are Parker W. Page of New York city, and Marcellus Bailey, of Washington, D. C.

C. J. KINTNER, *Ex'r.*

(Endorsement: Serial No. 547; paper No. 17; intf. with Freeman; dated M'ch 14, 1884.)

3651 In the United States Patent Office.

Application of SAWYER AND MAN for a Patent for Improved Electric Lamps. Filed January 9, 1880. No. 547.

Amendments.

This specification is further amended by adding after the word "mentioned," in line 7, page 2, of amendment filed March 13, 1885, the following:

> E. The invention making the subject-matter of this application being improvements upon the lamps described in the patents above referred to, to the extent of the claims making part hereof.

Amend further by inserting the following paragraph after the word "shape," in line 20, page $\overset{2}{[3]}$* of amendment filed February 28, 1885:

> No especial description of making the illuminating-carbon conductors described in this specification and making the subject-matter of this improvement, is thought necessary, as any of the ordinary methods of forming the material to

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[* Figure enclosed in brackets erased in copy.]

F. be carbonized to the desired shape and size, and carbonizing it while confined in retorts in powdered carbon substantially according to the method in practice before the date of this improvement may be adopted in the practice thereof, by any one skilled in the arts appertaining to the making of carbons for electric lighting or for other use in the arts.

3652 Amend further by striking out the word "arch," in lines 2 and $\overset{5}{[4,]}$* claim 2, and substitute therefor the word conductor.

Amend further by striking out the word "veg*i*table," in line 8, claim 4.

Respectfully submitted.

AMOS BROADNAX,
Att'y for Sawyer and Man.

Dated April 21st, 1885.

(Endorsed: Serial No. 547; am'd't- E, F; 19. Filed Ap'l 21, 1885. U. S. Patent Office, April 21, 1885. Division XVI.)

3653 U. S. PATENT OFFICE,
WASHINGTON, D. C., *Apr.* 22, 1885.

Wm. E. Sawyer and A. Man, care of Amos Broadnax, No. 57 Broadway, N. Y. C.

SIR: Your application for a patent for an improvement in electric lights, filed Jan. 9, 1880, has been examined and allowed.

The final fee, twenty dollars, must be paid, and the letters patent bear date as of a day not later than six months from the time of this present notice of allowance.

If the final fee is not paid within that period the patent will be withheld, and your only relief will be by a renewal of the application, with additional fees, under the provisions of section 4897, Revised Statutes. The office aims to deliver patents upon the day of their date, and on which their term begins to run; but to do this properly applicants will be expected to pay their final fees at least twenty days prior to the conclusion of the six months allowed them by law. The printing, photo-lithographing and engrossing of the several patent parts, preparatory to final signing and sealing, will consume the intervening time, and such work will not be done until after payment of the necessary fees.

When you send the final fee you will also send, distinctly and plainly written, the name of the inventor and title of invention as above given, date of allowance (which is the date of this circular), date of filing, and, if assigned, the name of the assignees.

If you desire to have the patent issue to assignees, an assignment containing a request to that effect, together with the fee 3654 for recording the same, must be filed in this office on or before the date of payment of final fee.

[* Figure enclosed in brackets erased in copy.]

Additional copies of specifications and drawings will be charged for at the following rates: Single copies, uncertified, 25 cents; twenty copies or more, 10 cents each. The money should accompany the order.

Very respectfully, M. V. MONTGOMERY,
Commissioner of Patents.

3655 $20, m.

Memorandum
of
Fee paid at U. S. Patent Office.

Serial No. 547,188.

Inventors:
Sawyer and Man.

Patent to be issued to assignee.

Name of invention, as allowed,
Electric lights.

Date of payment,
April 22, 1885.

Final fee,
$20.

Solicitor,
Amos Broadnax.

Date of filing,
Jan. 9, 1880.

Date of circular of allowance,
—— —, ——.

Send patent to attorney.

(Endorsed: U. S. Patent Office; Apr. 22, 1885.)

3656 & 3657 547. 1880. Townsend, 155
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No. 317,676.

William Edward Sawyer and Albon Man, ass'ors to Electro-Dynamic Light Company of New York,

Of New York, Brooklyn,
County of " Kings,
State of New York.
Electric lamps or lights.

Rec'd,	Jan'y 9, 1880.
Petition,	" "
Affidavit,	" "
Specification,	" "
Drawing,	" "

Model, Jan'y 9, 1880.
Cert. dep., " "
1 cash, $15, Jan'y 9, 1880.
Add'l fee cert., ——.
" " cash, $20, Apr. 22, 1885.
Examined Ap'l 21, 1885. C. J. Kitner, ex.
Issue Ap'l 22, 1885. J. W. Babson.
Patented May 12, 1885.
Circular, Apr. 22, 1885.
Amos Broadnax, 57 Broadway, N. Y. city.

3658 1880.

Contents.

Application papers.
1. Rejecten Feb. 28, 1880. (Electric lights.)
2. Letter, Apr. 26, 1880. Div. XVI. Incandescent.
3. Sub. spec., May 17, '80.
4. Rej. May 20, 1880.
5. Int. 146–30, Sep. 23, 1880.
6. Jan'y 28, '81, motion to dissolve denied.
7. June 2, 1883, dec'd favor Sawyer and Man.
8. Dec. 4, '84, am'd't A.
9. Feb. 19, 1885, rej.
10. " " " am'd't.
11. " 20, " "
12. Feb. 20, 1885, letter.
13. " 28, " am'd't B.
14. March 7, 1885, rej.
15. " 13, " am'd't- C and D.
16. " 14, " am'd't.
17. March 14, 1885, x Freeman.
18. April 20, 1885, dec'd favor Sawyer and Man.
19. " 21, " am'd't- E, F.

Title: Improvement in electric lights.
Ex'd: E. L. L. 36 Electricity.
C. F. Electric lights.

3659 EXHIBIT 13.

Received for record Oct. 22, 1878, and recorded in Liber H 23, page 448 of Transfers of Patents.

[SEAL.] In testimony whereof I have caused the seal of the Patent Office to be hereunto affixed.

W. H. DOOLITTLE,
Acting Commissioner.

Whereas, we, William Edward Sawyer, of the city, county and State of New York, and Albon Man, of Brooklyn, county of Kings, and State aforesaid, have made the following-entitled inventions, viz:

Firstly. Certain improvements in "electrical lighting apparatus and circuits."

Secondly. Certain improvements in "carbons for electric lights" and in the treatment thereof—for which we are about to apply for letters patent of the United States; and whereas the "Electro-Dynamic Light Company," a corporation created and existing under and by virtue of the laws of the State of New York, has purchased of us all our right, title and interest in and to said inventions and any and all letters patent of the United States, which may be hereafter granted for the same, and has paid us for the said inventions the sum of one dollar and given us other good and sufficient consideration for the same, the receipt of which we hereby acknowledge and with which we hereby declare ourselves satisfied, contented and paid, now, therefore, upon consideration aforesaid, we, the said William Edward Sawyer and Albon Man, have and do hereby sell, assign and convey to the said company the whole of our right, title and interest in and to said inventions, and any and all United States letters patents which may hereafter be granted 3660 for the same, for the said company to have, hold and enjoy for its own use and behoof and for the use and behoof of its legal representatives as fully and entirely as we would have held and enjoyed the same had this assignment and sale not been made, for the whole term for which said letters patent may be granted, including any extensions thereof, and through the whole of the United States and the territories thereof; and we do hereby covenant, for ourselves and our legal representatives, that we are now the sole owners of *of* said inventions and have good right and lawful authority to make and execute this conveyance, in manner aforesaid, and that we will at any and all proper and reasonable times make and execute any and all proper papers that may be necessary to apply for and obtain letters patent of the United States, for said inventions, and any and all proper papers that may be necessary to vest the title thereof in said corporation.

In witness whereof we hereunto set our hands and seals this, the 14th day of October, 1887.

W. E. SAWYER. [SEAL.]
ALBON MAN. [SEAL.]

Witnesses:
WILLIAM H. BROADNAX.
AMOS BROADNAX.

Endorsement: Consol. E. L. Co.; G. 3,553.

3661 EXHIBIT 14.

In consideration of the sum of five dollars to us in hand paid, we hereby assign, sell, and set over to the Electro-Dynamic Light Company of New York, our entire right, title and interest in and to an improvement in electric lights, as set forth in an application this day prepared and executed by us preparatory to applying for letters patent therefor; and we hereby request the Commissioner of

Patents to issue the said patent to the aforesaid company as our assignee.

Dated January 8, 1880.

WILLIAM EDWARD SAWYER.
ALBON MAN.

Witnesses:
WM. D. BALDWIN.
WM. H. CHURCH.

(Endorsed: Ex'd. F. C. T. U. — Patent Office. Received for record Jan. 9, 1880. Recorded Liber W 24, page 380. Consol. E. L. Co. *vs.* Edison E. L. Co. Compl't's Ex't No. 14. Assignment of Sawyer and Man to E. D. L. Co., May 11, 1886, T. G., exam.)

3662 EXHIBIT 15.

Received for record Oct. 5, 1882, and recorded in Liber J 28, page 429 of Transfers of Patents.

[SEAL.] In testimony whereof I have caused the seal of the Patent Office to be hereunto affixed.

Ex'd: M. T.

E. M. MARBLE,
Commissioner.

This deed of assignment, made this, the sixth day of April, 1881, between the Electro-Dynamic Light Company, a corporation created and existing under, and by virtue of the laws of the State of New York, of the first part; and William H. Church, of Brooklyn, county of Kings and State of New York, of the second part;

Witnesseth: That for the consideration hereinafter mentioned, the said Electro-Dynamic Light Company has and does hereby assign, transfer and convey to the said William H. Church, all and singular the letters patents of the United States, dated and numbered as follows, viz: one dated June 25, 1878, and numbered 205,303 for "improvement in electric lighting systems;" one dated June 18, 1878, and numbered 205,144 for "improvement in electric lamps;" one dated June 25, 1878, and numbered 205,305, for "improvements in regulators for electric lights;" one dated November 19, 1878, and numbered 210,152, for "improvement in switches for electric lights;" one dated December 10, 1878, and numbered 210,809, for "improvements in electric lamps;" one dated January 7, 1879, and numbered 211,262, for "improvements in carbons for electric lights;" one dated June 29, 1880, and numbered 229,335, for "carbons for electric lights;" one dated June 29, 1880, and numbered 229,476, for "improvement in electric switches;" one dated November 19, 1878, and numbered 210,151, for "improvement 3663 in electric meters;" one dated September 16, 1879, and numbered 219,771, for "improvement in electric lamps;" one dated February 8, 1881, and numbered 237,632 for "dynamo-electric machines;" and also two undivided fifths of the whole of letters patent of the United States, numbered and dated as follows, viz: one dated August 14, 1877, and numbered 194,111 for "electric engineering and lighting apparatus and system;" one dated August 21, 1877, and numbered 194,500, for "electric candles;" one dated August 28, 1877, and numbered 194,563, for "electric lighting apparatus;" one dated November 6, 1877, and numbered 196,834, for "electric engineering and lighting systems;" which interests in said last-mentioned letters patent were assigned by William E. Sawyer to Albon Man by a certain deed of assignment dated May 14, 1878, and recorded in Liber S 22, page 464, Transfers of Patents, and which interest- in said patents were duly assigned by said Albon Man to said Electro-Dynamic Light Company by deed of assignment duly recorded in the Patent Office in Liber C 24, *in* pages 294, 295, 296 and 297 and dated all of them July 15, 1878; together with all and singular the inventions owned by said company, and described, illustrated, claimed or suggested in said letters patents, and also all inventions owned by said company for which applications for patents are now pending in the United States.

And also covenants, assignments and agreements made by William E. Sawyer with Albon Man and assigned to said Electro-Dynamic Light Company and which are now owned by said company having reference to said patents and inventions, any or either of them, in which said company is interested, in so far as the said covenants or agreements appertain to letters patents for said inventions, any or either of them, in the United States of America, but not elsewhere; for the said William H. Church to have, hold and enjoy for his own use, benefit and behoof, and for the use, benefit 3664 and behoof of his assigns and legal representatives to the full end of the term for which said letters patent have been, or may hereafter be granted, issued, reissued or extended, any or either of them, in and for the whole of the United States and the territories, thereof, and also all covenants and agreements at any time made by the said William E. Sawyer and Albon Man, or either of them, jointly or severally, with the said Electro-Dynamic Light Company for the reissue or extension of said letters patent, any or either of them, or that in anywise appertains to said patents and inventions or applications for patents for the same in the United States of America, but not elsewhere; and that as fully and entirely as the same would, might or could have been held and enjoyed by the said Electro-Dynamic Light Company had this assignment and transfer not been made.

In trust, nevertheless, for the said William H. Church to hold to the use and benefit of the said Electro-Dynamic Light Company and especially to assign, transfer and convey to the Eastern Electric Manufacturing Company of Middletown, Connecticut.

All and singular the said letters patents and inventions and applications for letters patents, and the covenants and agreements aforesaid, the same to all intents and purposes as the said Electro-Dynamic Light Company does hereby assign, transfer and convey the said letters patents inventions, applications for patents, covenants and agreements to the said William H. Church and his assigns.

The consideration for this deed is that the said William H. Church subscribe for nine-twentieths of the whole of the capital stock of the Eastern Electric Manufacturing Company, and pay for the same by transferring, conveying and assigning to said company the whole of said letters patents, inventions, applications for letters patents, covenants and agreements aforesaid. The said William H. Church being hereby authorized to receive from said company the certificate or certificates of transfer of said stock of said Eastern Electric Manufacturing Company, and hold the same for the use and benefit of the share and script holders of the Electro-Dynamic Light Company and to thereupon divide the same among said share and script holders of the Electro-Dynamic Light Company according to their respective interest in said company, after having first assigned and transferred to such persons as shall be designated by the trustees of the Electro-Dynamic Light Company such shares of stock of the Eastern Electric Manufacturing Company as the said board of trustees deem expedient and proper, and which division of shares having been made and accepted as aforesaid, the trust hereby created shall cease and determine and the said trustee shall be discharged of his said trust. 3665

It being the intention of this instrument that the said William H. Church as such trustee shall convey to the said Eastern Electric Manufacturing Company the title absolutely to the letters patents, inventions, applications for letters patents, covenants and agreements aforesaid, and not to continue the trust hereby created.

In witness whereof the said Electro-Dynamic Light Company has hereto subscribed its name and affixed its seal by its president and treasurer the day and year above written.

ELECTRO-DYNAMIC LIGHT COMPANY,
By THO. WALLACE, *President.*
JACOB HAYS, *Treasurer.*

Witness:
AMOS BROADNAX.

3666 CITY, COUNTY, AND STATE OF NEW YORK, *ss:*

On this, the 15th day of December, A. D. 1885, personally came before me Jacob Hays, to me personally known to be the person whose name is hereto subscribed, and made solemn oath that on the sixth day of April, 1881, on the day of the date of the execution of the within assignment, he was treasurer of the Electro-Dynamic Light Company, and that Thomas Wallace was president of said company, at the date last aforesaid; and that the said instrument was signed by the said Thomas Wallace as president of said compa*d*y, and by deponent as treasurer thereof; and that the signatures written at the foot of said assignment are the signatures of deponent and said Thomas Wallace; and that they were duly authorized by said company to execute said instrument in manner and form as aforesaid.

JACOB HAYS.

Subscribed and sworn to before me this 15th day of December, 1885.

J. EDGAR BULL,
[SEAL.] *Notary Public, N. Y. Co., N. Y.*

3667 COMPLAINANT'S EXHIBIT NO. 16.

Assignment of April 6, '81. Church to Eastern Electric Manufacturing Co. May 11, '86. T. G., Ex'r.

CONSOLIDATED ELECTRIC LIGHT CO.
vs. } H, 3553.
EDISON ELECTRIC LIGHT CO. *et al.*

Received for record Oct. 5, 1882, and recorded in Liber J 28, page 433 of Transfers of Patents.

In testimony whereof I have caused the seal of the Patent [L. S.] Office to be hereunto affixed.

E. M. MARBLE,
Commissioner.

Ex'd: M. T.

This deed of assignment, made this the sixth day of April, 1881, between William H. Church, of Brooklyn, in the county of Kings and State of New York, trustee of the Electro-Dynamic Light Company, and of its share and scrip holders, of the first part; and the Eastern Electric Manufacturing Company of Middletown, Connecticut, a corporation created and existing under and by virtue of the laws of the State of Connecticut, and having an office and workshop in the city of New York, of the second part:

Witnesseth: That, whereas by a certain instrument of writing bearing even date herewith, the Electro-Dynamic Light Company, a corporation created and existing under and by virtue of the laws of the State of New York, assigned transferred and conveyed to the said William H. Church, all and singular the letters patent of the United States, dated and numbered as 3668 follows, viz: one dated June 25, 1878, and numbered 205,303, for "improvement in electric lighting systems;" one dated June 18, 1878, and numbered 205,144, for "improvement in electric lamps;" one dated June 25, 1878, and numbered 205,305, for "improvement in regulators for electric light;" one dated November 19, 1878, and numbered 210,152, for "improvement in switches for electric lights;" one dated December 10, 1878, and numbered 210,809, for "improvements in electric lamps;" one dated January 7, 1877, and numbered 211,262, for "improvement in carbons for electric lights;" one dated June 29, 1880, and numbered 229,335, for "carbons for electric lights;" one dated June 29, 1880, and numbered 229,476, for "improvement in electric switches;" one dated November 19, 1878, and numbered 210,151, for "improvement in electric meters;" one dated September 16, 1879, and numbered 219,771, for "improvement in electric lamps;"

one dated February 8, 1881, and numbered 237,632, for "dynamo electric machine," and also two undivided fifths of the whole of letters patent of the United States numbered as follows, viz: One dated August 14, 1877, and numbered 194,111, for "electric engineering and lighting apparatus and system;" one dated August 21, 1877, and numbered 194,500, for "electric candles;" one dated August 28, 1877, and numbered 194,563, for "electric lighting apparatus;" one dated November 6, 1877, and numbered 196,834, for "electric engineering and lighting systems;" which interest- in said last-mentioned letters patent were assigned by William E. Sawyer and Albon Man by a certain deed of assignment dated May 14, 1878, and recorded in Liber S 22, page 464, Transfers of Patents, and which interests in said patents were duly assigned by said Albon Man to said Electro-Dynamic Light Company by deed of assignment duly recorded in the Patent Office in Liber C 24, in pages 294, 295, 296 and 297, and dated, all of them, July 15, 1878; together with all and singular the 3669 inventions owned by said company and described, illustrated, claimed or suggested in said letters patent, owned by said company, any or either of them, whether owned by said company in whole or in part, and also all inventions owned by said company for which applications for patents are now pending in the United States, and also all assignments, covenants and agreements made by William E. Sawyer with Albon Man and assigned to said Electro-Dynamic Light Company, or which are now owned by said company, having reference to said patents and inventions, any or either of them, in which said company is now interested, in so far as the said covenants or agreements appertain to letters patents for said inventions, any or either of them, in the United States of America, but not elsewhere; for the said William H. Church to have, hold and enjoy for his own use, benefit and behoof, and for the use, benefit and behoof of his assigns and legal representatives, to the full end of the term for which the said letters patents have been or may hereafter be granted, issued, reissued or extended, any or either of them, in and for the whole of the United States and the territories thereof, and also

All covenants and agreements at any time made by the said William E. Sawyer and Albon Man, or either of them, jointly and severally, with the said Electro-Dynamic Light Company for the reissue or extension of said letters patents, any or either of them, or that in any way appertains to said patents and inventions or application for patents for the same in the United States of America, but not elsewhere, and that as fully and entirely as the same would, might or could have been held and enjoyed by the said Electro-Dynamic Light Company had said assignment and transfer not been made.

In trust nevertheless, for the said William H. Church to hold to the use and benefit of the said Electro-Dynamic Light Company, and especially to assign, transfer and convey to the 3670 said Eastern Electric Manufacturing Company of Middletown, Connecticut.

All and singular the said letters patents and inventions and applications for letters patent and the covenants and agreements aforesaid, the same to all intents and purposes as the said Electro-Dynamic Light Company conveyed the same to said William H. Church and his assigns.

The consideration for such deed from the Electro-Dynamic Light Company to said Church, being the said Church shall subscribe for nine-twentieths of the whole of the capital stock of the said Eastern Electric Manufacturing Company and pay for the same by transferring, conveying and assigning to said company the whole of the said letters patent, inventions, applications for letters patent, covenants and agreements aforesaid.

The said William H. Church is authorized by said deed to receive from said company the certificate or certificates of transfer of said stock of said Eastern Electric Manufacturing Company.

Now, therefore, the said William H. Church, having accepted the trust created by said deed, hereby covenants that he has subscribed for said nine-twentieths of the whole of the capital stock of the said Eastern Electric Manufacturing Company and that the certificate of transfer of said stock has been delivered to him by said company.

Wherefore, in consideration of said nine-twentieths of the whole of said capital stock of said Eastern Electric Manufacturing Company, the said William H. Church, as trustee for said Electro-Dynamic Light Company and its share and scrip holders has, and he does hereby assign, transfer and convey to the said Eastern Electric Manufacturing Company, all and singular, the aforesaid letters patents, and inventions and applications for letters patents, and all and singular the covenants and agreements so conveyed
3671 & 3672 to him by the Electro-Dynamic Light Company, as aforesaid, and that as fully and entirely as the same were conveyed to said Church by said deed, for the said Eastern Electric Manufacturing Company, its successors and assigns, to have, hold and enjoy for its and their own use, benefit and behoof absolutely through the whole of the unexpired term of said letters patent, any or either of them, and through all the renewals, reissues and extensions thereof.

In witness whereof the said William H. Church, trustee, has hereto set his hand and seal the day and year above written.

WM. H. CHURCH. [SEAL.]

Witness:
AMOS BROADNAX.

3673 COMPLAINANT'S EXHIBIT NO. 17.

Assignment of Eastern Electric Manufacturing Co. to Consolidated Electric Light Co. of Patent in Suit. May 11, '86. T. G., Ex'r.

CONSOLIDATED ELECTRIC LIGHT CO.
vs. } H, 3553.
EDISON ELECTRIC LIGHT CO. *et al.*

Received for record Oct. 5, 1882, and recorded in Liber J 28, page 441 of Transfers of Patents.

In testimony whereof I have caused the seal of the [SEAL.] Patent Office to be hereunto affixed.

E. M. MARBLE,
Commissioner.

(Ex'd: M. T.)

This deed of assignment made this thirtieth day of September, one thousand eight hundred and eighty-two, by and between the Eastern Electric Manufacturing Company of Middletown, Connecticut, a corporation created and existing under and by virtue of the laws of the State of Connecticut, and having an office in the city of New York of the first part; and the Consolidated Electric Light Company, a corporation created and existing under and by virtue of the laws of the State of New York, and having its principal place of business in the city of New York.

Witnesseth: That whereas the said Eastern Electric Manufacturing Company is the owner of certain inventions and letters patent of the United States, hereinafter mentioned and designated.

3674 And whereas, by a certain instrument in writing, dated June 10th, 1882, and a certain supplemental agreement dated July 8th, 1882, the said Eastern Electric Manufacturing Company, for the consideration of four thousand and five hundred shares of the capital stock of said Consolidated Electric Light Company of the par value of one hundred dollars each, full paid and non-assessable, and for other consideration mentioned in said contract of July 10th, 1882, and said supplement of July 8th, 1882, agreed to convey to said Consolidated Electric Light Company all and singular the inventions, letters patent, rights and franchises now belonging to it, and belonging to it at the time of making said agreement of June 10th, 1882.

Now, therefore, in performance, of said agreement and in consideration of said four thousand and five hundred shares of the capital stock of said Consolidated Electric Light Company of the par value of one hundred dollars each, full paid and non-assessable, and for other consideration mentioned in said contract the receipt of which is hereby acknowledged.

The said Eastern Electric Manufacturing Company hereby assigns, transfers and conveys to the said Consolidated Electric Light Company all and singular the invention, letters patent, rights and franchises now owned by it, and owned by it at the time of making said contract of June 10th, 1882, and especially the joint letters patent of the United States granted to William Edward Sawyer and Albon Man, dated and numbered as follows, viz:

One dated June 25th, 1878, and No. 205,303;
One dated June 18th, 1878, and No. 205,144;
One dated June 25th, 1878, and No. 205,305;
One dated November 19th, 1878, and No. 210,152;
One dated December 10, 1878, and No. 210,809;
One dated January 7th, 1879, and No. 211,262;
One dated June 29th, 1880, and No. 229,335;
One dated June 29th, 1880, and No. 229,476.

3675 And also the letters patent granted to William Edward Sawyer, dated and numbered as follows, viz: one dated November 19th, 1878, and No. 210,151; one dated September 16th, 1879, and No. 219,771; one dated February 8th, 1881, and No. 237,632.

And also two undivided fifths of the whole of each of the following letters patent granted to William Edward Sawyer, viz:

One dated August 14th, 1877, and No. 194,111;
One dated August 21st, 1877, and No. 194,500;
One dated August 28th, 1877, and No. 194,563;
One dated November 6th, 1877, and No. 196,334.

And also the joint letters patent of the United States granted to William E. Sawyer and Edward R. Knowles dated May 10th, 1881, and No. 241,242.

And also the joint letters patent of the United States granted to William Edward Sawyer and Robert Street, dated and numbered as follows, viz:

One dated May 10th, 1881, and No. 241,430;
One dated August 23rd, 1881, and No. 245,976.

Also the joint letters patent of the United States granted to William Edward Sawyer and William Sawyer dated and numbered as follows, viz:

One dated December 14th, 1880, and No. 235,460;
One dated January 11th, 1881, and No. 236,460.

And also the letters patent of the United States granted to Thomas B. Stillman numbered and dated as follows, viz:

One dated March 23rd, 1880, and No. 225,730;
One dated April 20th, 1880, and No. 226,632;
One dated May 11th, 1880, and No. 227,454.

And also the letters patent of the United States granted to Edward R. Knowles, dated May 11th, 1880, and No. 237,365.

3676 And also the letters patent of the United States granted to William Sawyer, dated and numbered as follows, viz:

One dated February 17th, 1880, and N.o 224,612.

Six dated May 11th, 1880, and numbered respectively, 227,386; 227,387; 227,388, 227,389; 227,390 and 227,845.

Two dated May 25th, 1880, and numbered respectively, 228,122 and 228,123.

Two dated July 20th, 1880, and numbered respectively, 230,345 and 230,346.

One dated October 12th, 1880, and No. 233,234.

Two dated December 14th, 1880, and No. 235,385 and 235,459 respectively.

One dated February 8th, 1881, and No. 237,608.

Together with all and singular the inventions owned by said Eastern Electric Manufacturing Company and described, illustrated, claimed or suggested in said letters patent, any or either of them, and all interest in said letters patent, any or either of them, whether owned by said company in whole or in part, and also all inventions owned by said company for which applications are now pending in the United States and especially the application No. 547, filed January 9th, 1880, and all the divisions thereof; and also any and all applications which may be made, arise or grow out of, or in anywise appertain to any or either of said letters patent or applications for patents now pending.

And also all assignments, grants, licenses, covenants and agreements owned by said Eastern Electric Manufacturing Company in anywise appertaining to said patent-, any or either of them, or to any patents or inventions appertaining to electric lighting now owned by said company are hereby conveyed to said Consolidated Electric Light Company for the said company to have, hold or enjoy for its own use, benefit and behoof; and for the use, benefit and
3677 behoof of its successors, assigns and legal representatives to the full end of the term for which said letters patent are or may hereafter be granted, issued, reissued or extended any or either of them, in and for the whole of the United States and the territories thereof.

And also all the property and assets of every nature and kind whatsoever belonging to the said Eastern Electric Manufacturing Company and all which belonged to it at the time of making said contract of June 10th, 1880, is hereby transferred and conveyed to the said Consolidated Electric Light Company and that as fully and entirely as the same would or might have been held and enjoyed by the said Eastern Electric Manufacturing Company had this assignment and transfer not have been made.

And the said Eastern Manufacturing Company hereby covenants with the said Consolidated Electric Light Company that it is now the sole owner of the whole of said inventions and letters patent; that it has now the sole and exclusive right to the said inventions and to work said letters patent, subject only to the licenses and agreements hereinafter mentioned, the whole of which are hereby conveyed to said Consolidated Electric Light Company as aforesaid; and that said inventions and letters patent, are free, clear and not encumbered by, or for any claim, lien mortgage or demand whatsoever; and that it has good right and lawful authority to make and execute this deed of assignment and transfer in manner and form as aforesaid.

And said Eastern Electric Manufacturing Company hereby covenants with the said Consolidated Electric Light Company that the following and no other licenses and contracts under and appertaining to said patents have been made by it and are now outstanding, viz: A certain license dated March 1st, 1881, to the Commonwealth

Electric Light and Manufacturing Company, of Pennsylvania, and a certain supplement thereto, dated June 8th, 1882, granting the 3678 right to use said patents and inventions in the State of Pennsylvania. A certain license dated October 14th, 1881, to the Illinois Electric Manufacturing Company for the State of Illinois. A certain agreement by said company with A. J. Works, dated August 27th, 1880, appertaining to certain rights under the patents then owned by it in the District of Columbia and State of West Virginia.

The said Eastern Electric Manufacturing Company hereby conveys to said Consolidated Electric Light Company all its right, title and interest in and to said licenses and agreements, and all its rights of action thereunto appertaining both in law and equity, and all benefits and advantages growing out of the same.

The said Consolidated Electric Light Company taking this assignment subject to the conditions and advantages of said licenses and agreements.

And it is hereby covenanted and agreed between the said Eastern Electric Manufacturing Company and said Consolidated Electric Light Company, and this assignment is made upon this express condition.

That said Consolidated Electric Light Company shall not sell, lease or otherwise dispose of all its patents, patent rights and other rights and property to any individual or corporation, nor by lease, licenss or otherwise grant to any individual or corporation having an interest directly or indirectly in any other patents or system of electric lighting, any rights under said patents, nor permit the use or exercise of such rights by such individual or corporation without the consent in writing of holders of not less than five-sixths of the capital stock of said Consolidated Electric Light Company; and that all conveyances, grants and licenses made by said Consolidated Electric Light Company under said patents, any or either of them in violation thereof shall be absolutely null and void as being without authority and of no force or effect in law.

In witness whereof the said Eastern Electric Manufactur- 3679 ing Company has hereunto signed its name and affixed its seal the day and year first above written. The words "and agreements" in the fourth line of seventh page having been first interlined. Also on page three the words "and also the letters patent granted to William Edward Sawyer, dated and numbered as follows, viz: one dated Nov. 19th, 1878, and No. 210,151; one dated September 16th, 1879, and No. 219,771; one dated February 8th, 1881, and No. 237,632" having been first written in the margin, and the words "and all which belonged to it at the time of making said contract of June 10th, 1880," having been first interlined between the sixteenth and seventeenth lines on the sixth page.

THE EASTERN ELECTRIC MAN'F'G CO.,
By HORACE LITTLE, *President*.
[SEAL.] W. N. PEARNE, *Secretary*.

Signed, sealed and delivered in presence of—
WM. H. CLARKSON.
JAMES M. SULLIVAN.

3680 & 3681 STATE OF NEW YORK, }
County of New York, } *ss:*

NEW YORK CITY, *September* 30, *A. D.* 1882.

Personally appeared Horace Little, president, and W. N. Pearne, secretary of the said The Eastern Electric Manufacturing Company, signers and sealers of the foregoing instrument, and acknowledged the same to be their free act and deed before me as the president and secretary, respectively, of said company, and the free act and deed of said company. And they also made solemn oath before me that they were the above-described officers of said company and that the seal affixed to the foregoing instrument was the corporate seal of said company and that it was affixed thereto by proper authority of said company, and that they signed their names thereto by like authority as the president and secretary of said company.

In witness whereof I have hereunto set my hand and affixed my official seal this thirtieth day of September, A D. 1882.

WILLIAM H. CLARKSON,
Commissioner for Connecticut in New York,
[SEAL.] 117 *Broadway N. Y. City,*
[SEAL.] *And Notary Public for New York County, N. Y.*

3682 COMPLAINANT'S EXHIBIT NO. 18.

Certificate of Incorporation of Electro Dynamic Light Co. *May* 11, '86.
T. G., Ex'r.

CONSOLIDATED ELECTRIC LIGHT CO. }
vs. } H, 3553.
EDISON ELECTRIC LIGHT CO. *et al.* }

We, Albon Man, William E. Sawyer, Hugh McColloch, Lawrence Myers, Jacob Hays, James P. Kernochan and William H. Hays, do hereby certify pursuant to the act entitled "An act to authorize the formation of corporations for manufacturing, mining, mechanical and chemical purposes," passed by the legislature of the State of New York, February 17th, 1848, and of the several acts extending and amending the same, that we desire to form, and hereby do form, a company to be known by the corporate name of "The Electro-Dynamic Light Company."

The objects for which said company is organized, are the production of light and power by means of electricity, the lighting of streets, buildings and other places, producing, conducting and distributing of electrical currents for lighting and other purposes and the manufacture and sale of all machinery necessary for and adapted to accomplish said objects, and the purchasing and holding of such property real and personal as may be lawful and necessary in the proper transaction of the said business.

The capital stock of said company shall be and is ten thousand dollars, in two hundred shares of fifty dollars each.

The term of existence of said company shall be fifty years from the date of this certificate.

The number of trustees of said company shall be seven and the names of the trustees who shall manage the business of the 3683 corporation for the first year are Albon Man, William E. Sawyer, Hugh McCulloch, Lawrence Myers, Jacob Hays, James P. Kernochan and William H. Hays, all of whom are citizens of the United States and of the State of New York.

The operations of the company are to be carried on in the city and county of New York, and State of New York.

Dated July 8th, 1878.

ALBON MAN.
W. E. SAWYER.
HUGH McCULLOCH.
LAWRENCE MYERS.
JACOB HAYS.
W. H. HAYS.
JAS. P. KERNOCHAN.

Witness as to James P. Kernochan:
IRVING PARIS, Jr.
Witness as to all but J. P. Kernochan:
WM. C. McKEAN.

CITY AND COUNTY OF NEW YORK, *ss:*

On this eighth day of July, A. D. 1878, before me personally appeared Albon Man, William E. Sawyer, Hugh McCulloch, Lawrence Myers, Jacob Hays, William H. Hays to me known to be the individuals described in and who executed the foregoing certificate, and they severally before me signed the said certificate, and acknowledged that they signed the same for the purposes therein mentioned.

WM. C. McKEAN,
[SEAL.] *Notary Public, New York City and Co.*

3684 CITY AND COUNTY OF NEW YORK, *ss:*

On this 10th day of July, A. D. 1878, before me personally appeared James P. Kernochan to me known to be the individual described in and who executed the foregoing certificate and he before me signed the said certificate and acknowledged that he signed the same for the purposes therein mentioned.

IRVING PARIS, Jr.,
[SEAL.] *Notary Public, N. Y. Co.*

Filed 11th July, 1878.

STATE OF NEW YORK,
City and County of New York, } *ss:*

I, Patrick Keenan, clerk of the said city and county, and clerk of the supreme court of said State for said county, do certify, that I have compared the preceding with the original certificate of incorporation of the Electro-Dynamic Light Company, on file in my office and that the same is a correct — therefrom, and of the whole of such original.

(Endorsed: Filed 11 July, 1878.)

In witness whereof I have hereunto subscribed my name and affixed my official seal this — day of —— 188–.

[SEAL.] PATRICK KEENAN, *Clerk.*

3685 COMPLAINANT'S EXHIBIT NO. 19.

Certificate of Incorporation of Eastern Electric Manufacturing Company. May 11, '85. *T. G., Ex'r.*

CONSOLIDATED ELECTRIC LIGHT CO.
vs.
EDISON ELECTRIC LIGHT CO. *et al.* } H, 3553.

STATE OF CONNECTICUT,
OFFICE OF SECRETARY OF STATE.

The Eastern Electric M'f'g Company.

Certificate of Organization.

To all persons to whom these presents may come:

The undersigned being the president and a majority of the directors of the Eastern Electric Manufacturing Company, a corporation organized under the statute laws of the State of Connecticut regulating the formation of joint stock corporations, and located in the town of Middletown, in the county of Middlesex, in said State, in pursuance of said statute laws, hereby certify as follows, to wit:

1st. The purposes for which said corporation is formed are the following, to wit:

To purchase letters patent of the United States and other countries, issued for improvement in electrical machines, or for the use and application of electricity; to manufacture and sell electric machines, to manufacture and sell machines or the generation or production of electricity; to manufacture and sell machines for the production of power by electricity; the production of power, heat and light by electricity; the lighting of cities, towns, villages, private residences and other places by electricity; the manufacture and sale of electrical signals for railroads and other 3686 purposes; the manufacture and sale of electrical machinery and apparatus relating to telegraphy; the construction and management of telegraph lines, the discovery and application of new uses for electricity and galvanism in the arts and sciences; the licensing and sale of rights to use such letters patent as the said corporation may own or be entitled to, to individuals, towns, cities or corporations; and to buy and sell and deal in any real and personal estate necessary or convenient for the prosecution of said business; and generally to do all things incidental to said business and the proper management thereof.

2nd. The amount of their capital stock actually paid in is two million dollars.

3rd. The amount of their capital stock actually paid in is two million dollars.

4th. The names of their stockholders and the number of shares by each respectively owned is as follows, to wit:

Names of stockholders.	No. of shares.
William Sawyer, New York	6,666
Horace Little, Ridgeway, Penn	6,667
Joseph Goodrich, Jr., Haverhill, Mass	2,222
Daniel J. Noyes, New York	2,223
John J. Anderson, New York	2,222

And in further pursuance of said statute laws, we cause this certificate to be deposited with the secretary of this State, and a duplicate thereof with the town clerk of the town of Middletown, in which said corporation is to transact its business.

Dated at Middletown, this 15th day of January, A. D., 1880.

HORACE LITTLE, *President.*
WILLIAM SAWYER,
D. J. NOYES,
JOHN J. ANDERSON,
HORACE LITTLE, *Directors.*

3687 STATE OF CONNECTICUT, *County of Middlesex,* } *ss:*

MIDDLETOWN, *January* 15, 1880.

Then and there personally appeared Horace Little, William Sawyer, Daniel J. Noyes and John J. Anderson, being the president and a majority of the directors of the Eastern Electric Manufacturing Company, and made oath to the truth of the foregoing certificate signed by them.

Before me—

W. U. PEARNE,
A Commissioner of the Superior Court for Middlesex County.

Rec'd and filed January 17, 1880.

STATE OF CONNECTICUT, *Office of Secretary of State,* } *ss:*

I, Charles A. Russell, secretary of the said State of Connecticut, and keeper of the seal thereof, and of the original record of the certificate of joint stock corporations of said State, do hereby certify that I have compared the annexed copy of the certificate of organization of the Eastern Electric Manufacturing Company, with the original records of the same now remaining in this office, and have found the said copy to be a correct transcript thereof and of the whole of the said original; and I further certify that the said original record is a public record of the State of Connecticut, now remaining in this office.

In testimony whereof, I have hereunto set my hand, and [SEAL.] affixed the seal of said State at Hartford, this 17th day of December, 1885.

CHARLES A. RUSSELL,
Secretary of State.

3688 COMPLAINANT'S EXHIBIT No. 20.

Certificate of Incorporation, Consolidated Electric Light Co. May 11, '85. *T. G., Ex's.*

CONSOLIDATED ELECTRIC LIGHT CO.
vs. } H., 3553.
EDISON ELECTRIC LIGHT CO. *et al.*

Certificate of incorporation of the Consolidated Electric Light Company.

STATE OF NEW YORK, } *ss:*
City and County of New York,

We the undersigned Horace Little, Edwin S. Thayer and John P. Adams do by these presents pursuant to and in conformity with the act of the legislature of the State of New York, passed on the seventeenth day of February, in the year one thousand eight hundred and forty-eight entitled "An act to authorize the formation of corporations for manufacturing, mining, mechanical and chemical purposes" and the several acts of the said legislature amendatory thereof, associate ourselves together and form a body politic and corporate and do hereby certify:

ARTICLE I.

That the corporate name of the said corporation is The Consolidated Electric Light Company.

ARTICLE II.

That the objects for which said corporation is formed are as follows: To manufacture, use, lease and vend, and license to 3689 use, lease and vend, machinery, implements, fixtures, tools and utensils for the production and maintenance of electric lights, and for the production and utilization of electricity for other purposes, and to buy, sell, lease, occupy, use and deal generally in such estate real, personal and mixed as the purposes of the corporation may require.

ARTICLE III.

That the capital stock of said corporation shall be twelve hundred thousand dollars.

ARTICLE IV.

That the said capital stock shall be divided into twelve thousand shares of one hundred dollars each.

ARTICLE V.

That the said corporation shall commence on the eight- day of September, A. D. one thousand eight hundred and eighty-two, and shall continue in existence for the term of fifty years.

ARTICLE VI.

That the number of trustees of the said corporation shall be thirteen and the names of those who shall manage its concerns for the first year are Horace Little of Ridgway, Pa., Hugh R. Garden of Warrentown, Va., Thomas Wallace of Ansonia, Conn., Preston B. Plumb of Topeka, Kansas, Henry T. Jenking of New York, N. Y., Jacob Hays of New York, N. Y., Albon Man of Brooklyn, N. Y., William Windom of Winona, Minnesota, Amos Broadnax of Brooklyn, N. Y., Edwin S. Thayer of New Bedford, Mass., Herbert L. Judd of New York, N. Y., John J. Anderson of New York, N. Y.; William Richardson, of New York, N. Y., all of whom are citizens of the United States and a majority of whom are citizens of the State of New York.

ARTICLE VII.

3690 That a part of the operations and business of the said corporation will be carried on out of the State of New York and that the princip*le* place of business of the said corporation within said State will be in the city and county of New York.

Dated New York, September 7, A. D. 1882.

HORACE LITTLE.
EDWIN S. THAYER.
JOHN P. ADAMS.

STATE OF NEW YORK,
City and County of New York, } *ss:*

On this seventh day of September, in the year one thousand eight hundred and eighty-two, before me, personally appeared Horace Little, Edwin S. Thayer and John P. Adams to me known and known by me to be the individuals described in the foregoing certificate and they severally signed the same in my presence and severally acknowledged to me that they signed the same for the purposes therein specified.

[SEAL.] GEORGE W. WALLACE,
Notary Public (62), *City and Co. N. Y.*

(Endorsed: Certificate of incorporation of the Consolidated Electric Light Company. State of New York, office of the secretary of the State. Filed and recorded Sept. 8, 1882. Anson S. Wood, deputy secretary of state, 10 hr. 30 m.)

3691 STATE OF NEW YORK,
Office of the Secretary of State, } *ss:*

I have compared the preceding with the original certificate of incorporation of Consolidated Electric Light Company, with acknowledgement thereto annexed, filed and recorded in this office on the eight- day of September, 1882, and do hereby certify the same to be a correct transcript therefrom and of the whole of the said original.

[SEAL.] Witness my hand and the seal of office of the secretary of state, at the city of Albany, this 20th day of May, one thousand eight hundred and eighty-four.

JOSEPH B. CARR,
Secretary of State.

3692 COMPLAINANT'S EXHIBIT NO. 22.

Edison's patent, No. 341,644.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, of Menlo Park, New Jersey, assignor to the Edison Electric Light Company of New York, N. Y.

Incandescent Electric Lamp.

Specification forming part of Letters Patent No. 341,644, dated May 11, 1886. Application filed May 31, 1881. Serial No., 34652. (No model.)

To all whom it may concern:

Be it known that I, Thomas A. Edison, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful improvement in electric lamps; and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

The object I have in view is to produce a simple method and means for sealing incandescent electric lamps, so that when the carbons are destroyed the lamps can be taken apart, supplied with new carbons, and again exhausted and sealed at a less cost than the first expense of manufacture. This I accomplish by providing the glass support for the filament of each lamp with a sufficiently large ground surface with which fits closely a ground surface of similar size on the globe or bulb, one or both of the surfaces being, if necessary, first covered with a viscous substance, which fills the interstices and makes an air-tight joint. The lamp is exhausted, as usual, and the pressure of the atmosphere holds the surfaces together, the viscid substance requiring no packing to hold it in place.

3693 As just stated, the lamp is made in two glass parts secur together by a ground glass joint aided by atmospheric pre ure. The wires leading to the incandescing conductor are seale into one of the glass parts of the lamp by the fusion of the gla around and upon such wires. For the incandescing conductor the is employed a carbon filament—viz., a conductor of carbon of filamentary size, and having consequently a high resistance, which permits of the use of small leading-in wires, which can be successfully sealed into the glass without danger of breaking the seal at such points.

The lamp globe, it will be understood, is exhausted by connection with suitable vacuum apparatus, and is "sealed off" from connection with the vacuum apparatus by the fusion of a glass tube extending from one glass part of the lamp.

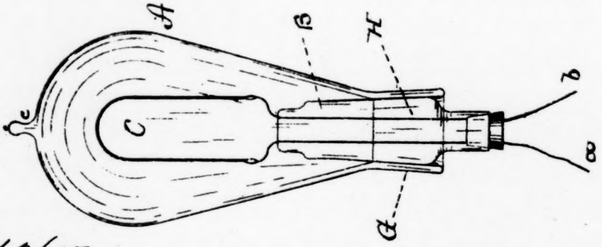
(No Model.)

T. A. EDISON.

INCANDESCENT ELECTRIC LAMP.

No. 341,644. Patented May 11, 1886.

Fig. 3.



No. 286.
C. E. Light Co.
v.
McK Light Co.
} p 3695

Fig. 2.

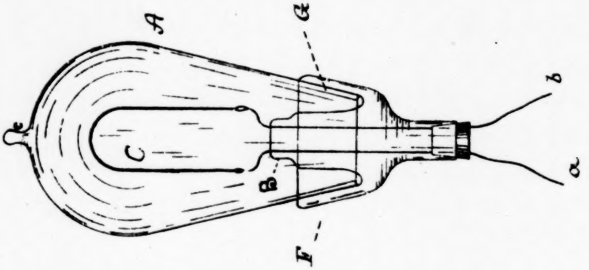
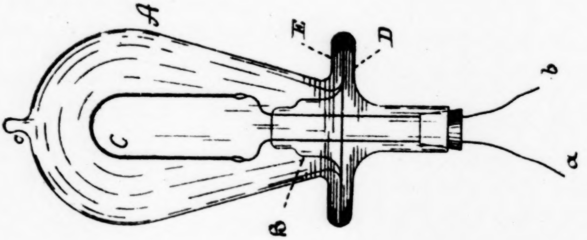


Fig. 1.



Attest:

S. D. Mott

N. W. Seely

Inventor:

T. A. Edison

per

Dyer & Wilber

Attorneys

The lamp produced is separate from the vacuum apparatus, and has each of its two glass parts formed of a continuous glass piece by the fusion of the glass, the only point in the glass globe where the glass tube is not fused into one piece being at the ground surfaces where the two parts meet.

In the drawings,

(Here follows diagram marked p. 3695.)

Figure 1 is an elevation of one form of the lamp embodying my invention, and Figs. 2 and 3 elevations of other forms.

A is the glass globe or bulb. B is the glass support for the filament; *a b*, the leading-in wires, and C the incandescing carbon filament.

In Fig. 1 the glass support is shown as provided with a solid horizontal flange, D, which is ground on its upper surface, while the bulb, A, at its lower end, is turned outwardly to form a horizontal flange, E, which is ground on its under surface and fits closely the upper surface of the flange D. Before the bulb A is exhausted the carbon is inserted into the same and the ground surfaces of the flanges D E brought together, one or both of such surfaces being first rubbed by a viscid substance—such as
3694 bird-lime, paraffine, or liquid rubber or grease. The bulb is
then exhausted, as usual, and sealed off at *c* by the fusion of the glass.

In Fig. 2 the glass support has an upturned cup flange, F, and the lower end, G, of the bulb is fitted inside of the same, the meeting surfaces being ground. A viscid substance is used in the joint, as before explained. The end, G, of the bulb may be fitted over the cup, F, if desired.

In Fig. 3 the lower end, G, of the bulb is fitted over the tapering body, A, of the glass support. When the carbon is broken the globe may be used over again. It is opened by breaking off the sealing teat, *c*, allowing the air to rush into the vacuum. The globe can then be separated at the joint. A new exhausting tube is sealed on where *c* is broken off, a new carbon filament is connected with the wires, and the globe is exhausted and again sealed.

What I claim is—

1. A separate incandescent electric lamp consisting of an exhausted glass inclosing chamber made in two parts, each of which is formed of a continuous glass piece by the fusion of the glass, the two parts being provided with ground meeting or junction surfaces aided in their adhesion by atmospheric pressure, and an incandescing carbon filament secured to leading-in wires passing through one of the parts, and sealed by fusion into the glass thereof, substantially as set forth.

2. A separate incandescent lamp consisting of an exhausted glass inclosing chamber made in two parts, each of which is formed of a continuous glass piece by the fusion of the glass, the two parts being provided with ground meeting or junction surfaces covered with a viscid substance, and aided in their adhesion by atmospheric

pressure, and an incandescing carbon filament secured to
3696 leading-in wires passing through one of the parts, and sealed
by fusion into the glass thereof, substantially as set forth.

3. A separate incandescent electric lamp consisting of an exhausted glass inclosing chamber made in two parts, each of which is formed of a continuous glass piece by the fusion of the glass, the two parts being provided with ground meeting or junction surfaces aided in their adhesion by atmospheric pressure, and one of such parts having the sealing teat, *c*, and an incandescing carbon filament secured to leading-in wires passing through one of the parts and sealed by fusion into the glass thereof, substantially as set forth.

This specification signed and witnessed this 20th day of May, 1881.

THOMAS A. EDISON.

Witnesses:

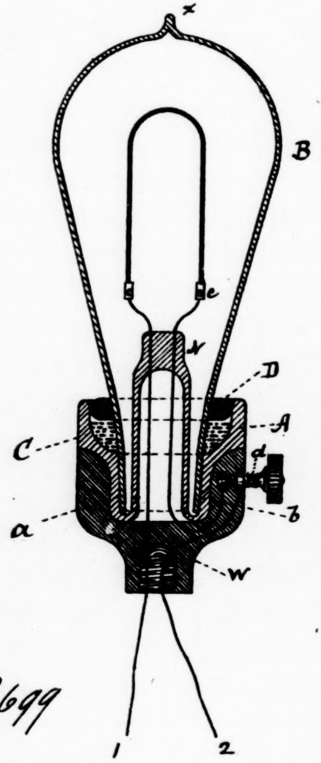
RICHARD N. DYER.
H. W. SEELY.

(No Model.)

T. A. EDISON.

ELECTRIC LAMP.

No. 263,878. Patented Sept. 5, 1882.



No 286.
C.E. Light Co
v
McK Light Co

p. 3699

Attest:–

S D Mott

F. W. Howard

Inventor:–

Thos. A. Edison

per Dyer & Wilber

Attys

3697 COMPLAINANT'S EXHIBIT NO. 23.

Edison's patent No. 263,878.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, of Menlo Park, New Jersey, assignor to the Edison Electric Light Company of New York, N. Y.

Electric Lamp.

Specification forming part of Letters Patent No. 263,878, dated September 5, 1882. Application filed December 15, 1880. (No model.)

To all whom it may concern:

Be it known that I, Thomas A. Edison, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful improvement in incandescent electric lamps (case 271); and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawing, and to the letters of reference marked thereon.

My invention relates to that class of electric lamps in which the light is caused by the incandescence of a carbon filament, and has for its object the production of an arrangement which will maintain a vacuum in the globe which contains the carbon.

In prior applications and patents I have shown methods of sealing the various parts of the lamp together by a fusion of the glass itself, thereby forming at the joints a vitreous seal of the same character and durability as the body of the lamp itself. Under some circumstances an unfused seal may be sufficient, the parts being put together so that while a joint practically tight for a limited period is secured they may, when desired, be separated. To 3698 accomplish this may be stated as the special object of the invention hereinbefore set out in more general terms. My arrangement for this purpose consists in setting the globe in a glass socket, both being ground, so that they will fit tightly together. Afterward, the space left being filled with mercury and a packing of rubber used to close the whole tightly and retain the mercury in the space, the air is exhausted from the globe at its top, which is then sealed, so that a vacuum is maintained.

The accompanying drawing is a sectional view of a lamp constructed according to my invention.

(Here follows diagram marked p. 3699.)

W is an insulating base, usually of wood. A is the glass socket fitting therein. It is, when seen in section, somewhat of the form of the letter W, the central limb being extended upwardly and forming a support for the wires leading to the clamps, the wires being suitably sealed therein, this central portion extending up within the body of the globe B. The socket A is ground at *a* and the globe B correspondingly ground at *b*, so that they fit tightly together. A space C, is thus left, which is filled in with mercury, forming a liquid seal. Above the mercury is placed a rubber ring, D, which fits tightly and prevents the mercury from escaping.

1 2 are the wires of the circuit, by which electricity is supplied to the lamp. These wires terminate in the platinum clamps *c*, which hold the carbon. A portion of the circuit is formed by the screw *d*, which may be drawn back to break the circuit and extinguish the lamp, or *vice versa*.

After the globe B is blown a stem remains at *x*, by means of which the air is exhausted, and the globe is then sealed and the stem broken off, leaving the globe perfectly air tight and keeping a vacuum in its interior.

What I claim is—

3700 1. The central tube conductor or support for the incandescing conductor, formed with a chamber at its base and fitted to receive tightly therein the neck of the inclosing globe, substantially as set forth.

2. In an incandescing lamp, the combination of the chambered central tube or support and the inclosing globe, ground or adapted to fit tightly, substantially as described.

3. The combination, in an incandescing lamp, of the chambered central tube or support adapted to hold a liquid seal, the inclosing globe having a neck fitted to the chamber, and a packing for securing the liquid seal, substantially as set forth.

This specification signed and witnessed this 3d day of December, 1880.

THOS. A. EDISON.

Witnesses:
H. W. SEELY.
WM. CARMAN.

(No Model.)

T. A. EDISON.

INCANDESCENT ELECTRIC LAMP.

No. 264,657. Patented Sept. 19, 1882.

Fig 1

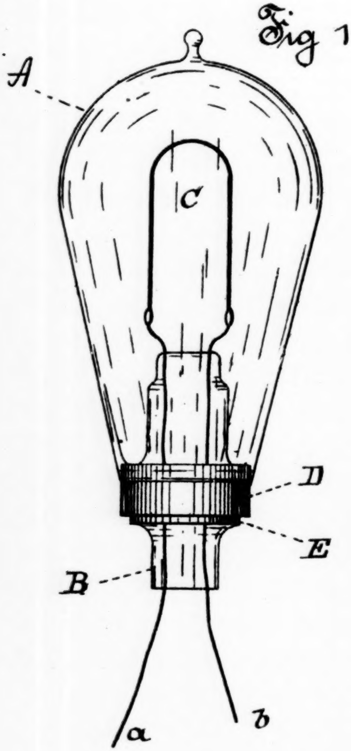
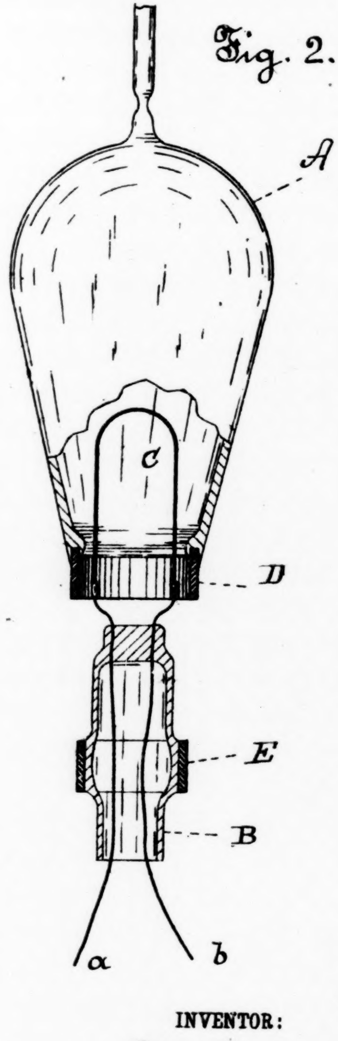


Fig. 2.



No. 286.
C. E. Light Co.
v.
McK. Light Co
M. 3703

WITNESSES:

O. D. Mott
M. J. Blassett

INVENTOR:

T. A. Edison

BY Dyer & Wilber

ATTORNEYS.

(No Model.)

T. A. EDISON.

INCANDESCENT ELECTRIC LAMP.

No. 264,657. Patented Sept. 19, 1882.

Fig 1

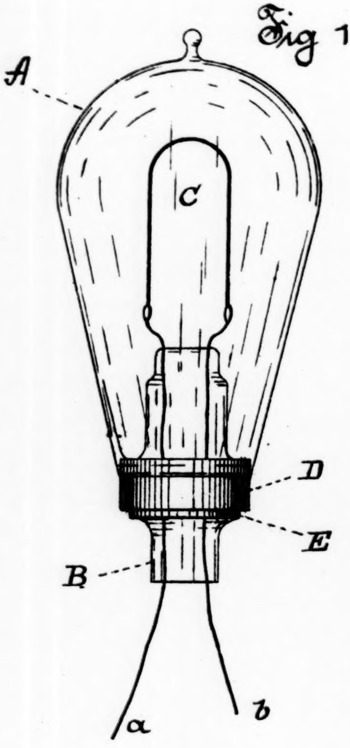
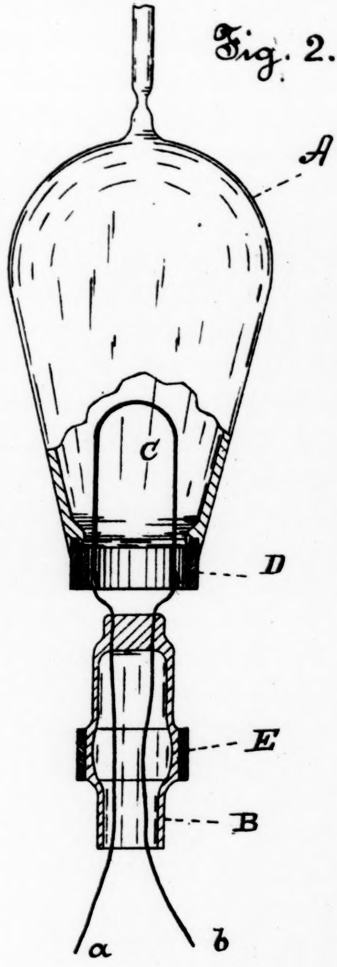


Fig. 2.



No. 286:
C.E. Light Co.
v.
McK Light Co
} p. 3705

WITNESSES:

O. D. Mott
M. J. Clagett

INVENTOR:

T. A. Edison

BY Dyer & Wilber

ATTORNEYS.

3701 & 3702 COMPLAINANT'S EXHIBIT NO. 24.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, of Menlo Park, New Jersey, assignor to the Edison Electric Light Company of New York, N. Y.

Incandescent Electric Lamp.

Specification forming part of Letters Patent No. 264,657, dated September 19, 1882. Application filed August 30, 1881. (No model.)

To all whom it may concern:

Be it known that I, Thomas A. Edison, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful improvement in incandescent electric lamps (case No. 322); and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

The object I have in view is to produce another form of incandescing electric lamp which can be taken apart when the carbon is destroyed and the principal parts again utilized. This I accomplish by providing the lower end or neck of the glass bulb or globe with a ring of platinum, which is sealed into the glass of the globe and is soldered to another platinum ring sealed into the glass of the wire support. After the platinum rings are soldered together the globe is exhausted and sealed. When the carbon is broken the platinum rings can be separated by melting the solder by heat, or eating it away with acid, and the parts can be used over again, it being only necessary to supply a new carbon filament, to solder the platinum rings together again, and to re-exhaust and reseal the globe. For this last purpose the globe
3704 will be heated at the top, and will be perforated and provided with a glass tube for making connection with a suitable exhausting apparatus.

In the drawings,

(Here follow diagrams marked pp. 3703 and 3705.)

Figure 1 is a view of the lamp complete, and Fig. 2 a vertical section of the two parts of the lamp before the platinum*s* rings are soldered together.

A is the glass globe; B, the glass wire support; C, the carbon filament, and *a b* the leading-in wires. D is a platinum ring, sealed to the glass at the lower end of the neck of the globe, and E is another platinum ring, which is dropped over the upper end of the glass wire support, and sealed to the glass of the enlarged portion of the wire-support. One of these rings is preferably smaller than the other, so that they fit closely over the other. These platinum rings are soldered together before the lamp is exhausted. To separate the two glass portions of the lamp, the solder can be melted or eaten away by acid.

It will be understood that the tubular glass wire support B is hermetically sealed at its upper end by being flattened and fused upon the leading-in wires *a b*, such leading-in wires passing out through this tube. After the globe A is hermetically sealed at its lower end, and secured to the support B by the soldering of the platinum rings D E together, the lamp is exhausted by means of the glass tube attached to the globe, which is sealed off by fusion of the glass. The joints between the platinum rings and the two glass portions of the lamp are made air tight by the fusion of the glass upon such rings.

What I claim is—

1. In an incandescing electric lamp, the combination, with the two portions of the lamp made entirely of glass, of a joint between said parts, composed of two platinum portions attached to the glass parts by the fusion of the glass upon them, said platinum
3706 portions being hermetically secured together, substantially
as specified.

2. In an incandescing electric lamp, the combination of the two portions of the lamp made entirely of glass, the carbon filament supported from one of said glass portions by leading-in wires passing through and sealed into the glass by the fusion of the glass thereon, and a separable metallic joint between the two glass portions of the lamp, substantially as specified.

3. In an incandescing electric lamp, the combination of the two glass portions with the lamp of the carbon filament supported from one of said glass portions by leading-in wires passing through and sealed into the glass by the fusion of the glass thereon, a sealed glass exhausting tube on one of said glass portions, and a separable metallic joint between the two portions of the lamp, substantially as specified.

4. In an incandescing electric lamp, the combination, with the glass globe A, of a tubular glass wire support, B, extending up into the globe and hermetically sealed at its upper end upon the leading-in wires, and the platinum rings D E, secured to the lower end of the globe and to the sides of said tubular support by the fusion of the glass upon said rings, such rings being secured together to form a separable air-tight joint, substantially as specified.

This specification signed and witnessed this 21st day of May, 1881.

THOMAS A. EDISON.

Witnesses:
RICH'D N. DYER:
H. W. SEELY.

3707 COMPLAINANT'S EXHIBIT NO. 25.

CONSOLIDATED ELECTRIC LIGHT CO.
vs.
EDISON ELECTRIC LIGHT COMPANY *et al.* } Equity. 3553.

Canadian Patent No. 11968. *Issued to Thomas Alva Edison for "Edison's Electric Lamp," November* 11, 1880.

Department of agriculture, patent office.

OTTAWA, CANADA, *August* 7, 1885.

Certified to be true and correct copies of the original petition and oath remaining on record in this office of Thomas Alva Edison, relating to his application for a patent, and on which patent was granted to the said Thomas Alva Edison, bearing date the eleventh day of November, 1880, for "improvements on electric lamps, and in carbons or incandescing conductors therefor, and in means for and methods of manufacturing the same," and that said petition and oath were filed in this office October 20th, 1880.

[L. S.] As witness the seal of the patent office hereto affixed.

A. J. CAMBIE,
Acting Deputy Commissioner of Patents.

3708 *Petition.*

To the commissioner of patents, Ottawa :

The petition of Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, electrician, showeth : That he hath invented new and useful improvements on electric lamps, and in carbons or incandescing conductors therefor, and in means for and methods of manufacturing the same not known or used by others before his invention thereof, and not being in public use, or on sale for more than one year previous to his application in Canada, with his consent and allowance as such inventor, the title or name whereof, is Edison's electric lamps, and means and methods for manufacturing the same.

Your petitioner therefore prays that a patent may be granted to him for the said invention ; and, for the purpose of the patent act of 1872, your petitioner elects his domicile in the city of Ottawa, Province of Ontario, Canada.

And your petitioner hereby appoints L. W. Serrell of New York, N. Y., or his associate, T. G. Coursolles of Ottawa, Canada, his attorney, with full powers of substitution and revocation, to prosecute the present application for patent, to sign the drawings, to receive the patent, and to transact all business in the patent office, connected therewith.

Signed at New York, this 8th day of October, 1880.

(Signed) THOMAS ALVA EDISON.

In the presence of—
(Signed) GEO. T. PICKNEY.

3709 *Oath.*

UNITED STATES OF AMERICA,
State of New York, County of New York.

I, Thomas A. Edison, of Menlo Park, in the county of Middlesex and State of New Jersey, United States of America, electrician, make oath and swear that I verily believe that I am the first inventor of new and useful improvements in electric lamps, and in carbons or incandescing conductors therefor, and in means for, and methods of manufacturing the same described and claimed in the annexed specifications, and for which I solicit a patent by my petition, dated October 8th, 1880.

And I further make oath that the several allegations contained in said petition are respectively true and correct.

THOMAS ALVA EDISON.

Sworn before me at New York, State of New York this eight day of October, 1880.

GEO. T. PINCKNEY,
Notary Public.

Certified that the annexed is a true copy of a patent registered in the patent office under number (11968) granted to Thomas Alva Edison, and bearing date the eleventh day of November, 1880, for "Edison's electric lamp, and means and methods for manufacturing the same," with true copies of the specification and drawings remaining on record in this office, duplicate copies of which were attached to the patent above mentioned.

3710 Department of agriculture, patent office.

OTTAWA, CANADA, *July 31st*, 1885.

As witness the seal of the patent office hereto affixed.

A. J. CRAMBIE,
[L. S.] *Acting Deputy Commissioner of Patents.*

Specification.

To all whom it may concern:

Be it known, that I, Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, electrician, have invented certain new and useful improvements in electric lamps and in carbons or incandescing conductors therefor, and in means for and methods of manufacturing the same. As is now generally known, I prefer to use in my system of electric lighting, an electric lamp consisting essentially of an incandescing conductor, sealed hermetically in a glass-inclosing globe. In manufacturing carbons for such and for all classes of electric lamps, the practice, so far as I know, has been to make them of as low resistance as possible, a porous carbon having been used which was dipped or soaked in some carbonizable liquid

until its pores were filled and then subjected to recarbonization, which process was repeated until the pores of the original carbon were filled with carbon. By this process the resistance of the carbon is lessened, while its liability to disintegration under high heat is increased. Such carbons are unfit for use in electric lamps giving light by incandescence. For such lamps I have discovered that the incandescing material should have the highest possible resistance in a very small bulb, and be capable of resisting the disintegrating effects of very high heats and the absence of atmospheric
3711 pressure; and further, that carbons, which are purely structural in character, alone possess these qualities. By purely structural is meant a carbon wherein the natural structure, cellular or otherwise, of the original material is preserved unaltered; that is, not modified by any treatment which tends to fill up the cells or pores with unstructural carbon or to increase its density, or to alter its resistance.

One object of this invention, therefore, is to provide such carbons and means and methods for their manufacture.

In practice, the incandescing conductor of a lamp should be of about one hundred *omhs* resistance. While this may be varied within certain limits, the resistance stated is a preferable one and is a very high resistance compared to the carbons referred to as previously used. It is essential that the high resistance should be had without increase of radiating surface, that is, only the radiating surface necessary to give a certain standard amount of light at the proper degree of incandescence should be used. I have discovered that incandescing conductors possessing the qualities enumerated may be made of such natural fibres or fibrous bodies as are capable of carbonization, especially such as are large, filamentary and cellular in character.

Of such there are several varieties, of some of which a single fibre or several fibres aggregated together artificially are used; of some, a piece composed of numerous elementary fibres are used.

I have found that the preferable single fibres are those of which jute, bast, manila, hemp, etc., are good types, the most preferable one being a fibrous grass from South America, called "monkey bast" fibre, each blade of which is generally round, and composed of a great number of elementary fibres held together by a natural cement or rosin, which, carbonizing, locks all the elementary fibres together into a homogeneous filament. The treatment next herein described applies, however, to all the fibres of this class.

3712 These blades vary somewhat in size, and are also slightly tapering. It being necessary that the conductors should be of an uniform size, I reduce them and also any other fibres varying in size to uniformity by passing them through a cutting die which shaves off the extraneous matter or a revolving cutter may be passed along the fibre or they may be reduced in any other practical way.

When desired I may take several fibres of the above-named grass, or several of any other natural fibres, and after bunching them together dip them into a solution of sugar or other carbonizable liquid and then carbonize as one fibre, the carbonized cementing liquid binding them firmly together into a large filament of higher resistance, but of no greater radiating surface than the carbonized paper incandescing conductor heretofore described by me.

So far as capable of illustration this part of the invention is shown in Figs. 1, 2 and 3. Upon the ends of the fibre, *A*, whether simple or compound, are fixed prior to carbonization, the clamps, *B*, made of any suitable carbonizable material, lignum-vitæ, boxwood, etc., being well adapted therefor. They may be made flattened or square, but preferably are cylinders. A small hole is bored through the centre and the fibre inserted therein, as shown in Fig. 2.

It is advantageous to moisten the inserted ends of the fibre with a solution of sugar or with other carbonizable liquid. Pieces of platinum wire, *c*, *c*, are inserted into the clamps as shown in Fig. 1.

Upon carbonization, the material of clamps, *B*. *B*, shrinks around and upon the wires and fibre binding them tightly together, which result is aided by the carbonization of the liquid, applied as before suggested to the inserted ends of the fibre.

Of those materials wherein the piece necessary to form a conductor is composed of a large number of fibres, I have discovered that excellent results pertain to the use of the plants of the family *Arundenerra* or Gigantic grasses, commonly known as bamboo or 3713 cane or cane bamboo. In such, the primary fibres making up the mass of the material extends from end to end, parallel to each other, increasing the strength and obviating danger of breakage from cross or oblique grain.

Of the bamboo cane the hard, glossy exterior is the best to use, and the softer or pithy part should be rejected. To produce the best results, in giving light, it is essential that the carbons should be of uniform size throughout the portion that is to be rendered incandescent in order that the radiating surface and resistance be regular and uniform insuring even heating and incandescence.

To accomplish this the cane bamboo or other material used is treated as follows, and by the following means: The cane is split into pieces somewhat wider than necessary, and the inner or pith portion removed. The material chosen (either the case or bast, or other if desired), cut into strips, is passed through a shaving device in which a cutting or shaving knife is fixed, the material being forced against the knife by a movable block provided with an adjustable stop-screw by which the distance of the block from the knife can be regulated, regulating in turn the thickness to be given to the slip. In this device the slip or filament is shaved on both sides until the proper thickness is attained.

It is then placed in a clamp composed of two halves of a length equal to the desired length of the slip. In one half a shoulder or offset is formed at a distance from the edge greater than the desired width upon which one edge of the fibre rests which is then clamped between the two halves and the protruding portion carefully shaved off, which may be done by hand or by a cutting blade moved by machinery. On the opposite side of the clamps is an offset in one half, at a distance from the edge exactly equal to the width to be given the slip.

As it is desirable to form the extended bearing upon which
3714 take the clamps securing the carbon to metallic conductors,
homogeneous and in one piece with the body, provision is
made therefor.

Upon the side last referred to of the clamps and at the ends, are made projections of the exact shape and size to be given the broadened ends of the carbons. The slip shaved upon both sides and one edge is transferred to the opening in the clamps and the extra material shaved or cut off. The slip is now of uniform size throughout its body, and with enlarged ends formed upon it. The enlarged ends are entirely upon one edge instead of the enlargement being equally distributed upon both edges. This construction enables the slips when placed on edge—the straight edge—in the carbonizing flask to move therein as they are contracted in the process of carbonization.

This part of the invention is illustrated in Figs. 4, 5, 6, 7 and 8, in which Fig. 4 is a top view and

Fig. 5 is a side view of the device used for shaving the sides. Fig. 6 is an end view and Fig. 7 a side view of the clamps used in shaving the edges. Fig. 8 is a view of a complete filament.

In these figures, *A* is a suitable base, having upon its supports, *a*, *a*^{1}, for the working devices, these supports leaving an open space between them in which such working devices are mainly located.

In front of *a*^{1} is fixed a block, *B*, fashioned at one end to receive and support at the proper angle the knife or plane, *b*. In front of *A* is a block, C, attached to screw *D*, sliding in *A*, and caused to rotate so as to move *C* by disc *E*, working in a slot in *a*. *D*, being prevented from rotating by screw *d*, taking into a feather cut in its side.

Upon the side of *C* is lug *G*, through which passes the screw, *g*, which is set to strike against *B*, and consequently limit the movement of *C*, keeping it at any desired distance from *B*, which distance is the thickness intended to be given the slip.

The slip S, is placed between B and C, and drawn through
3715 between them, being forced by C, against the edge of the
knife until one side is smoothed. It is then taken out and
replaced with the shaved side next to C, and the operation repeated.
By these operations and means the slip is reduced to an uniform
thickness.

The clamp for reducing to an uniform width is made of two parts H, I, of a length equal to the length to be given to the slip, and held together by pieces *x*, one at each end having a slot *o*, in one end so as to permit of a limited movement of the parts H, I, from each other.

The part I, is formed with shoulders or offsets *v*, *w*, along its entire length, taking into a corresponding recess in H, forming when the two parts are in position slots along the entire length of the clamp, the offsets *v*, *w*, forming the bottom of the slots.

Upon one side at each end of each part are formed the lugs or projections *h*, *h*, the size and shape of the enlarged ends of the finished carbons.

In *h*, *h*, are the small recesses *i*, *i*, for the purposes hereinafter set forth.

The slip S, of a greater width than the widest portion of the finished slip is placed in the clamp in the slot whose bottom is the offset *v*, the clamps tightened and the protruding portion removed down to the surface of the clamps.

The edge thus prepared forms a straight edge, a gauge for the finishing, the slip being placed in the clamp in the slot whose bottom is the offset *w*, and the extra material removed on the line formed by the surface of the clamp, and the projections *h*, *h*.

This being done a saw or knife is run through the recesses *i*, *i*. The result is the slip shown in Fig. 8, having an uniform body with the enlarged clamps for securing the carbon in the clamps and provided with the recesses *i*, which are of use in securing the slip in the carbonizing flask, and afterwards for permitting the clamping screws to pass through.

Sometimes it is desirable to form the ends thicker in both directions. In such cases the preliminary cutting in the first 3716 machine simply reduces the slip to dimension equal to the desired width and thickness of the ends, and it is then finished off in the clamps, one set of clamps being made with shallow grooves so that the slip might be laid flatwise therein.

Good, natural and purely structural carbons may be made of wood as the wood is an example of the class of materials alluded to in which the mass of the material is composed of a number of elementary fibers naturally bound together.

In all instances the wood is first to be formed into the shape of what is generally known in my system as the loop or horseshoe and carbonized and not to be subjected to any further processes which will tend to fill up its pores and alter its density or resistance.

The wood may be prepared by several methods; for instance it can be shaped by cutting or stamping by a die. A thin veneer of wood properly smoothed and brought to the desired thickness is taken and laid upon a mold or bed plate, a cutting die is then forced down upon it, cutting out a piece in the desired shape for the incandescing material and with thickened ends for attachment to the clamps, or a number of veneers may be taken and secured together, and then cut into proper shape by a band, jig or circular saw.

This is illustrated in Fig. 9, which is a section of the cutting die and mold with a veneer in position, and in Fig. 10 which shows the resultant piece ready for carbonization. In these figures A, is a cutting or stamping die provided with the cutting or stamping edge *a*, projecting from the face of A, and of the same size and contour as the wooden horseshoe E. B is the mold or bed plate, having a groove or recess D, whose upper edge is of a size and shape just sufficient to receive *a*, but increasing in size towards the base to permit the ready escape of anything which may be forced in at the top. C is a piece of veneer in position for the operation of the stamp or die A.

Upon force being applied to A, shoe E is cut from the wood
3717 with the broadened ends *c*, for attachment to the clamps
homogeneous and unitary therewith. This is then taken and placed in a suitable carbonizing flask fully illustrated herein. The result is a porous structural carbon of high resistance, excellently fitted for use in lamps intended to give light by incandescence, and not needing any further treatment which might alter or modify its purely natural structure. Another method is as follows:

A block of wood is taken and cut or formed, so that its centre shall be a web bounded at the sides by thicker portions. The grain of the wood is from side to side, and the thickness of the web is about the desired breadth of the carbon.

From the block so fashioned, pieces whose width approximate the desired thickness of the carbon are split, shaved or cut off. These pieces are then sufficiently softened by moisture and heat so as to be bent into a circular or horseshoe or oval form, and they are retained in such shape in a proper carbonizing flask and carbonized. This method is illustrated in Figs. 11, 12 and 13, in which Fig. 11 represents a block formed as before described, Fig. 12 a piece, split, cut or shaved therefrom, and Fig. 13 the same after carbonization, in which A is the web of the block, the centre of the block being reduced in thickness, while the ends *a*, *a*, are left broad or thickened for fastening to the clamps. This block is split, cut or shaved into pieces like Fig. 12, which are then bent into the shape shown in Fig. 12 or into any other desirable shape, and then carbonized while in such form. The result is a carbon with broadened ends for clamping unitary with itself, and which is porous, structurally unaltered, of high resistance and with a minimum tendency to disintegration under high heat. It is evident that the block shown in Fig. 11 could be made of disintegrated fiber, paper, pulp, papier maché, etc., by powerful pressure, and the individual carbons then cut off from such block, but in practice I so far prefer to make the block and resultant carbons of wood.

3718 Another method is as follows :—

A block of wood is taken and cut in a milling machine or lathe for turning irregular forms; until the shape is that of an elongated oval, of which about one-third, including an end is cut upon somewhat larger axes than the remainder, in order to provide for the clamps. The interior is then reamed out in a suitable machine, so that the block then resembles a series of carbon horseshoes with closed ends, piled upon each other.

The length of the oval is with the grain of the wood. The block is then split or sawed into very thin layers or slips, each forming ultimately one horseshoe carbon. The slips are then carbonized preferably in a nickel flask of a description shown herein; after carbonization the greater portion of the broader end of the slip is cut off, leaving the horseshoe in shape for use. This broader end which connects what are afterwards the ends of the horseshoe, may, if desired, be cut off prior to carbonization, but as this broader connecting end tends to support and keep in shape the portions afterwards forming the horseshoe, it is better to leave it on until after carbonization.

Either before or after carbonization, preferably before, and before the slips are sawed or split from the block, small holes are made in the broad end through which pass the clamp-screws.

This is illustrated in Figs. 14, 15 and 16, of which

Fig 14 is a perspective view of the block partially turned in proper shape.

Fig. 15 is a front view of a carbon after carbonization.

Fig. 16 is a side view of a carbon properly secured in clamps.

3719 In these figures A is a block of wood which in a proper machine is turned so that its exterior shape is that of an oval, composed of two ovals, B, C, of different axes, thereby forming a broader portion for the clamps, the interior being reamed out to present a uniform smooth surface F. This block so shaped is then split or sawed into very thin layers or slips of a thickness sufficient for one carbon horseshoe, as seen in Figs. 15 and 16. These slips are then carbonized and a portion of C broken or cut off at *c c*, as shown in dotted lines in Fig. 15.

At some stages in the process, preferably while in the shape shown in Fig. 14, holes, *d d*, are drilled for the reception of the screws *e*, which fasten the clamps *d* to the carbon.

It is desirable in manufacturing carbon slips, or filaments of the style generally known as the horseshoe carbons for use as the incandescing conductors in electric lights, that they should be carbonized evenly and uniformly, and that their shape should be preserved, that the carbonization should be effected without warping or twisting the body of the carbon.

As, however, the material contracts largely in the process of carbonization, means are required which, while holding the material in position to avoid twisting or warping, shall at the same time guarantee even and thorough carbonization and permit the material to move so that the inevitable contraction during the process may proceed without danger of rupturing or otherwise damaging the carbons. For this purpose means and methods as follows are used:

For fibers of the class where a single fiber is used, and clamps or enlarged portions for clamps are secured thereto, a carbonizing flask is used in the bottom of which is cut a groove approximating in form the shape desired for the finished carbon, but somewhat longer, in which groove is laid the fiber with its attached clamps.

3720 A heavy metal-ic cover is then laid thereon, confining the fiber in place, so that it preserves its shape during carbonization, while at the same time it is free to contract. The cover may in turn be grooved and receive another fiber, and a series be used so that many may be carbonized at once in one flask. This flask and all its parts should be made of nickel, which is best adapted to stand the high heats necessary to thorough carbonization. This flask is illustrated in Fig. 17, in which D is a flask or box of metal, capable of withstanding a high degree of heat, having a groove, E, of the desired shape cut in its bottom, as shown in Fig. 17. As fibrous material contracts or shrinks in the process of carbonization, it is necessary to provide for the movement attendant thereon, care being taken at the same time to prevent any movement which would allow of warping or distortion. This is effected by the groove E, which allows a longitudinal movement but prevents any other.

In this groove the fiber with its attached ends is placed, a cover F being then laid over it. A corresponding groove may be cut in the upper surface of the cover F, and another fiber laid therein, and a number of such covers, limited by the capacity of the flask or box D, may be used, so that many may be carbonized at one operation. When the flask or box E is full, the lid F is fastened tightly thereon, and the whole placed in any suitable furnace for carbonization. The result is what is now known as the horseshoe carbon made as a single fiber, with carbon clamps and proper conductors securely attached thereto by the process of carbonization.

As these carbon clamps, from their much larger size, relatively contain a large quantity of deleterious gases which come out very slowly when under the action of the vacuum pumps, it is preferable that clamps be used which have first been carbonized and subjected in vacua to heat sufficient to produce a high degree of incandescence.

3721 When such are used, a very small amount of sugar applied to the ends of the fibers serves by its carbonization to bind them securely together.

The carbons made of the other materials set forth have enlarged ends made upon them, for affording a large and certain connection with the clamps as set forth. For their carbonization a flask constructed in either of the following methods is used. These several forms are unitary in principle, in that they confine and support the material during its carbonization, preventing any distortion, while at the same time provision is made for contraction, and they differ only slightly in the details by which these results are attained.

In one form a plate is provided with a groove or recess of the shape and size desired for the carbon. At one end of the groove is a recess, just large enough to receive one of the enlarged ends of the strip, a pin being used to secure that end therein.

At the other end of the groove is an elongated recess, whose excess of length is equal to the contraction of the material during carbonization, in which rests the other end of the filament to which may be attached or on which may be placed a small weight to keep it straight. During the carbonization this end is drawn up in its elongated recess, the other end remaining fixed. In another form a groove or recess is made of the elliptical form desired with recesses at the ends just sufficient to admit of the enlarged ends of the filament placed sideways therein. The top or apex of the groove is enlarged in this case, one boundary edge being upon a curve equal to the length of the uncarbonized material, while the other is of the

length and shape desired by the filament after carbonization. In another form a recess is cut in a plate of the form desired for the carbon, but of a size that will accommodate the uncarbonized material. In the recess fits and slides a plate, slightly smaller than the recess, so that when the plate is laid in the recess, a groove is left sufficient in size to just receive the filament. Upon
3722 the outer edge of the recess, and at the proper points are
made side recesses just large enough to receive the enlarged ends of the filament. The filament is laid in the groove formed between the recess and its plate, the enlarged ends laying in the recesses provided therefor, weight being laid on the latter to confine them therein. During carbonization, as these ends are fixed, contraction draws down the bow portion, which carries the plate with it, the upper portion of the — preserving the shape of the material.

These plans may be better understood by reference to Figs. 18, 19, 20, 21, 22, 23, 24, 25 and 26, in which Figs. 18, 21, 24 and 25, are plan views of carbonizing plates, unitary in principle, but differing slightly in detail. Figs. 20 and 23, are an edge and side view respectively, of a slip or filament ready for carbonization. Figs. 19, 22, 26 and 27, are details more fully hereinafter referred to. A is the nickel plate in which is cut the groove A of the shape desired for the finished carbon, and of a depth sufficient to receive the slip or filament S.

The coefficient of contraction of the fibre is determined by experiment, and the length of the groove is made equal to the length desired for the finished carbon, plus the contraction of the material during the process of carbonization. In figure 18 this extra length is at one end of the groove, enlarged at one end into a small chamber, just sufficient to receive one of the enlarged ends *c*, of the filament which is secured therein by a pin *e*. A small wedge *f* may also be placed in the chamber to assist in keeping the enlarged end in shape, the pin *e* passing through *c* and *f*. The other end of the groove *a*, is made into a long chamber *b*, whose length is equal to or greater than the amount of contraction, in length of filament in carbonization, upon the free end of the slip or filament the clamp *d* is secured.

3723 The plate A with the slip or filament secured in position as described, is covered by a smooth plate, or a series may be used, piled one upon another, the smooth under surface of one forming the cover to the one underneath.

They are then placed in a suitable nick*le* case, and on being subjected to the first low heat, carbonization and contraction proceed evenly and equally throughout each slip or filament, the contraction drawing up the loose end in the chamber *b*, until at the conclusion of the process the end *d* is exactly opposite *c*. The cases and plates used are made of nickel, as no other metal stands the high heat necessary in the final stage of carbonization.

In figure 21, the groove *a* is shown, formed into a chamber *a* at the bow of the horseshoe. In this case the slip S is laid flatways in the groove, the ends *e c* fitting into chambers at the end of the groove upon which weights *o* are laid.

By this means the ends are held in position during carbonization, while the contraction is from *x* to *x* during the process. Figure 44 shows the same construction and method of operation as in figure 18 except that while in figure 18, the slip is placed edgewise in the groove, in figure 24 it is placed flat or sideways in the groove. In figure 25 the plate A is formed with a chamber, in which slides a plate *c* smaller than the chamber by the size of the filament or strip, so that when the plate *C* is placed in the chamber, a groove shall be left in which is placed in the filament or strip its ends *c c* resting in chambers fitted for them, and held in place therein by weights *g g* laid thereon in chambers made therefor. As the filament is thus fastened at the ends as carbonization proceeds, the ensuring contraction pulls the bow towards the ends forcing the plate *C* towards the end B of A.

In all these plans, however, the filament is kept under strain during carbonization with one or more points fixed against moving,
and the contraction proceeds against the strain which con-
3724 stantly keeps the filament against or in contact with a former,
preserving its shape and obviating any risk of warping or
twisting. In all, provision is made for keeping flat, and in their proper relative position, the enlarged ends of the carbon.

It is also essential that they should be carbonized evenly and equally throughout their entire mass.

This may be accomplished by a furnace of the following description: Preferably a nickel flask is used, composed of two parts, a base plate provided with numerous legs, so as to support the same, and permit the heat to reach the bottom, and a case or box which sets thereon. A series of plates, constructed as before described, is laid upon the bottom, so as to form a pile, and the box or case placed thereon, its edges resting upon the bottom.

The flask is then placed in an oven of a size sufficient to leave a space on every side of the flask. The oven is provided with a top in which is a peep-hole having a removable cover for inspection of the interior. A pipe connected to a source of supply of any gaseous combustible passes around the oven in several branches, inlet pipes therefrom carrying the gas, in as many places as necessary, to the interior of the oven for consumption there.

A pipe connected to a suitable air blast passes around the oven in the same manner from which lead branch pipes; one passing into each inlet pipe of the gas supply so that air under suitable pressure is mingled with the gas at the point of combustion furnishing the proper blast for ensuring the necessary high degree of heat. The gas and air pipes are furnished with proper valves so that the relative supply of each may be regulated. By this means the supply may be so regulated that at first the flask is subjected to a comparatively moderate heat only which is then gradually brought up to the highest degree necessary. The carrying into effect of this
part of the invention may be more clearly understood by
3725 reference to Figs. 28, 29 and 30, of which Fig. 28 is a view of
a carbonizing plate grooved to receive a filament. Fig. 29 is
a perspective view of a series of the plates in the carbonizing flask.

Fig. 30 is a perspective view of the carbonizing oven. In these figures A is a carbonizing plate grooved to receive a filament and to have it secured therein.

The carbonizing flask is composed of two portions *B* and *C*. B is a base provided with numerous legs *b b b b* in order to raise it above the bottom of the oven to permit the free passage of heat there around. Upon B is arranged a series of the plates *A*, each containing a filament and over the series is placed a cover *C* securing them all upon the base and within the flask. The flask so filled is placed within the oven *D*, provided with the cover *E*, and exit *e* for the escape of the products of combustion being provided. A peep-hole may be provided, which is closed by cover F through which the condition of the flask may be observed. A pipe *G* connected to a source of supply of any gaseous fluid passes around the oven in several branches, inlet branches *g g*, therefrom conveying the gas in as many places as necessary to the interior of the oven for consumption.

H is an air tube connected with a suitable blast and passing around the oven in the same manner as *G*, from which lead branch pipes, *h h h*, one passing into each branch inlet *g*, so that air under pressure is mingled with the gas at the point of combustion, furnishing a supply of air for proper combustion and insuring the necessary high degree of heat. Both *G* and *H* are provided with ordinary stop-cocks or valves by which the supply of either air or gas absolutely or relatively to each other may be regulated. The oven, *D*, is of such a size that when the flask is placed in position therein, there is a space on every side between the flask and the oven. The flask filled with plates and filaments is placed in the oven and the fire kindled by lighting the gas. By means of the valve, before mentioned, the supply of fuel may be so regulated that 3726 at first the flask is subjected to a moderate heat which may be gradually brought up to the required point. The blast ensures a high degree of heat directed immediately upon the flask and evenly distributed thereon. When heated for a sufficient time the gas is turned off and the flask may be allowed to cool down in the oven. During the process carbonization there is sometimes danger that the material under treatment may be oxydized to such an extent as to interfere with proper carbonization. This oxydation is due to the oxygen in the air present in the flask and to the oxygen eliminatsd from the wood itself at the commencement of the process. If desired to prevent this an auxiliary tube may be used passing into the flask through which is introduced therein prior to firing and during the burning an atmosphere of hydrogen or of some hydrocarbon or of some other element which will take up the oxygen and prevent its action upon the filaments.

In a system of electric lighting such as proposed by me in which separate electric lamps devoid of regulating devices are used at the places of consumption, the entire regulation for all the lamps being performed at the central station, as with water or gas supply, it is essential that a constant electro-motive force or pressure be maintained. And as in such a system the lamps are arranged upon the multiple-arc or derived-circuit system, it is essential that there should be a certain standard resistance in each derived circuit. This has been attained by placing one lamp of such standard resistance in each derived circuit. It is desirable that all lamps used should be of equal lighting value, each giving a certain standard amount of light. This has been attained by giving each a certain definite or standard amount of radiating surface.

Ordinarily this radiating surface has been that with which the standard pressure, or electro-motive force and the standard resistance should give a light equal to sixteen candles. Some-
3727 times, however, it is desirable in some parts of the system to use lamps which each give a much less amount of light, for instance in chandeliers, where it is desirable to divide the total amount of light produced among a larger number of lamps than ordinary; that is, that the light of one, say, standard 16-candle lamp be divided between two, three or four lamps each of eight, five and one-third, or four candle power respectively. This result may be attained in the following way: In a derived circuit are placed two lamps, each being carefully provided with an incandescent conductor of one-half the resistance and one-half the radiating surface of the incandescing conductor of the standard lamp of the system. A single circuit-breaker is provided for both lamps in order that both shall be turned off or on simultaneously. When desirable the two lamps may be arranged in one holder, which may form a bracket, or may form a section of a group of lamps, or of a chandelier. This part of the invention is shown in Figs. 31, 32 and 33, wherein Fig. 31 is a diagram showing one standard lamp, and two half lamps in derived circuits from the same main conductors. Fig. 32 is a view of two half lamps arranged in one holder, and Fig. 33 is a diagram showing the connection in such holder.

In these figures, $C\ C_1$ are the main conductors leading to and from any suitable source of electric energy at the central station.

In the multiple arc 1, thereto, is a lamp *A*, of standard resistance and radiating surface. In the multiple arc 2 are the two lamps *B B*, each of which has just one-half the radiating surface and one-half the resistance of *A*. One circuit-breaker, *b*, is provided, controlling the circuit through both lamps, as a consequence with an uniform standard electro-motive force or pressure. Each of these lamps will each give one-half the light which A would give. If it is desired to increase the number the same proportion between the number used and the standard resistance and radiating surface should exist.

3728 For two, three or more lamps a suitable holder, *F*, of insulating material is made, sockets *S* being made therein to each lamp. To each socket metallic conducting plates are placed on opposite sides, as at *c c*, *d d*, for forming contact with metal slips, or pieces, on the necks of the lamps.

The socket may be provided with a plain or screw-threaded aperture *B*, by which it may be attached to the wall as a bracket, or to a framing, so that it may constitute a portion of a group of lamps, or of a chandelier. Upon the socket is a circuit-breaker consisting of a metallic screw *D*, secured in a seat *h*, and which may be turned to infringe upon or be cleared from contact with a metal block *e*.

The conductor *C* passes through $c\ c^1$ to *c*, and the conductor C^1 through *d*, d^1 to the metal seat *h* of the screw *D*. Instead of two lamps, as instanced, any number may be used, care being taken that the resistance of each be a fractional part of the standard resistance of one ordinary lamp, the denominator of the fraction being the number of smaller lamps in the one derived circuit. If more than two are used, the block *e* and screw *D* are placed somewhere in the circuit leading through all the lamps, in order that all may be turned on or off simultaneously, all the divided lamps being used as one standard lamp.

In the lamps generally used in my system and referred to hereinbefore, the light is produced by the incandescence of a conductor in an hermetically sealed vessel, the incandescing conductor being the small carbon now generally designated as the "horseshoe carbon." Such, however, are designed for small lamps, usually fifteen to eighteen candle power, and the conductor required therefore being small is hermetically sealed in glass. When it is desired to produce, on the same principle, a much greater light, say one-hundred-candle power, the conductor thereto must also be much larger.

3729 While I have succeeded satisfactorily in sealing somewhat larger conductors hermetically in the glass it is generally not so effective or desirable a method of passing large conductors into the bulb as where small conductors are used.

Wherefore there seems to be a necessity for some other method which in the case of larger conductors shall pass the conductor into the bulb of the lamp without contact with the glass thereof, and at the same time furnish an effective and lasting hermetical seal.

This I have succeeded in doing by the employment in the lamp of two columns of mercury sustained in tubes attached to the lamp bulb, at ordinary barometric height by the pressure of the atmosphere and serving both as seals to preserve the vacuum in the lamp bulb and as parts of the circuit through the incandescent conductors.

A glass globe or bulb is blown of proper size having an annular opening in its base of a size to admit of the passage into the globe of an insulating base supporting the carbon. After this base is put in the globe the annular opening is closed and two tubes connecting with the interior of the globe are connected hermetically thereto of a length somewhat greater than the barometric column of mercury. From the clamps of the carbons conductors pass one from each clamp into the proper tube. The lower ends of the tubes are placed in proper mercury reservoirs insulated from each other, one reservoir being connected to one pole of the source of electricity, the other to the other pole.

The air being exhausted from the globe the mercury rises in the columns or tubes, forming a seal for the vacuum, and also forming

a circuit to the conductors attached to the clamps. The lamp is supported upon or by a frame whose standards are provided with adjusting screws so that its height may be regulated or the leveling of the stand secured. The part of the invention is shown in detail,
in Fig. 34, which is a view of a lamp embodying this part of
3730 the invention, shortened somewhat in proportion to its height
as indicated in the dotted line. A glass globe or bulb *A*, is blown having an annular opening in its base of a size to admit of the base *a, a,* passing therethrough. The line of this opening is indicated at *i, i.* Upon the top of the bulb is formed a tube, the continuation of the projection, *N*, by which the lamp is attached to the air pump. Upon a suitable base *a, a,* of insulating material are fastened by proper devices, the clamps *b, b,* holding and supporting the horseshoe, *B*, the clamps being connected to metallic conductors e, e^1 ; passing a little distance, say several inches below the base *a, a.* Two glass tubes c, c^1, each of a diameter several times greater than that of e or e_1 ; and several inches longer than a column of mercury supported *in vacuo* by atmospheric pressure are united near their top as at *m*, and their united tops formed into a circle the diameter of or slightly larger than the diameter *i, i,* of the opening in *A*. The base *a, a,* supporting the carbon, and with its attached conductors is introduced into *A*, and the tubes *c, c,* are then secured by sealing at *i, i,* to *A*, the conductor *e*, projecting downwardly into *c* and *e*, into c^1. For supporting the lamp thus formed, a stand is employed consisting of an insulated top *E*, and base E^1 united by metallic standards *F*, F^1, which are connected to the base E_1, by adjustable screw connections g, g^1, so that as circumstances require the top may be raised, lowered or inclined. Upon the metal standards *F, F,* are binding screws whereby conductors 1, 4, to and from the source of electricity are attached. The top *E*, is provided with a central aperture, or it may be annular, permitting the tubes c, c_1, to pass through and below it, while supporting the globe. Upon the base *E*, is located a vessel made of insulating material, not affected by mercury, divided into compartments *D*, D^1, or two separate distinct vessels may be used. The tube *c*, passes into one *D*, to near its bottom, while *c* passes into D^1. A wire, 2, connects *D* and *F*, and a wire, 3,
connects D^1 and F_1. The parts being placed in position as
3731 shown in the figure, the vessels *D*, D_1, are filled with mer-
cury, and the tube continuation of *N*, before mentioned, fastened to the pumps. As the air is exhausted from the bulb the mercury rises in *C*, and C^1. During this operation care must be taken that the compartments *D*, D^1, are kept supplied with mercury, and that upon the completion they are still full. Upon the proper degree of vacuum being attained, the bulb is sealed at *N*, and the tube removed, at this stage the mercury has risen to and remains at *x, x,* the height at which atmospheric pressure sustains a column of mercury *in vacuo*, the mercury contacting with e, e^1, and passing a little distance above their ends.

The column *C*, C^1, should be of such a diameter as to give no greater resistance to the current than does either of the conductors e, e_1, 2 or 3. For high-candle-power incandescent lamps this arrangement makes a very reliable and durable seal, obviating any danger there may be of seal breakage, arising from difference of expansion coefficient likely to exist where large metallic conductor is sealed directly to or in glass.

For such reason, in large lamps, this method may prove preferable to that of sealing direct.

Hitherto, in manufacturing the lamp, the carbon having been prepared from paper, wood or other suitable fibre, was placed in the lamp whose parts are then sealed; the lamp was then exhausted of air, a current being applied during the process of exhaustion, heating the carbon.

Prior to sealing in the lamp, and the process of exhausting the completed lamps, the carbons were not heated, and prior to heating any defects therein could not be discovered. It is practically impossible to produce all the loops or slips of absolute uniformity or homogeneity, or to carbonize all of them absolutely uniform throughout their entire mass.

When heated to redness generally throughout their length,
3732 some show spots either less red or of a brighter red than the
average of the carbons, indicating for the first time faults in
the carbons.

Where there is a bad fault in the carbon a white incandescence appears, determining the life of the lamp, and also affecting its resistance. Such lamps are unfit for use, and the entire cost of their manufacture has proved a loss.

I now propose to furnish a simple and easy method and means of testing the carbons before they are put in the lamp proper, and so prevent defective or unsuitable carbons from being embodied in completed lamps to be only thrown away upon the discovery of the faults, increasing in fact the net cost of the faultless ones.

This is accomplished by a preliminary heating of the carbons *in vacuo*, which by the following means can be cheaply, rapidly and effectually done.

What may be called a temporary lamp is formed of a globe or chamber of proper size, with an aperture at its top of a size sufficient to admit of the passage of a carbon and its supporting base. The neck of the supporting base passes tightly through a soft rubber cork which fits into the aperture in top of the globe. The cork is so sized that its upper side is a little distance below the top edge of the aperture so that when the cork is in position, a chamber is formed on top. On one side of the wall of the aperture is an opening having a tube upon its exterior, the opening being into the chamber referred to as formed above the cork. A mercury reservoir is connected to the opening by a flexible tube. When the cork is put into place the reservoir is elevated, and the mercury flows thence forming a seal over the cork; *per contra*, the reservoir being depressed the mercury flows back into the reservoir barring the cork. The globe is connected to a proper exhaust tube, several Springel drops being simultaneously used, by this means a carbon may be placed in the globe, it sealed and exhausted quickly, and the cur-

rent applied testing the carbon, which standing the test
3733 may be placed in a permanent lamp. Suitable mechanism for
carrying this part of the invention into effect is shown in Fig. 35, which is a sectional view of the preliminary proving or testing lamp, in which Fig. Q is the usual glass carbon support which is sealed to the glass globe in the completed lamp at *r*. *a* is the carbon to be proved, secured thereto in the usual way. *C* is the temporary proving lamp, having at its upper end an aperture sufficiently large to admit the carbon and its support and provided with a soft rubber cork B, through which the neck of the carbon support Q, passes. The cork *B* fits tightly in the aperture, the sealing being further rendered secure by a mercury seal *E*, a mercury reservoir *d*, being elevated when necessary so that the mercury therefrom flows down through a tube *c*, over the top of the cork. From the bottom of the proving lamp *C*, proceeds two tubes, one *n*, connecting with a McLeod gauge. The other tube *b*, leads to and connects with the vacuum apparatus. In operation the carbon to be tested is placed in the proving chamber or lamp *C*, and the mouth hermetically sealed. The stop-cock *x* in tube *b* is then opened giving free communication between the chamber *C* and the vacuum apparatus. When the proper degree of exhaustion is attained, circuit is closed through carbon *a*, heating it to incandescence, causing defects if any to be visible.

If the carbon proves defective it is discarded, the only loss being the labor and material which are small, involved in the manufacture of the carbon, and not as hitherto, the labor and materials which were many times greater necessary to a completed lamp.

It is evident that several carbons may be tested at once in the proving chamber or temporary lamp. One of the objects in giving a very high resistance to the incandescing conductors used in my system of lighting is to attain economy of material in the conductors therefor. The resistance usually given them is suffi-
3734 cient for any desired economy in ordinary thickly settled
localities. For use, however, in sparsely settled neighborhoods as say the outskirts or suburbs of a town or city, it may be desirable to have a lamp by the use of which still greater economy of conductor is attained. In such localities, in order to lessen the number of lights needed in the streets, it may also be desirable to have a lamp by which the volume of light is increased in order that economy in the erection of lamp-posts, etc., may be observed, and it may also be desirable to use lamps in which the volume of light may be increased in other localities.

As there is eventually a limit to the effective life of the carbon used, it seems desirable to so arrange a lamp that the operative life of the lamp may be prolonged beyond the average life of a carbon to the end that the cost of the labor expended in embodying a carbon in a lamp may be reduced.

Both or either of these results are attained in the following way: An enclosing globe is used made and put together in the usual manner in my lamps.

To the inner ends of one of the conductors leading into the lamp is fastened a double clamp, that is, one that is Y-shaped a carbon being fastened to each limb of the Y clamp. At the other end each carbon is fixed in an individual clamp, each clamp having its own conductor leading outside of the lamp. The wires leading out of the lamp and the wires leading from a suitable source of electricity are united at a circuit-controlling device, constructed so that it may close the circuit through either carbon, the circuit through the other remaining open, or it may close the circuit through both, as carbons in a series, or it may close a circuit through each, the circuit through them being derived or multiple arc circuits. This part of the invention is more clearly shown in Fig. 36, in which *A*, is a glass globe and *B*, the supporting neck united at *a*, *b*.

Through the neck *B* passes the conductors 6, 7, 8, which are sealed therein. Upon the inner terminal of 6, is the Y-shape clamp
3735 *D*, in each leg of which is fixed a carbon *e* or *g*. The other
ends of these carbons are in separate clamps *e*, being fastened in the clamp *d*, of conductors 8 and *g*, in clamp d^1 of conductor 7.

The conductors 6 7 and 8, and the circuit conductors 5, 9, are connected to a key E, composed of metal contact points; 1, 2, 3, 4 and anvils *x*, *s*, *z*, as follows: Circuit conductor 5, is connected to point 1, contacting with *x*, and to anvil *s*, on which 2, contacts, while 9, is connected to anvil *z*, with which both 3 and 4 may make contact. Conductor 6, is connected to anvil *x*; 7 to point 4 which contacts with *z*, and 8 to 2, which contacts with *s*, and to 3, which contacts with *z*. If points 1 and 3 be put in contact with their anvils *x*, *z*, circuit is formed, 5^1 via 1, *x*, 6, *D*, *e*, *d*, 8, 3, *z* to 9, the circuit through *g* being open. If 1 and 4 be closed on *x* and *z* the circuit is formed 5 via 6, D, g, d^1, 7, 4, z, to 9, the circuit through *e* being open and g alone in circuit and use. If 2 and 4 be closed on *s* and *z*, the circuit is from 5^1 via *S*, 2, 8, *e*, *D*, *g*, 7, 4, *z*, to 9, and both *e* and g are in one circuit, that is in series.

If 1, 3 and 4 be closed on *x*, *s* and *z*, the circuit is from 5^1 via 1, x, 6 to D, where two paths are formed, the current consequently dividing, one circuit being D, *e*, 8^3, *z* to 9, the other D, g, 7, 4, z, to 9, both carbons being in circuit, but each having its own circuit, which is a derived one, so far as the main circuit is concerned.

When both are use- in multiple arc it is evident that the net resistance of the circuit is one-half the resistance of one, and a certain sized conductor is required.

If both are used in series, the resistance is double that of one, and four times that of the multiple arc, in which case, the conductor may be diminished three-fourths. As the volume of light is that of two ordinary lamps, it is evident that a much less number may be used with the same light-giving result. Thus economy in laying main conductors, and in the erection of lamps is secured.

3736 It is evident that as one carbon only may be used at a time that by so using one only at a time, the life of a manufactured lamp is practically doubled, for where one carbon has reached its effective limit the circuit there through is transferred to the other, thus saving the expence involved in sealing one carbon and its globe, the cost of a globe, and of its exhaustion.

It is evident that while only two carbons are shown, that more may be sealed in one globe, D, being provided with the same number of clamps, and each carbon provided with a separate return wire, for which proper connections are made by enlarging key E, on the principle shown.

It is also evident that E may be provided with lever contacts, instead of the screw contacts used to explain the principle of my invention.

In electric lamps formed by sealing an incandescing conductor hermetically in glass-enclosing globe, there may be danger sometimes that the glass and wire will separate at the point where the conducting wires pass through, and are sealed into the glass globe. This is due to the fact that the conducting wires near the incandescing material become very hot by conduction and that the coefficient of expansion of the glass and wire are so different. In the lamp made on my plan owing to the high resistance of the incandescing material, such small conductors are used that the danger referred to has been of minor or the very least importance. It may be desirable, however, to provide means which reduce the danger to a minimum, while affording at the same time, the necessary support for the very small and delicate conductors and incandescing material.

One part of this invention has for its object the provision of such means which is done as follows:

A small glass bulb is blown of a little larger diameter than the distance apart of the ends of the carbon. Through this globe are passed and sealed therein the conductors leading to the carbon, each conductor being sealed therefore in two places, one contig-
3737 uous to the clamps for receiving and supporting the carbon,
the other seal being almost diametrically opposite. The carbon and clamps being placed in position, this small globe is placed in an aperture left for the purpose in the larger enclosing globe, and sealed thereto at about the meridian line of the smaller bulb. The larger bulb is provided with a tube by which it is attached to the air-exhausting apparatus, and where it is sealed after the vacuum is produced. Connected to this tube is a branch tube leading from the smaller bulb, so that both are simultaneously exhausted. This is shown in detail in Fig. 37, in which A is the glass-enclosing globe formed with the tube a for attachment to the exhausting apparatus. A small bulb B is made attached to the supporting neck C, and formed with a tube b. Through the bulb B the conductors 1, 2 are passed and sealed therein, 1 being sealed at c, c^1, and 2 at e, e. The bulb B is then sealed into A at the lines z, z, and the tube b connected to the tube a, the bulb B practically forming the seal to A. The tube a is then connected to the exhaust apparatus. It is evident that a vacuum is created in both A and B. When a proper degree of exhaustion is reached, the tube b is sealed off at y after which the tube a is sealed off at x, x.

The vacuum in globe A, is thus protected by two sealings of each wire c e and c^1 e^1, to only one set of which is there any danger, c^1 e^1, the other set c e, from its distance from the heated portion of the lamp, never heating sufficiently to be affected.

As very small conductors are used, it is necessary for stability that they be supported near the carbon, which is done at the sealings c^1 c^1, but if either of these, from their proximity to the light is ever so heated as to crack, it will still subserve its functions as a support, while the vacuum is preserved by the seals c e, more distant from the clamps. Sometimes it may be desirable to make a
lamp in which a less permanent seal is used, involving a
3738 less expensive method of sealing, and which may be taken
apart readily for the substitution of a carbon or for other
purposes.

This may be done as follows: Upon a tube, closed at one end, is supported the carbon, the conductors therefrom passing through the tube, and being sealed hermetically in the top thereof. The enclosing globe is made with a neck somewhat larger than the tube, so the carbon may be passed therethrough.

A rubber packing is interposed between the outer walls of the tube and inner walls of the neck securing the two together, the ends of the tube projecting beyond the end of the neck.

This projecting portion of the tube passes through the base of a rubber cup, the base of the neck resting upon the bottom of the interior of the cup. At the top of the cup a rubber packing fills the space between the exterior of the neck and the interior of the cup. The space in the cup is filled with mercury, which is retained in place in the cup by the packing last referred to, forming with the rubber a good seal for any temporary uses. Fig. 38 shows a lamp embodying this portion of the invention. A is the enclosing globe made with a long neck, A_1, through which may be passed the carbon B, attached to the clamps b b, connected to conductors 1, 2, which are sealed in the top of a tube C at c c, the tube C being somewhat smaller than the neck A_1. Around the base of C is a soft rubber plug, D, which fits into the lower part of the neck A, forming a tight joint between the two, supporting — and the carbon in position in A_1, and A F is a socket or cup, through the bottom of which by tight joint passes the end of C, the end of D resting in the cup. At the tap of the cup a washer E of soft rubber fills tightly the space between A_1 and the inner wall of the cup F, the space in the cup being filled with mercury, H, or other suitable liquid.

The lamp so put together is exhausted and then sealed at
3739 a in the usual manner, the combination of the cup F, plugs
or washers D and E, and the mercury H forming a reliable
seal.

Having thus described my invention, what I claim is hereby declared to be as follows:

1st. An incandescing conductor formed of one or more carbonized natural fibres, substantially as set forth.

2d. A carbon clamp for uniting the incandescing and the metallic conductors formed of a carbonizable material, substantially as set forth.

3rd. The method of uniting the incandescing and the metallic conductors, which consists in inserting both in clamps made of carbonizable material and then carbonizing the whole together, substantially as set forth.

4th. The slip of carbonization having enlarged ends formed in one piece and homogeneous therewith upon one edge, or one side and one edge, the remaining edge and side being straight, substantially as set forth.

5th. The method of forming a slip or filament for carbonization consisting in securing a blank in clamps or holders, having the configuration desired for the carbon and shaving or cutting away the superfluous material, substantially as set forth.

6th. A slip or filament for forming on carbonization, the incandescing conductor of an electric light, made of bast, or fibre, like cane and bamboo, substantially as set forth.

7th. A slip or filament for forming by carbonization the incandescing conductor of an electric light, made of a material composed of fibres laying parallel through the length of the slip or filament,
substantially as set forth.

3740 8th. A slip or filament for carbonization, provided with
slots or holes in its enlarged ends for holding it in the carbonizer and for passage of the clamping screws when placed in a lamp, substantially as set forth.

9th. The combination of the shaving knife, the block *C*, and means for moving it, and the adjustable limiting screws, substantially as set forth.

10th. The clamp formed of two portions, one being provided with offsets or shoulders, forming the bottom of slots acting as straightedges or *guages* to the slip under treatment, substantially as set forth.

11th. The clamp provided with slotted projections at the ends, for forming the broadened or thickened ends of the slip and the slots therein, substantially as set forth.

12th. The method of forming carbons for electric lamps which consist- in forming the wood into the shape desired for the carbon and then carbonizing the same substantially as described.

13th. The method of forming carbons for electric lamps which consists in cutting or stamping from a veneer a piece of wood with thickened or broadened ends and of the shape desired, and then carbonizing the same substantially as described.

14th. The horseshoe with thickened or broadened ends for attachment to the clamps formed or cut from one piece of wood, substantially as set forth.

15th. The method of forming carbons for electric lamps which consist- in shaping a block of wood as described, then cutting, splitting or shaving into straight pieces adapted for single car-
3741 bons, then bending such pieces into the desired form and
carbonizing in such form, substantially as described.

16th. That block for the manufacture of carbon for electric lamps consisting of the central web and thickened or broadened ends, substantially as set forth.

17th. The method of forming carbon for the incandescing conductors of electric lights, consisting in first cutting or turning a block of wood into the shape of an oval having a broadened portion then carbonizing and then removing a portion of the broadened part, substantially as described.

18th. A carbon horseshoe composed of a filamentary body with broadened ends turned from one piece of wood and then carbonized, substantially as described.

19th. The method of manufacturing carbons for incandescent electric lamps, uniform and regular in shape and carbonization consisting in carbonizing filaments while one or both ends are secured in a certain definite position relatively to the amount of contraction, so that when carbonized and contracted the ends shall be in proper position to each other, substantially as set forth.

20th. The method of manufacturing carbons for incandescent electric lamps, consisting in maintaining the slips or filaments under constant strain, and with one or both ends fixed while in process of carbonization, substantially as set forth.

21st. The method of manufacturing carbons for incandescent electric lamps, consisting in carbonizing the slips or filaments while in grooves, which maintain the shape and provide for contraction during carbonization, substantially as set forth.

3742 22nd. The carbonizing plate provided with a groove for shaping the material, and a chamber or chambers permitting contraction during carbonization, substantially as set forth.

23rd. A carbonizing flask and the plates thereof made of nick*le*, substantially as set forth.

24th. The carbonizing flask or box provided with grooves for the reception of the fibre, substantially as set forth.

25th. The carbonizing oven, consisting of a case and a system of gas and air supply pipes combined substantially as described, and for the purposes set forth.

26th. The combination of a case or -over therefor*s* provided with an inspection aperture and cover, means for supplying gaseous fuel to the interior of the case*d* and means for mingling air under pressure with the fuel, substantially as set forth.

27th. The combination with one derived circuit of a multiple-arc system of two or more lamps, each of a fractional resistance and radiating surface of the *resistance and radiating surface of the* standard lamps of the system, the fraction being the number used, substantially as set forth.

28th. The combination with one socket or holder, and one derived circuit, of one circuit-controller and two or more lamps each of a fractional resistance an- radiating surface of a standard lamp substantially as set forth.

29th. The combination with the incandescing condition of an electric lamp of two fluid columns sustained by atmospheric pressure and forming both a part of the circuit and a hermetical seal to the lamp, substantially as set forth.

3743 30th. The combination with the incandescing conductor and the fluid columns of reservoirs connected to the source of electricity and into which the columns dip for the maintenance of the columns and the completion of the circuit therethrough substantially as set forth.

31st. The combination with an electric lamp of the stand or support therefor, consisting of an insulating base and top connected by adjustable standards substantially as set forth.

32nd. The combination with a globe or chamber of a much larger chamber or reservoir connected to air-exhausting apparatus, which maintains therein a high degree of exhaustion, substantially as set forth.

33rd. The combination of a proving chamber or globe, a mercury reservoir for sealing the same, and exhaust reservoir or chamber and means for exhausting the same, substantially as set forth.

34th. The combination of a globe or chamber a second and much larger globe chamber or reservoir a valved tube connecting them, means for maintaining a high degree of exhaustion in the larger reservoir or chamber, and connected thereto, and gauge for determining the degree of exhaustion, substantially as set forth.

35th. The combination with the globe or chamber of a proving lamp of a mercury reservoir connected to the globe or chamber so that the stopper thereof may at will be covered or not covered by mercury, substantially as set forth.

36th. The method of testing carbons consisting in subjecting them to the action of a current in a temporarily exhausted globe
3744 or receiver, prior to their embodiment in completed lamps, substantially as set forth.

37th. The combination in one electric lamp of two or more incandescing conductors and means for connecting them in the electric circuit; either in series or multiple arcs, substantially as set forth.

38th. The combination in one electric lamp of two or more incandescing conductors, and means for making or breaking an electric circuit through either one, as may be desired, substantially as set forth.

39th. The combination in one electric lamp, of two or more incandescing conductors, and means for completing the circuit through either or through both substantially as set forth.

40th. The combination of contact points 1, 2, 3, 4 anvils X, S, Z, and circuit connections, substantially as set forth.

41st. In an electric lamp, the combination with the enclosing globe or chamber of a second chamber through and into which the conducting wires pass, and are sealed; both chambers being hermetically sealed together and exhausted, substantially as set forth.

42nd. The method of sealing the enclosing globe or chamber of an electric lamp by sealing an auxiliary or secondary globe or chamber in the opening of the first or enclosing globe, substantially as set forth.

43rd. The method of preserving the vacuum in the enclosing globe of an electric lamp, consisting in sealing the conducting wires at two points in a vacuum globe hermetically sealed to the enclosing globe, substantially as set forth.

3749 44th. The combination with the neck of the enclosing globe and the carbon-supporting tube, of a cup containing a liquid receiving the end of the neck of the enclosing globe, and through which passes the carbon-supporting tube and washers or plugs filling the space *bweeetn* the neck and cup and neck and tube substantially as set forth.

THOMAS ALVA EDISON.

New York, N. Y., October 8th, 1880.

Signed in the presence of—
GEO. T. PINCKNEY.
CHAS. H. SMITH.

This is the specification referred to in the affidavit of Thomas Alva Edison hereto annexed. Sworn before me this eighth day of October, A. D., 1880.

GEO. T. PINCKNEY,
Notary Public.

(Here follow diagrams marked pp. 3745, 3746, 3747, & 3748.)

3750

CANADA.

Patent of Invention.

Whereas Thomas Alva Edison of Menlo Park, in the State of New Jersey, one of the United States of America, electrician, has in pursuance of "the patent act of 1872," by his petition to the commissioner of patents, stated that he has invented new and useful improvements in electric lamps, and in carbons or incandescing conductors therefor, and in means for and methods of manufacturing the same, the title whereof is "Edison's electric lamps and means and methods for manufacturing the same," not known or used by others, before his invention thereof, and not being at the time of his application in public use, or on sale for more than one year previous to his said application in Canada, with his consent or allowance, and has elected his domicile at the city of Ottawa, in the Province of Ontario, in Canada. And whereas the said Thomas Alva Edison has also complied with the other requirements of the said act.

The present patent grants to the said Thomas Alva Edison, his executors, administrators and assigns, for the period of fifteen years from the date of these presents, the exclusive right, privilege and liberty of making, constructing and using and vending to others to be used, the said invention of Thomas Alva Edison, and which is called or known by the title or names of "Edison's electric lamp, and means and methods for manufacturing the same," and whereof a short description is as follows:

It consists 1st, in an incandescing conductor, formed by one or more carbonized natural fibres; 2nd, in a carbon clamp for uniting the incandescing and the metallic conductors, formed of a carbonizable material; 3rd, in the method of uniting the incandescing and the metallic conductors, which consists in inserting both in clamps, made of carbonizable material, and then car-
3751 bonizing the whole together; 4th, in the slip for carbonization, having enlarged ends formed in one piece, and

Impt in Electric lamps and in carbons or incandescing conductors therefor and in methods for and means of manufacturing the same No. 11968.

References.
Fig 1,2,3.
A. Fibre.
B. Clamp.
C. Platinum wire
a. Supporting neck

4,5,6.
A. Base.
a. Supports.
a' "
B block.
b knife.
C block.
D screw.
d "
E disc.
G screw
H Clamp
I "
O slot
S clip
w offset
h
i screws

Fig 9.10.
A DW
a cutting edge
B bed plate
D Recess
E Horse shoe.
C Veneer.
e end of E.

Fig 14.15,16.
A Block of wood
B oval
C "
D clamp.
F wire
F surfaces
C line of separation
a holes
2. screws.

Fig 11 & 12.
A web of the block
E End " " "

Fig 1
Sectional

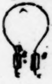


Fig 2
Elevation

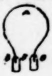


Fig 3

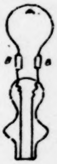


Fig 5
Side view.

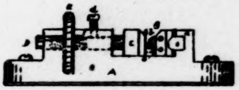


Fig 4 Plan.

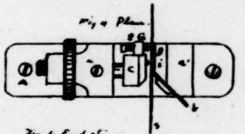


Fig 7 side view

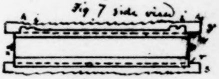


Fig 8
side view

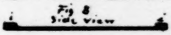


Fig 6 End view

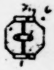


Fig 11.
Perspective

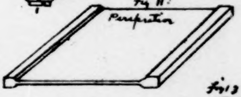


Fig 9 Section

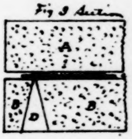
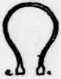


Fig 10
Elevation



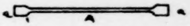


Fig 13

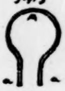


Fig 14
Perspective

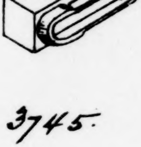


Fig 15
Elevation

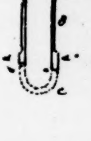
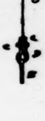


Fig 16
Side View



No. 286.
C.E. Light Co.
v.
McK. Light Co.
p. 3745.

Improvements in electric lamps and in carbons or incandecing conductors therefor and in means for and methods of manufacturing the same. No 11968.

References.
Fig 17, 18, 19, 20, 21.
22, 23 24, 25 26, 27.

A. Nickel plate.
a Groove.
B Sand
b chamber
C Plate.
c Enlarged Ends.
D Flask
E Groove.
G Pan.
F Cover.
F' Lid.
f wedge
g Wiper
e Wiper
S Filament
H.} Amount of concentration
H'} " of filament
d Clamp
a Chamber.

Fig 29 & 30
A Carbonizing Plate.
B Base.
C Lug.
D Oven.
E Cover
e Exit
G Pipe Gas supply.
g Branch pipe.
H Pipe Air supply
h Branch pipe
C Cover
F Cover

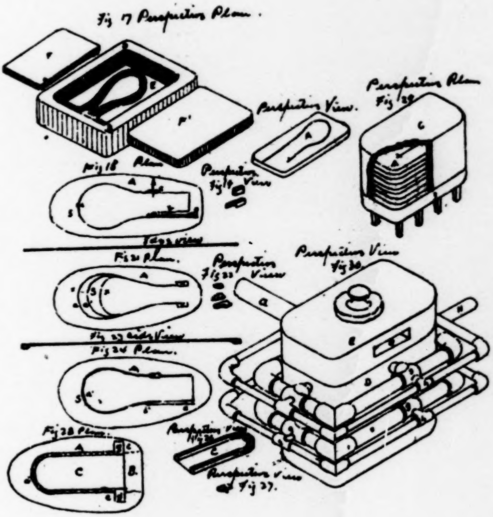


Fig 17 Perspective Plan.
F
E
F'
Perspective View.
A
Perspective Plan
Fig 29
C
A
Fig 18 Plan
A
S
Perspective
Fig 19 View
Fig 20 Edge View
Fig 21 Plan.
A
S
Perspective
Fig 22 View
Perspective View
Fig 30.
a
E
D
H
Fig 23 Side View
Fig 24 Plan.
A
S
Fig 28 Plan.
A
C
B.
Perspective View
Fig 26
C
Perspective View
of Fig 27.

No. 286.
C.E. Light Co.
v.
McK Light Co.
} p. 3746

Improvements in electric lamps and in carbons or incandescing conductors therefor, and in means for and methods of manufacturing the same. No 11968.

Diagram
Fig 31.

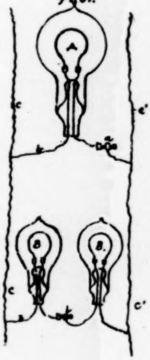


Fig 32
Elevation

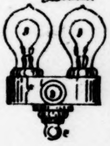
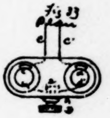
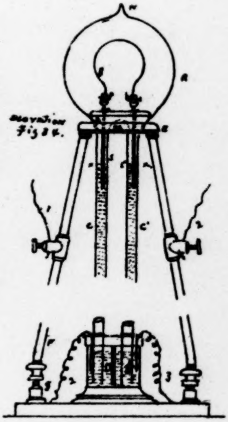


Fig 33
Plan



Elevation
Fig 34.



REFERENCES
Fig 31, 32, 33.

R Lamp.
c Conductor.
c' " " "
B Lamp
a circuit breaker.
b " " "
1 multiple arc.
2 " "
F Holder.
D screw
E " Aperture.
C Conducting Plate
c' " "
d " "
d' " "
h seat
e metal block.

REFERENCES
Fig 34.

a Base.
A Bulb.
b Clamps.
B Horse shoe.
c'c glass tubes.
1'1 conductors.
D'D Compartment.
E insulating top.
E' Base.
F standards.
F' " "
SS' screw connection
ll' line of opening.
m Junction of CC'
x Height of mercury.
1 conductor
4 "
n Projections
2.3 Wires

No. 286.
C.E. Light Co.
v.
McK Light Co.
} p 3747.

Improvement in electric lamps and in carbons or incandescing conductors therefor and in means for and method of manufacturing the same.

No 11 96L.

REFERENCES.

Fig 35
A Carbon
B Rubber cork
b tube
C lamp globe.
c tube.
d mercury reservoir
e " seal
n tube.
a support.
r point of sealing
x stop cock.

Fig 36.
A Globe.-
ab point of sealing A.B.
B support neck.
D Clamp
d "
d' "
E Key
C Carbon
G Carbon.
b anvil
x "
z "
1234 Contacts
5.6.7 8.9 Wires.

Fig 37
A Globe.
B "
L tube.
C' support neck.
c c' places of sealing wires 1
s s' " " " 2
x places of sealing tube a
z " " " tube b.
1 wire
2 "
a tube.

Fig 35
A Globe.
B carbon.
D soft Rubber plug
a place of sealing a
C tube
E Washer.
F cup
H mercury
1 conductors
2 "
place of sealing wires 1, 2
B b clamps
A' neck.

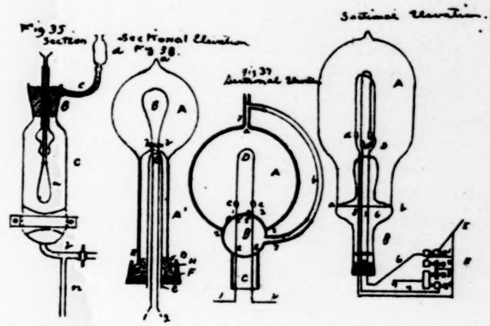


Fig 35.
Section
Sectional Elevation
a Fig 38.
a
Fig 37
Sectional Elevation
Sectional Elevation.
A
B
C
c
b
n
A'
D
E
F
H
L
1
2

No. 286.
C.E. Light Co.
v.
McK. Light Co.
p. 3748

homogeneous therewith upon one edge or one side and one edge, the remaining edge and side being straight; 5th, in the method of forming a slip or filament for carbonization, consisting in securing a blank in clamps or holders, having the configuration desired for the carbon, and shaving or cutting away the superfluous material; 6th, in a slip or filament for forming in carbonization the incandescing conductor of an electric light, made of bast or fibre like cane and bamboo; 7th, in a slip or filament for forming by carbonization the incandescing conductor of an electric light made of a material composed of fibres laying parallel through the length of the slip or filament; 8th, in a slip or filament for carbonization provided with slots or holes in its enlarged ends for holding it in the carbonizer, and for passage of the clamping screws when placed in a lamp; 9th, in the combination of the shaving knife, the block *c* and means for moving it, and the adjustable limiting screw; 10th, in the clamp formed of two portions, one being provided with offsets or shoulders, forming the bottom of slots, acting as straight-edges or gauges to the slip under treatment; 11th, in the clamp provided with slotted projections at the ends, for forming the broadened or thickened ends of the slip, and the slots therein; 12th, in the method of forming carbons for electric lamps, which consists in forming the wood into the shape desired for the carbon, and then carbonizing the same; 13th, in the method of forming carbons for electric lamps which consists in cutting or stamping from a veneer a piece of wood with thickened or broadened ends, and of the shape desired, and then carbonizing the same; 14th, in the horseshoe with thickened or broadened ends for attachments to the clamps formed or cut from one piece of wood; 15th, in the method of forming carbons for electric lamps which consists in shaping a block of wood as described, then cutting, splitting or shaving into
3752 straight pieces adapted for single carbons, then bending such
pieces into the desired form, and carbonizing in such form; 16th, in the block for the manufacture of carbons for electric lamps consisting of the central web and thickened or broadened ends; 17th, in the method of forming carbons for the incandescing conductors of electric lights, consisting in first cutting or turning a block of wood into the shape of an oval, having a broadened portion then carbonizing and then receiving a portion of the broadened part; 18th, in a carbon horseshoe composed of a filamentary body with broadened ends turned from one piece of wood, and then carbonized; 19th, in the method of manufacturing carbons for incandescent electric lamps, uniform and regular in shape, and carbonization, consisting in carbonizing filaments while one or both ends, are secured in a certain definite position, relatively to the amount of contraction, so that when carbonized and contracted, the ends shall be in proper position to each other; 20th, in the method of manufacturing carbons for incandescent electric lamps, consisting in maintaining the slips or filaments under constant strain, and with one or both ends pierced while in process of carbonization; 21st, in the method of manufacturing carbons for incandescent electric lamps, consisting in carbonizing the slips or filaments while

in grooves which maintain the shape and provide for contraction during carbonization; 22nd, in the carbonizing plate provided with a gro-ve for shaping the material, and a chamber or chambers permitting contraction during carbonization; 23rd, in a carbonizing flask and the plates thereof made of nick*le*; 24th, in the carbonizing flask or base provided with grooves for the reception of the fibre; 25th, in the carbonizing oven consisting of a case and a system of gas and air supply pipes combined; 26th, in the combination of a case or cover therefor, provided with an inspection aperture and cover, means for supplying gaseous fuel to the interior of the case, and means for mingling an under
pressure with the fuel; 27th, in the combination with
3753 one direct circuit of a multiple or system of two or more
lamps each of a fractional resistance and radiating surface of the standa*a*d lamp of the system, the fraction being the number used; 28th, in the combination *10th* one socket or holder, and one desired circuit of one circuit-controller, and two or more lamps, each of a fractional resistance and radiating surface of a standard lamp; 29th, in the combination with the incandescing conductor of an electric lamp of two fluid columns sustained by atmospheric pressure, and forming both a part of the circuit and a hermetical seal to the lamp; 30th, in the combination with the incandescing conductor and the fluid columns or reservoirs connected to the source of electricity, and into which the columns dip for the maintenance of the columns, and the completion of the circuit therethrough; 31st, in the combination with an electric lamp of the stand or support therefor consisting of an insulating base and top connected by adjustable standards; 32nd, in the combination with a globe or chamber of a much larger chamber or reservoir connected to an air-exhausting apparatus which maintains therein a high degree of exhaustion; 33rd, in the combination of a proving chamber or globe, a mercury reservoir for sealing the same, and exhaust reservoir or chamber and means for exhausting the same; 34th, in the combination of a globe or chamber, a second and much larger globe, chamber or reservoir, a valved tube connecting them, means for maintaining a high degree of exhaustion; in the larger reservoir or chamber and connected thereto and a gauge for determining the degree of exhaustion; 35th, in the combination with the globe or chamber of a proving lamp of a mercury reservoir connected to the globe or chamber, so that the stopper thereof may at will be covered or not covered by mercury; 36th, in the method of testing carbons consisting in subjecting them to the action of a current in a temporarily exhausted globe or receiver, prior to their embodiment in
completed lamps; 37th, in the combination in one electric
3754 lamp of two or more incandescing conductors, and means for
connecting them in the electric circuit, either in series or multiple arcs; 38th, in the combination in one electric lamp, of two or more incandescing conductors, and means for making or breaking an electric circuit through either one, as may be desired; 39th, in the combination in one electric lamp, of two or more incandescing conductors, and means for completing the circuit through either

or through both; 40th, in the combination of contact points 1, 2, 3, 4, anvils X, S, Z and circuit connections; 41st, in an electric lamp, the combination with the enclosing globe or chamber of a second chamber through and into which the conducting wires pass and are sealed, both chambers being hermetically sealed together and exhausted; 42nd, in the method of sealing the enclosing globe or chamber of an electric lamp, by sealing an auxiliary or secondary globe or chamber in the opening of the first or enclosing globe; 43rd, in the method of preserving the vacuum in the enclosing globe of an electric lamp, consisting in sealing the conducting wires at two points in a vacuum globe hermetically sealed to the enclosing globe; 44th, in the combination with the neck of the enclosing globe and the carbon-supporting tube of a cup containing a liquid receiving the end of the neck of the enclosing globe, and through which passes the carbon-supporting tube, and washers or plugs, filling the space between the neck and cup and the neck and tube.

But for fuller detail of the invention, reference must be had to the specification and drawings, one duplicate whereof is hereunto annexed, and forms an essential part of this patent.

Provided, that the grant hereby made is subject to adjudication before any court of competent jurisdiction. And further, that this patent is subject to the condition that the same and all the rights and privileges hereby granted shall cease and determine and the
patent shall be null and void at the end of two years from
3755 the date hereof, unless the patentee, his executors, administrators or his assignee or assignees, shall within that period commenced, and shall after such commencement continuously carry on in Canada, the construction or manufacture of the invention hereby patented in such manner that any person desiring to use it, may obtain it, or cause it to be made for him at a reasonable price, at some manufactory or establishment for making or constructing it in Canada.

And further that this patent shall be void if, after the expiration of twelve months from the granting hereof, the patentee, his executors or administrators, or his assignee or assignees, for a whole or a part of his interest in the patent, imports, or causes to be imported into Canada, the invention for which the patent is granted.

In testimony whereof, the Honorable Mackenzie Bowel, one of the Queen's privy counsel for Canada, has hereunto signed his name, and the seal of the patent office has been hereunto affixed at the city of Ottawa, in the Dominion of Canada, this eleventh day of November, in the year of our Lord one thousand eight hundred and eighty.

M. BOWELL.

Countersigned,
J. C. TACHE,
Deputy Commissioner.

OTTAWA, *October* 31*st*, 1882.

The patentee having adduced proof that he has been, for reasons beyond his control, prevented from carrying on the manu-

3756 facture of his invention within the two years mentioned in section 28 of the patent, October of 1872, further delay of one year is granted to him. As witness the seal of the patent office hereunto affixed.

J. A. CAMBIE,
Acting Deputy Commissioner.

(Endorsed: Canada, patent of invention in favor of Thomas Alva Edison, for "Edison's electric lamp and means and method for manufacturing the same." Issued on the 11th day of November, 1880, and registered under No. 11968 in the patent office of Ottawa.) J. C. Tache, deputy commissioner.

3757 COMPLAINANT'S EXHIBIT NO. 27.

Agreement between Sawyer and Man of March 19th, 1878.

Received for record April 4, 1882, and recorded in Liber A 28, page 117, of Transfer- of Patents.

In testimony whereof I have caused the seal of the Patent Office to be hereunto affixed.

E. M. MARBLE,
Commissioner.

United States Circuit Court, Southern District of New York.

CONSOLIDATED ELECTRIC LIGHT COMPANY
vs.
THE EDISON ELECTRIC LIGHT COMPANY and THOMAS A. EDISON.

Memorandum of agreement between Wm. E. Sawyer, of the first part, and Albon Man, of the second part.

The party of the first part has made certain inventions and obtained certain patents having reference to the distribution, regulation, production and use of electricity, and especially its use for electric lighting and the forms of burners or lamps, and the 3758 media menstrum or bath, in which light is produced to prevent oxidation, combustion and transference, and is engaged in experiments in these matters to render the same practical, has agreed to sell and convey to the party of the second part fifty-five one-hundredths parts of all his said inventions and patents and discoveries of and concerning the use, distribution, regulation and production of electric currents, especially as relating to electric lighting and all other matters and things affecting the same, for the sum of $2,500, to be paid to the party of the second part within two months as he may require it; he to procure all necessary patents at his own expense; Man to have ten days to complete his arrangements for associates with him, and $150 to be paid to Sawyer meantime for experiment under the agreement with and between these parties dated Feb'y 15, 1878. When all is completed and signed, Sawyer to go on with his experiments and take out his patents, and whenever Man and his associates are ready, a joint stock company to be formed and all inventions and patents to be assigned to it and the stock to go, $\frac{55}{100}$ to Man and his associates, and $\frac{45}{100}$ to Sawyer.

This has no reference to Sawyer's patent electric engine or telegraphs, but does to and includes inventions and discoveries made in aid of electric lighting or other uses of electricity under the experiments above referred to.

Dated March 19, 1878.

(Signed) W. E. SAWYER.
ALBON MAN.

Witness:
WM. HALLIE.

3759 COMPLAINANT'S EXHIBIT NO. 28.

Agreement between Sawyer and Man of May 11, 1878. *T. G., Ex.*

United States Circuit Court, Southern District of New York.

THE CONSOLIDATED ELECTRIC LIGHT CO.
vs.
THE EDISON ELECTRIC LIGHT CO. and THOMAS A. EDISON.

Received for record April 4, 1882, and recorded in Liber A 28, page 118, of Transfers of Patents.

In testimony whereof I have caused the seal of the Patent Office to be hereunto affixed.

E. M. MARBLE,
Commissioner.

NEW YORK, *May* 11, 1878.

Whereas, on the 19th day of March, 1878, an agreement was made between the parties hereto, to which reference for particulars is hereby made; and

Whereas, contrary to the expectations of the parties, the plans originally proposed by the party of the first part did not prove practically successful, and the party of the second part then came in and made certain suggestions which were generally adopted, and has, from time to time, made suggestions in relation to the subject-matters of said agreement, which have been adopted, and through which suggestions it is believed that success has been achieved; and

3760 Whereas, the parties hereto are unable to distinguish which of them is the author of different parts of the inventions hereinafter referred to:

Therefore, it is hereby agreed by and between William Edward Sawyer, party of the first part, and Albon Man, party of the second part, in modification of their previous agreement, as follows:

That instead of the letters patent being taken out in the name of the party of the first part solely, it shall be taken out in the names of both parties hereto, and the interest to be held by said parties in the same shall be to the party of the first part $\frac{45}{100}$ and to the party of the second part $\frac{55}{100}$. In other respects the agreement of March 18, 1878, referred to, shall stand, except that the party of the second part is considered to have accepted, and does hereby accept the inventions mentioned in said agreement and those inventions jointly made by himself and the party of the first part, to wit, $\frac{55}{100}$ of the same, for the sum of $2,500, of which sum the party of the first part hereby acknowledges the receipt of $1,372.75; the balance, viz., $1,127.25, to be paid to the party of the first part, from time to time, as he may call for the same, to cover the expenses of letters patent about to be applied for in the United States, and to meet his personal expenses.

Certain inventions, covered by letters patent of the United States, as follows: "Electric engineering and lighting apparatus and system," No. 194,111, dated August 14, 1877; "electric candles," No. 194,500, dated Aug. 21, 1877; "electric apparatus," No. 194,563, dated Aug. 28, 1877; and "electric engineering and lighting system," No. 196,834, dated Nov. 6, 1877; having been assigned to the extent of $\frac{3}{5}$ thereof to James Flanagan, and the party of the first part claiming that he has the right, as he stated at the time of making the agreement of March 19th, to withdraw the same from the said Flanagan and obtain a reassignment thereof
3761 within one year from about the 15th of February last, the party
of the first part hereby agrees to assign to the party of the second part the remaining $\frac{2}{5}$ of said patents, which he now holds, and within the time limited by this agreement with said Flanagan, to redeem from him the other $\frac{3}{5}$, and assign the same to the company to be formed by the party of the second part for the purpose of holding and operating under all the patents obtained and to be obtained, which are referred to in this agreement and in the agreement of March 19th, 1878.

The inventions herein referred to, which are to be jointly patented by the parties herein, are to be considered as though they had been the sole inventions of the party of the first part under the agreement of March 19th, 1878, and a joint stock company is to be formed and all the patents obtained and to be obtained, as proposed in said agreement, are to be assigned to the said company when formed, including the $\frac{2}{5}$ interest in the four Flanagan patents hereinbefore enumerated and agreed to be assigned to the party of the second part, and the stock of the company is to be distributed as set forth in said agreement.

The joint inventions of the parties hereto being at present as follows:

Electric lamp,
Regulator for electric lights, and
Electric lighting system,

and other apparatus and inventions now under consideration. It is hereby agreed that the party of the first part shall devote his time and attention exclusively to perfecting the same and to the procurement of United States letters patent upon the same, the expenses of procuring said patents to be borne by him; but after the proposed company is formed, which shall be with all reasonable dispatch 3762 after the joint patent on the lamp is obtained, the company is to bear the expense of all new patents and new inventions.

And the said Sawyer hereby agrees to assign to said company any rights remaining to him in any of his telegraphic inventions, in so far as their application to the purposes of electric lighting is concerned.

W. E. SAWYER.
ALBON MAN.

Witness:
P. M. STRATTON.

3763 COMPLAINANT'S EXHIBIT No. 30, EDISON'S CANADIAN PATENT. Dec. 17, 1888.

Department of agriculture, patent office.

OTTAWA, CANADA, *Aug.* 7, 1885.

Certified to be true and correct copies of the original petition and oath remaining on record in the office of Thomas Alva Edison, relating to his application for a patent, and on which patent was granted to the said Thomas Alva Edison, bearing date the tenth day of January, 1880, for "improvement in electric lamps and in the method of manufacturing the same," and that the said petition and oath were filed in this office December 19th, 1879.

As witness the seal of the patent office hereto affixed.

A. J. CAMBIE,
Acting Deputy Commissioner of Patents.

Petition.

To the commissioner of patents, Ottawa:

The petition of Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, electrician, showeth:

That he has invented new and useful improvements on electric lamps and in the method of manufacturing the same, not known or used by others before his invention thereof, and not being in public use or on sale for more than one year previous to this application in Canada, with his consent and allowance as such inventor, the title or name whereof is—

3764 "Edison's electric lamp."

Your petitioner therefore prays that a patent may be granted to him for the said invention; and, for purpose of the patent act of 1872, your petitioner elects his domicile in the city of Ottawa, Province of Ontario, Canada.

And your petitioner hereby appoints L. W. Serrell, of New York, N. Y., or his associate, L. J. Conrsolles, of Ottawa, Canada, his attorney, with full powers of substitution and revocation, to prosecute and present application for patent, to sign the drawings, to receive the patent, and to transact all business in the patent office connected therewith.

Signed at Menlo Park, N. J., this 8th day of December, 1879.

(Signed) THOMAS A. EDISON.

In the presence of—
(Signed) S. L. GRIFFIN.

3765 *Oath.*

UNITED STATES OF AMERICA,
State of New Jersey, County of Middlesex, } *ss:*

I, Thomas Alva Edison, of Menlo Park, in the county of Middlesex, and State of New Jersey, United States of America, make oath and swear that I verily believe that I am the first inventor of new and useful improvements on electric lamps, and in the method of manufacturing the same described and claimed in the annexed specifications, and for which I solicit a patent by my petition, dated December 8th, 1879.

And I further make oath that the several allegations contained in said petition are respectively true and correct.

THOMAS A. EDISON.

Sworn before me, at Menlo Park, New Jersey, this eighth day of December, 1879.

[SEAL.] S. L. GRIFFIN,
Notary Public.

Certified that the annexed is a true copy of a patent registered in the patent office, under number 10791, granted to Thomas Alva Edison, and bearing date the tenth day of January, 1880, for Edison's electric lamp, with true copies of the specification and drawings remaining on record in this office, duplicate copies of which were attached to the patent above mentioned together with certificate No. 89, dated October 13th, 1883, of the payment of the fee for a further term of ten years.

3766 Department of agriculture, patent office.

OTTAWA, CANADA, *July* 31*st*, 1885.

[L. S.] As witness the seal of the patent office, hereto affixed.

A. J. CAMBIE,
Acting Deputy Commissioner of Patents.

To all whom it may concern:

Be it known that I, Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, electrician, have invented an improvement in electric lamps, and in the method of manufacturing the same, of which the following is a specification.

In a former application made by me for letters patent in Canada, an improvement in electric lamps is set forth, wherein a filament of carbon is enclosed in a glass bulb, and the atmosphere removed as nearly as possible, and the carbon is brought to an incandescence by an electric current to form the lamp.

My present invention relates to an improvement in the process of manufacturing the carbon filament and in the means for securing the same to the conductors.

I make use of paper of the desired thickness as free as possible from foreign substances or adulterations, and for this purpose I prefer and use "bristol-board." With suitable instruments, such as a punch and die, I cut out a narrow strip of this paper, preferably in the form of an elliptical bow or an arc of a circle, the ends of the strip being by preference wider than the other portions.

A number of these pieces of paper are laid flatwise in the bottom of a mold, preferably of wrought iron, and there is laid on them a light weight in the form of a flat piece of gas-retort carbon or other
device that will not be distorted by the heat. If several of
3767 these are laid one on the other in the mold, a piece of tissue
paper is interposed between each one and the next.

A cover is used to close the mold, and the mold is raised very gradually to a temperature of about six hundred degrees Fahr. This allows the volatile portions of the paper to pass away, and at the same time the mold retains the paper in its proper shape, and the paper is prevented from curling up or becoming distorted as it would be likely to do if the heat was applied suddenly, or the light weight dispensed with.

The mold is now placed in a furnace and heated almost to a white heat and then removed and allowed to cool gradually. The carbon filaments will be found to be smaller than the card-board blanks and to be sufficiently strong and flexible for handling. The ends of the carbon are to be secured to the metallic conductors in any convenient manner.

The carbon filaments prepared as aforesaid are very uniform in their resistance to the electric current, and I make them thin and of a sufficient length to offer a great resistance to the passage of the current.

The clamps that connect the conductors to the ends do not require to be pressed with much force on the carbon, because the resistance to the passage of the current between the clamps and the carbon will be less than the resistance of the carbon filaments, hence but little heat will be developed at the clamps.

In ordinary electric lamps the large carbons do not offer much resistance to the electric current, and unless the clamps are very firmly pressed upon the carbon, the current meets with considerable resistance at the clamps, and hence heat is developed at such clamps.

The clamps that I prefer are made of a steel spring tipped
3769 at the ends with platina or similar metal; the spring is bent
into a circle or bow, and the ends crossed and turned back towards each other similar in shape to the figure 8, with the opening for the carbon between the spring ends at the upper part, the object of this shape is that the pressure of the clamps on the carbon may be increased by the expansion of the spring by the heat of the

lamp, instead of being lessened as it would be, if the wire was only bent into a single bow.

The spring clamps are connected to the platina or similar conducting wires by clips, and the platina wires pass through the glass of the globe or bulb that contains the lamp, the air is to be exhausted from the bulb by any suitable means, and it is preferable to exhaust said air as perfectly as possible, say to the one-eight hundred thousandth of an atmosphere.

The lamps are suspended or supported in any convenient manner, and the electric current from a magneto-electric machine, or other source of electricity is passed through the lamp, and brings the carbon filament to a high incandescence, and the lamp is very durable, and a large number of such lamps can be placed in the electric circuit in multiple arc, or otherwise as desired.

(Here follows diagram marked p. 3768.)

In the drawing—

Fig. 1 is a vertical section of the lamp complete.

Fig. 2 is a side view in larger size of the clamping device.

Fig. 3 is a section at the line *x x* in still larger size.

Fig. 4 is the wire forming one of the clamps before it is bent up to shape.

Fig. 5 is the paper blank before it is carbonized, and

Fig. 6 is a section of the box.

3770 The blank *a* is cut out of paper material such as "bristol-board," in the proper shape, the form shown in Fig. 5 is preferred, the same is laid in the metal mold *b*, and when several are laid one on the other, pieces of thin paper are introduced between. The weight *d* is laid on these; it is to be heavy enough to prevent the paper curling up under the action of the heat, but it allows the paper to contract as the volatile matters are expelled by the heat. This weight *d* is of gas-retort carbon. The cover *e* is placed on the mold and secured, and the mold is heated as before described. The carbon filament *i* forms the lamp when rendered incandescent by the electric current passed through it. The clamp is made of the wire *h* at the ends of which are tips or small rivets *r* of platina or similar material. The wire is bent up and crossed as shown so as to act as a spring in clamping the end of the carbon filament that is placed within such clamp *x*. The wire is attached to a small stock *o* into which the conducting wire *t* passes and is clamped.

The conductors for the two ends of the carbon are inserted into the glass, and the latter intimately melted around them, the carbon and clamps are connected to the wires and the parts introduced within the neck of the bulb *m*, and the glass melted at *r*, the air is exhausted from the globe by the tube *k*, that passes away as shown by dotted lines, and the tube melted together while the vacuum is maintained.

The lamp is ready for the conductors to be attached to it, and the carbon is rendered incandescent by the current that passes through

No 286.
E. Light Co.
v.
McK. Light Co.
} p. 3768.

Improvement in Electric lamps and in the method of manufacturing the same.

10791XX

Fig 1 Vertical Section.

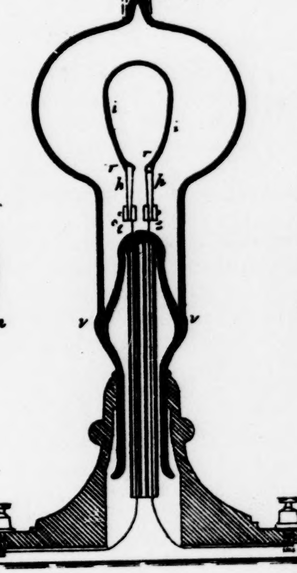


Fig 2 Elevation

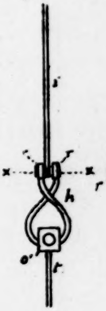


Fig 3 Section at XX

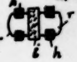
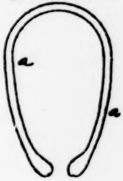


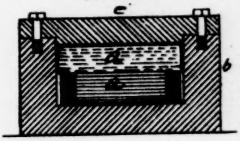
Fig 4 Elevation

Fig 5. Elevation.



References.
a Blank of Bristol board
b mould or box
d Weight
e Cloth
h Clamp
i Electric lamp
o Block.
m Glass bulb.
r Rivets.
t Wires.
v Place at which glass and support are melted together.

Fig 6
Section.



the same. It is durable as there is nothing to combine with the carbon and it is substantially indestructible.

I claim as my invention—

First. The manufacture of carbons for electric lights from paper.

3771 Second. The method herein specified of manufacturing carbons for electric lights, consisting in exposing the filament of paper to the action of heat in a mold to drive off the volative portions, and carbonize the paper, substantially as set forth.

Third. A carbon for electric light made a filament with the ends broader for the clamping devices that connect the conductors.

Fourth. The clamp for the carbon of an electric lamp composed of a bow or elliptical spring with the ends crossing each other and receiving between them the carbon substantially set forth.

THOMAS A. EDISON.

Menlo Park, N. J., December 8th, 1879.

Signed in the presence of—
EDWIN M. FOX.
S. L. GRIFFIN.

This is the specification referred to in the affidavit of Thomas Alva Edison, hereto annexed, sworn before me this eighth day of December, A. D. 1879.

S. L. GRIFFIN,
Notary Public.

3772 DOMINION OF CANADA, PATENT OFFICE.

This is to certify that the Edison Electric Light Company, the holder of patent No. 10791, granted to Thomas Alva Edison, for alleged new and useful improvements on electric lamps, and in the method of manufacturing the same, bearing date the tenth day of January, one thousand eight hundred and eighty, has paid to the commissioner of patents on the 4th day of May, 1883, the sum of forty dollars, being the fee required for the further term of ten years, to commence and be computed on and from the tenth day of January, one thousand eight hundred and eighty-five, as provided by section 17 of the patent act of 1872, amended by the act of 1883.

In testimony whereof I have hereunto set my hand and caused the seal of the patent office to be hereunto affixed, at the [L. S.] city of Ottawa, in the Dominion of Canada, this thirteenth day of October, in the year of our Lord one thousand eight hundred and eighty-three.

J. H. POPE,
Commissioner of Patents.

Countersigned:
A. J. CAMBIE,
Acting Deputy Commissioner.

3773 46 VICTORIA.

CHAP. 19.

An act to amend the patent act of 1872.—(Assented to 25th May, 1883.)

Her majesty, by and with the advice and consent of the senate and house of commons of Canada, enacts as follows:

1. Section seventeen of "the patent act of 1872," is hereby repealed, and the following is substituted therefor:

"17. The term limited for the duration of every patent of invention issued by the patent office shall be fifteen years; but at the time of the application therefor it shall be at the option of the applicant to pay the full fee required for the term of fifteen years, or the partial fee required for the term of five years, or the partial fee required for the term of ten years. In case a partial fee only is paid the proportion of the fee paid shall be stated in the patent, and the patent shall, notwithstanding anything therein or in this act contained, cease at the end of the term for which the partial fee has been paid, unless at or before the expiration of the said term the holder of the patent pays the fee required for the further term of five or ten years, and takes out from the patent office a certificate of such payment (in the form which may be from time to — adopted) to be attached to and to refer to the patent, and under the signature of the commissioner, or, in case of his absence, another member of the privy council; and in case such second payment, together with the first payment, makes up only the fee required for ten years, then the patent shall, notwithstanding anything therein or in this act contained, cease at the end of the term of ten years, unless at or before the expiration of such term the holder thereof pays the further fee required for the remaining five years, making up the full term of fifteen years, and takes out a like certificate
3774 in respect thereof. Every patent heretofore issued by the patent office in respect of which the fee required for the whole or for any unexpired portion of the term of fifteen years, has been duly paid according to the provisions of the now existing law in that behalf, has been and shall be deemed to have been issued for the term of fifteen years, subject, in case a partial fee only has been paid, to cease on the same conditions on which patents hereafter issued are to cease under the operation of this section."

3775 CANADA.

Patent of Invention.

10791.

Whereas, Thomas Alva Edison, of Menlo Park, in the State of New Jersey, one of the United States of America, electrician, has, in pursuance of "the patent act of 1882," by his petition to the commissioner of patents, stated that he has invented new and useful improvements on electric lamps, and in the method of manufacturing the same, the title or name whereof is "Edison's electric lamp," not known or used by others, before his invention thereof, and not being, at time of his application, in public use, or on sale for more than one year previous to his said application, in Canada, with his consent or allowance, and has elected his domicile at the city of Ottawa, in the Province of Ontario, in Canada. And whereas the said Thomas Alva Edison has also complied with the other requirements of the said act:

The present patent grants to the said Thomas Alva Edison, his executors, administrators and assigns, for the period of five years from the date of these presents, the exclusive right, privilege, and liberty of making, constructing and using and vending to others, to be used the said invention of Thomas Alva Edison, and which is called or known by the title or name of "Edison's electric lamp," and whereof a short description is as follows:

It consists 1st in the manufacture of carbons for electric lights from papers; 2nd in the methods of manufacturing carbons for electric lights, consisting in exposing the filament of paper to the action of heat in a mold to drive off the volatile portions, and carbonize the paper; 3d in a carbon for electric lights made as a filament with the ends broader for the clamping devices that 3776 connect the conductors; 4th in the clamp for the carbon of an electric lamp composed of a bow or elliptical spring, with the ends crossing each other and receiving between them the carbon.

But for fuller detail of the invention, reference must be had to the specification and drawing, one duplicate whereof is hereto annexed, and forms an essential part of this patent.

Provided, that the grant hereby made is subject to adjudication before any court of competent jurisdiction. And, further, that this patent is subject to the condition that the same and all the right and privileges hereby granted, shall cease and determine, and the patent shall be null and void at the end of two years from the date hereof unless the patentee, his executors, administrators, or his assignee or assignees, shall within that period have commenced; and shall after such commencement continuously carry on in Canada, the construction or manufacture of the invention hereby patented in such manner that any person desiring to use it, may obtain it, or cause it to be made for him at a reasonable price, at some manufactory or establishment for making or constructing it in Canada.

And further that this patent shall be void if, after the expiration of twelve months from the granting hereof, the patentee, his executors or administrators, or his assignee or assignees, for a whole or part of his interest, in the patent, imports, or causes to be imported into Canada, the invention for which this patent is granted.

In testimony whereof, the Honorable John Henry Pope, commissioner of patents, has hereunto signed his name, and the [L. S.] seal of the patent office has been hereunto affixed, at the city of Ottawa, in the Dominion of Canada, this tenth day of

3777 January, in the year of our Lord one thousand eight hundred and eighty.

J. H. POPE.

Countersigned:
J. C. TACHE,
Deputy Commissioner.

Certificate No. 89, of the payment of the fee for a further term of ten years hereunto annexed.

A. J. CAMBIE,
Acting Deputy Commissioner.

Endorsed: Canada, patent of invention in favor of Thomas Alva Edison, for "Edison's electric lamp," issued on the 10th day of January, 1880, and registered under No. 10791 in the patent office at Ottawa. J. C. Tache, deputy commissioner.

3778 DEFENDANT'S EXHIBIT "INTERFERENCE STIPULATION." John H. Kitchen, Examiner.

The complainant, by its counsel, hereby stipulates and consents that the defendant may introduce and file in evidence, at or before the closing of its proofs in this suit, and as a part of said proofs, the deposition of any witness examined in the interference (Sawyer & Man *vs.* Edison), with the right on the part of either party to recall any such witness for further examination or cross-examination, and also that defendant may introduce and file in evidence in this suit any exhibits contained in said interference record. Such depositions of witnesses to have same force and effect as if the witnesses had been regularly called, sworn and examined herein, and such exhibits to have same force and effect as originals properly proven, introduced and filed in this suit, subject to objection as to competency and materiality.

This stipulation to be without prejudice to the claim of the complainant that it has already well and sufficiently introduced the entire interference record in evidence, and that the same is now a legal part of the complainant's case herein.

Dated Mar. 14, 1889.

THOMAS B. KERR,
For Compl't.
H. D. DONNELLY, *For Def't.*

3779 NEW YORK, *March 21st*, 1889.

Met pursuant to adjournment.

Present, same counsel as before.

Pursuant to stipulation between counsel for the respective parties dated March 14th, 1889, the defendant offers and files in evidence, in behalf of the defendant, the following depositions and exhibits from the interference record of Sawyer and Man *vs.* Edison, to wit:

I. Depositions of Martin N. Force, Edward H. Johnson, two depositions of John Kruesi, depositions of Francis R. Upton, Stephen

D. Field, T. B. Stillman, William Sawyer, James A. Russell, James D. Potter and James E. O'Keefe.

II. The following exhibits, of which the following is a list, are offered and filed in evidence, to wit:

(1) Edison Exhibit No. 1, sketch referred to in answer 16 of Edison.

(2) Edison Exhibit No. 3, referred to in answer 26 of Edison.

(3) First incandescent lamp, referred to in answer 27 of Edison.

(4) Edison Exhibit No. 4, referred to in answer 29 of Edison.

(5) Edison's Exhibit No. 5, referred to in answer 29 of Edison.

(6) Edison's commercial incandescent electric lamp, referred to in answer 33 of Edison.

(7) Edison's Exhibit No. 6, referred to in answer 39 of Edison.

(8) Edison's Exhibit No. 7, referred to in answer 42 of Edison.

(9) Edison's Exhibit No. 8, referred to in answer 60 of Edison.

(10) Edison's Exhibit No. 9, put in by Sawyer and Man, X Q. 173 of Edison.

3780 (11) Batch of patents put in on Edison's behalf after X Q. 373, as follows viz:

Letters patent of Thomas A. Edison No. 224,339, dated Feb'y 10th, 1880; 227,227, dated May 4th, 1880; 227,228, dated May 4th, 1880; 227,229, dated May 4th, 1880; 223,898, dated January 27th, 1880; also specification of English patent of Thomas A. Edison, No. 2402 June 17th, 1879; also letters patent 205,144 of Sawyer & Man dated June 18th, 1878; 210,152 of Sawyer & Man, dated November 19th, 1878; 210,809 of Sawyer & Man dated December 10th, 1878; 219,771 of Wm. E. Sawyer, dated Sept. 16th, 1879; 211,262 of Sawyer & Man dated January 7th, 1879; 229,335 of Sawyer & Man dated June 29th, 1880; 227,118 of Albon Man dated May 4th, 1880.

(12) Edison Exhibits No. 10, Upton article in Scribner's.

(13) Edison's Exhibit 11, referred to in Upton's answer 31.

(14) Edison's Exhibit 12, referred to in Kruesi's answer 47.

(15) Edison's Exhibit 13, referred to in Edison's answer 379.

(16) Edison's Exhibit 14, referred to in Batchelor's answer 7.

(17) Edison's Exhibit 15, referred to in Batchelor's answer 28.

(18) Edison Exhibit Nos. 23 and 24 referred to in Stillman's answer 14.

(19) Edison's Exhibit No. 25, referred to in Stillman's answer 16, being a copy of Edison's Exhibit 23 published in N. Y. "Sun," January 5th, 1880.

III. Also all other exhibits referred to in the depositions of Edison, Batchellor, Force, Johnson, Kruesi, Upton, Stillman, Sawyer, Russell, Potter, Field and O'Keefe.

3781 IV. The defendant further offers in evidence the following stipulation entered into between counsel for the parties to the said interference on the 11th day of October, 1882, of which the following is a copy, the defendant's "N. Y. Herald and Sawyer Book Stipulation." The following is the stipulation referred to, viz:

In Interference—SAWYER AND MAN
vs.
EDISON.
} Paper Carbons for Incandescent Electric Lamps.

Present: George W. Dyer, counsel for Edison, and Amos Broadnax, counsel for Sawyer and Man.

Parties met, pursuant to agreement, at the office of Amos Broadnax, at No. 10 Pine street, 11th October, 1882.

Counsel for Edison, in behalf of Edison, puts in testimony a book entitled Electric Lighting by Incandescence, by William Edward Sawyer, published by D. Van Nostrand, of New York, 1881. The same is marked Edison Exhibit "Sawyer Book."

Book objected to by counsel for Sawyer and Man as incompetent, irrelevant and immaterial, and not evidence in any sense.

Counsel for Edison also puts in evidence copy of the New York "Herald" of December 24, 1879, and the same is marked Edison Exhibit "Herald, December 24, 1879."

Also copy of the New York "Herald" of January 5, 1880; the same is marked Edison Exhibit "Herald, January 5, 1880."

Also copy of New York "Herald" of January 6, 1880; the same is marked Edison Exhibit "Herald, January 6, 1880," 11th October, 1882, J. E. B.

3782 Counsel for Sawyer & Man enters the same objection to the said papers that he entered to said book.

Counsel for Sawyer & Man admits that the book marked Edison Exhibit Sawyer Book, was written and published by William E. Sawyer, one of the parties to this interference, at the date set down in said book, and that letters signed W. E. Sawyer in the "New York Herald" of December, 1879, and January 5 and 6, 1880, were written and published by William E. Sawyer, one of the parties to this interference, at the rates shown in said newspapers; but counsel for Sawyer & Man, nevertheless, reserves his right to urge all legal objections against the said book and said articles in said newspapers, excepting the fact that the book and said articles in said newspapers were written and published by William E. Sawyer; and counsel for Sawyer & Man reserves especially the right to show that William E. Sawyer is not now and never has been a party in interest to this interference; and that at the time he wrote the letters in the newspapers put in evidence he did not own the whole or any part of the invention in controversy, excepting as a mere stockholder in the Electro-Dynamic Light Company; and that at the time he wrote the book in question he had no interest whatever in the inventions; that he was openly hostile to the owners of said inventions, patents and the other patents granted to said Sawyer & Man; that one of his avowed purposes in writing said book was to destroy and injure the patents and inventions theretofore made and obtained by William E. Sawyer and Albon Man, both jointly and severally, meaning so many of them as were then owned by the Electro-Dynamic Light Company, and that the statements in said books in many particulars are false and malicious. And counsel for Sawyer & Man gives notice to counsel for Edison that as he understands the decision of the

Commissioner he may put in rebutting testimony, not only to the book and the newspaper articles, but also to the testimony-in-chief put in on behalf of Mr. Edison, and that if the counsel for Mr. Edison has a different understanding of the Commissioner's de- 3783 cision, then he gives notice that he will move the Commissioner immediately or as soon as he can prepare the necessary papers for leave to put in such testimony and request counsel for Edison to state upon the record whether he agrees with counsel for Sawyer & Man as to his right to put in such rebutting testimony under the decision of the Commissioner in opening his decision.

Counsel for Edison accepts the notice above given, and states that he does not know what construction will be given to the order of the Commissioner in reopening the case.

Counsel for Edison further gives notice that he here closes his testimony.

J. EDGAR BULL,
[SEAL.] *Notary Public, N.Y. Co., N.Y.*

It is stipulated between counsel that Defendant's Exhibit "Batchellor Note Book No. 52," offered in evidence, March 7th, 1889, before question 171 of the deposition of the witness Batchellor be retained in the custody of Mr. Dyer, one of the counsel for the defendant, and that a copy of said book is to be marked in evidence in lieu of the original and with the same force and effect, defendant's counsel agreeing to produce the original at the hearing or at any reasonable time if requested by complainant's counsel.

Adjourned to 3 p. m. at Mr. Dyer's office, 40 Wall street.

3784 MARCH 23D, 1889.

Met pursuant to adjournment.

Counsel for defendant now produces the book which was marked for identification "Defendant's Exhibit A, Feb'y 20, 1889," after answer 3 of the deposition of the witness, George W. Sawyer, and tenders it to the counsel for the complainant for examination if desired, stating that it is not the purpose of the defendant now to offer that book or any part of it in evidence. Counsel for defendant further states that the book was shown for identification to the witness, George W. Sawyer because it was believed to contain good secondary evidence of matters which have since been sufficiently proven by the best evidence, namely, by the original minutes, contained in the original minute book of the Electro Dynamic Light Company, of a meeting and transactions of the board of trustees of said Electro Dynamic Light Company, held March 20th, 1879.

Counsel for defendant, in accordance with the request made by counsel for complainant, as appears of record on the cross-examination of the witness Sharp, hereby offers in evidence the sworn statement of the witness Sharp, referred to during his cross-examination, and the same is marked "Defendant's Exhibit Sharp's Statement."

Counsel for defendant also offers in evidence the following publications in the "Scientific American," viz:

An article entitled "Another New Electric Light," published in the "Scientific American" for November 16th, 1878, at page 304, and the same is marked "Defendant's Exhibit Sawyer-Man Scientific American Article No. 1."

An article entitled "The Sawyer-Man Electric Lamp," published in the "Scientific American" for December 7th, 1878, at pages 351, 354 and 355, and the same is marked "Defendant's Exhibit Sawyer-Man Scientific American Article No. 2."

3785 Two articles entitled respectively "The Sawyer-Man Electric Light" and "A New Form of Carbon," published in the "Scientific American" for March 8th, 1879, at page 145, and the same are marked respectively "Defendant's Exhibit Sawyer-Man Scientific American Article No. 3," and "Defendant's Exhibit Sawyer-Man Scientific American Article No. 4."

Counsel for complainant waives proof of publication and objects to the exhibits as incompetent.

3786 DEFENDANT'S EXHIBIT "ARNOUX-HOCHHAUSEN" LETTER.
J. H. K., Ex.

Arnoux & Hochhausen, electric experts, dynamo-electric machines, for electric lights, electrotyping, gold, silver, nickel, brass, and copper plating, 2 and 4 Howard street, corner Centre street.

NEW YORK, *Jan'y* 9, 1880.

Mr. Chas. A. Cheever.

D'R SIR: The horseshoe lamp which has found its way into your possession, was put in ours on the 22d Dec. last.

We at once recognized it as a lamp which we had seen at the corner of Walker & Elm streets prior to 1st May last. We saw several styles of carbon burners there about the same time. One object of the experiments made, was to obviate the shadows cast by the carbon-holder, & this amongst others was devised.

Should you desire legal attestation of these facts with dates, by advising with our attorneys, we will put them in possession of the same so that they will be able to draw the necessary papers. We refer you to Mess. Knox & Woodward.

Yours very truly, ARNOUX & HOCHHAUSEN.

3787 DEFENDANT'S EXHIBIT BROADNAX-CHEEVER LETTER.
J. H. K., Ex.

Charles A. Cheever.

P. O. box 3592.

5 TRIBUNE BUILDING, NEW YORK, *Jan'y 8th*, 1888.

DEAR SIR: In reply to your question I have to say that some time in November, 1878, I saw in operation an electric lamp at 94 Walker street in the city of New York. The alleged invention of William E. Sawyer & Albon Man fitted up with a U-shaped carbon. I saw the lamp in successful operation there a number of times. It was in all respects the same as the lamp you show me and which is marked A. M. & B.

Very truly yours, &c., AMOS BROADNAX,
97 *Broadway, N. Y.*

Chas. A. Cheever, Tribune building.

3788 CONSOLIDATED CO.
vs.
MCKEESPORT CO.

DEFENDANT'S EXHIBIT MAN-CHEEVER LETTER. APRIL 4, 1889.
W. T. F., S. E.

3 MERCER ST., N. Y. *Dec. 12th,* 1880.

Chas. A. Cheever, Esq.

DEAR SIR: I have received your two notes of 11th inst., enclosing letter from the Patent Office advising Messrs. Baldwin, Hopkins & Peyton of substitution of Mr. Broadnax as attorney in carbon-arch matter. You are quite right in supposing that I had nothing whatever to do with the matter, and that I should if acting in it have taken all measures to avoid the least discourtesy to Mr. Baldwin, who has in all things conducted himself in the matter not only courteously, but efficiently & to my entire satisfaction. You will also permit me to disclaim on the part of the Electro-Dynamic Light Co. and its officers, not only any intentional discourtesy, but also to express to Mr. Baldwin through you the thanks of the company for his efficient and able management of the matter. The fact is, I suppose, that the whole subject-matter has been left to Mr. Broadnax, the attorney. You will, I think, agree with me that Mr. Broadnax is a gentleman who would not intentionally be discourteous to any one. I shall submit your letter to him and I am sure he will be able to make satisfactory explanation; possibly his letters to Mr. Baldwin may have miscarried or he may have failed to see him as he is now in Washington, and some urgency in getting hold of the details of the matter which he could not do in the Patent Office without filing the power of attorney to himself may have driven him to file it before communication with Mr. Baldwin. Of these things I cannot know, but of the desire of a portion of the officers of the company to keep Mr. Baldwin in the case I do not know, and that the matter of keeping him retained has not yet been acted upon by the company, and that Mr. Broadnax
3789 knew this and is not only of himself and naturally opposed to any discourteous action in any case, but would be especially careful to avoid even the appearance of giving offense under these circumstances. I re-enclose the notice of the department to Baldwin dated Dec'r 9th. I shall see you as soon as possible after our meeting of to-morrow.

Very respectfully yours, ALBON MAN.

As I told you the object of the substitution was to have all patent matters under one supervision.

ALBON MAN.

3790 DEFENDANT'S EXHIBIT B, "HERALD" ARTICLE OF JAN'Y 5, 1880. W. T. F., S. E.

EXHIBIT B.

(From the "Herald" of January 5, 1880.)

No. 78 WALKER STREET,
NEW YORK, *January* 4, 1880.

To the editor of the "Herald:"

Notwithstanding the assertion that one of Mr. Edison's electric lamps has been running for 240 hours I still assert, and am prepared to back up my assertion, that Mr. Edison cannot run one of his lamps up to the light of a single gas jet (to be more definite, let us call it 12 candle power) for more than three hours. To be still more definite I offer to Mr. Edison at No. 226 W. 54th street, in this city, an opportunity to prove what he says.

From the private residence in that street wires are run a circuit of a thousand feet. Mr. Edison shall have every facility; he shall use my wires; he shall have my dynamo machine or other generator of electricity he may prefer, and all I ask is that the power of his light shall be measured by a photometer; that once in place it shall not be interfered with; and that a committee of gentlemen, preferably nominated by the editors of the New York press, shall be present to certify to the facts of the test.

Furthermore, I will place one of my lamps side by side with Mr. Edison's; it shall run at a power of 25 candles; it shall outlast the entire forty lamps at Menlo Park, run at the power of 25 candles; my lamp to stand as it is put up, and Mr. Edison to put up a further lamp as fast as the preceding lamp shall have burned out. I am anxious for this test, and if Mr. Edison has really one of his horseshoe lamps 240 hours he will not refuse to accept my offer, for he will be treated with the utmost courtesy and shall have everything his own way. I adhere in every particular to my original challenge to Mr. Edison.

Respectfully, W. E. SAWYER.

3791 CONSOLIDATED E. L. CO.
vs.
McKEESPORT L. CO.

DEFENDANT'S EXHIBIT C, HERALD OF JAN'Y 6, 1880. W. T. F., S. E.

EXHIBIT C.

(From the "Herald" of January 6, 1880.)

Mr. Sawyer's Exhibitorium.

To the editor of the Herald:

Your remarks this morning were both interesting and to the point. A great newspaper as the Herald undoubtedly is, should be impartial. I don't know much about the newspaper business, but I know that much. In all the time I have been working at this problem of electric lighting, I have been working simply and solely with a view to a genuine scientific success. I have made no money out of it. Instead of selling out I have increased my original interest by $19,000; have bought my own stock from those to whom I made a gift of it, at 50 per cent. of its par value. I think I know enough about this business not to make a very great mistake, and am not risking my reputation by any wild challenges.

The Herald is in error in implying that this is my residence, and that in consequence, this is a kind of a family matter. I hunted New York over to find some one who would permit me to use his house for a public exhibition. As may be imagined, it was not an easy thing to do. Allow me to correct. My residence is No. 261 W. 42nd street; my office is No. 78 Walker street, my shop is No. 141 Elm street, the exhibitorium is No. 226 W. 54th street.

W. E. SAWYER.

3792 Defendant's Exhibit Sawyer-Man Scientific American Article No. 1.

(Scientific American, November 16th, 1878.)

Another New Electric Light.

During the past week the Electro-Dynamic Light Company of New York have exhibited an electric light which is, to say the least, very promising. The apparatus employed was the Sawyer-Man electric lamp, the joint invention of William E. Sawyer, a well-known and successful electrical inventor of this city, and Albon Man, of Brooklyn. As we hope soon to lay before our readers a complete description of the *the* lamp, with illustrations of its mechanism, we will merely remark in this connection that the lamp is enclosed in a hermetically sealed globe of glass, filled with nitrogen, and appears to differ from the common mode of exhibiting the electric light in non-supporters of combustion, mainly in the addition of a slender pencil of carbon, which completes the circuit between what would otherwise be the two carbon poles, and by its incandescence furnishes light in the place of the ordinary voltaic arc. An essential feature of the invention is an ingenious device for dividing the current, and for maintaining a constant uniform resistance in the circuit, whether the lamps are on or off. The light exhibited was steady and brilliant.

3793 & 3794 Defendant's Exhibit Sawyer-Man Scientific American Article No. 3.

(Scientific American, March 8th, 1879.)

The Sawyer-Man Electric Light.

It will be remembered that in our issue of December 7th, 1878, we gave illustrations of this novel and promising form of electrical apparatus. Since that date the inventors have been busy with endeavors to perfect the invention, and, on the evening of February 20, a public exhibition of the light was given in this city by the Dynamo-Electric Light Co. Several improvements in details of construction have been made, but no radical changes. The chief improvement is in the bearing of the upper carbon-holder, to allow for expansion; the lamp has also been made slightly taller. The light exhibited was soft, pure and steady, and susceptible of perfect regulation. Any lamp in the circuit could be turned up or down, from a dull glow to brilliant incandescence, without affecting the rest. An important improvement has also been made in the switch.

The dynamo machine used was about half the size of the one previously employed; there were more lights in the circuit, and the illumination was more brilliant and satisfactory. Comparison was made with gas light, and also with the voltaic arc, clearly demonstrating the superiority of light by electric incandescence for ordinary uses. The carbons used in the Sawyer-Man lamp are now proved to be comparatively indestructible. If, however, the lamp should be broken or otherwise injured by accident, it can be as easily and cheaply removed and repaired as an ordinary gas-burner. As regards economy, tests upon a large scale have not yet been feasible. With the power at command, the indications are that the production of light by this system will range between one-fifth and one-half the cost of gas.

3795 DEFENDANT'S EXHIBIT SAWYER-MAN SCIENTIFIC AMERICAN ARTICLE NO. 4.

(Scientific American, March 8th, 1879.)

A New Form of Carbon.

In describing the Sawyer-Man electric light, last December, mention was made of the peculiar carbons employed, the manner of their production being a secret which Mr. Sawyer did not choose at that time to disclose.

We have now been favored with an exhibition of the process, and a very pretty experiment it makes. The carbons in question are about half an inch long, with the diameter of one sixteenth of an inch. Their color is steel gray, and the surface is hard as steel; within the carbon is tolerably soft.

In his earlier experiments, Mr. Sawyer employed as the source of incandescence, slender pencils of gas-retort carbon in an atmosphere of illuminating gas. The carbons were slowly destroyed, but at the same time they took on a superficial deposit, evidently of carbon, but unlike in lustre and hardness any carbon that Mr. Sawyer had seen. Inferring that a more rapid deposit would be made in a denser hydrocarbon, Mr. Sawyer experimented with a great variety of such liquids, finding olive oil most satisfactory. His method is simply to heat the carbon to an extremely high temperature, by passing through it an electric current, while it is immersed in the oil. The best results are obtained by the use of a pencil of willow carbon, upon which an intensely hard deposit of carbon rapidly forms, as the hydrocarbon is decomposed by the heated pencil.

3796 CONSOLIDATED *vs.* MCKEESPORT.

DEFENDANT'S EXHIBIT MORTON SANITARY ENGINEER LETTER, APRIL 24, 1889. W. T. F., S. E.

To the editor of the Sanitary Engineer:

Having a sincere respect for Mr. Edison as an enthusiastic and ingenious investigator, I am sorry to see his name used by writers who evidently are quite ignorant of the subjects about which they treat in a way that will inseparably connect it with discreditable (because false) claims, evidently made in the interest of financial speculators.

No one can more thoroughly appreciate than I do the originality of conception, the indefatigable patience and immense labor which have been involved in the series of experiments, of which a sketch has been given in the "New York Herald" of Sunday, the 21st; but when I see the conclusion of these, which every one acquainted with the subject will recognize as a conspicuous failure, trumpeted as a wonderful success, I have only left before me the two alternative conclusions—that the writer of such matter must either be very ignorant and the victim of deceit or a conscious accomplice in what is nothing less than a fraud upon the public.

Such writing as this, in fact, has the melancholy result of placing Mr. Edison and his electric light in the same category with Mr. Keely and his "water motor," Mr. Payne and his "electric engine," Mr. Garey and his "magnetic motor," and others of the same class.

Against this I protest in behalf of true science and for the sake of Mr. Edison himself, who has done and is doing too much really good work to have his record defaced and his name discredited in the interest of any stock company or individual financiers.

HENRY MORTON.

3797 STEVENS INSTITUTE OF TECHNOLOGY, *December 22d*, 1879.

P. S.—When I say that the achievements described by the "Herald" of Sunday, the 21st, constitute "a conscious failure," I do not, of course, mean that Mr. Edison has not now, as he had a year ago, a lot of electric lamps running at Menlo Park; but that his year's work, starting out with the most confident assertion of an accomplished success, only awaiting granting of patents to be made public, has ended in landing him in an old method repeatedly tried and abandoned by others, and which this description furnishes no reason to believe has received any important improvement in Mr. Edison's hands.

3798

CONSOLIDATED
vs.
McKEESPORT.

DEFENDANT'S EXHIBIT MORTON SANITARY ENGINEER INTERVIEW, APRIL 26, 1889. W. T. F., S. E.

A Scientific View of it.

(From the "New York Times" of December 28th.)

Prof. Henry Morton, the president of the Stevens Institute of Technology, who is well known for his researches in physics, and whose experiments were a source of unfeigned pleasure and astonishment to Prof. Tyndall, recently sent a communication to the "Sanitary Engineer" protesting against the trumpeting of the result of Edison's experiments in electric lighting as a "wonderful success," when "every one acquainted with the subject" will recognize it as a "conspicuous failure." To this was added the statement that Edison "has done and is doing too much really good work to have his record defaced and his name discredited in the interests of any stock company or individual financiers." Edison, to whose attention this letter was called, was reported in a newspaper yesterday morning as inviting Prof. Morton or any other electrician to visit the Menlo Park laboratory and see the light in practical operation. In conversation with a Times reporter yesterday Prof. Morton said that for several reasons he did not think he would accept Mr. Edison's kind invitation. "What is needed to be learned," said the professor, "is the durability of these new lamps of Mr. Edison's and the actual economy in the conversion of power into light by his arrangement. For example, according to the statement in the 'Sun,' Mr. Edison places his present lamps and machines as yielding him what is equivalent to 10 gas-burners for every horse power. Now, my own experience with the best dynamo-electric machines, such as those of Siemens, Weston, Brush and Maxim, using the ordinary carbon poles, show that we may obtain a light of from 1,200 to 1,600 candles per horse power. Assuming a gas-3799 burner to be equal to from 12 to 16 candles, this would be about 100 burners per horse power. As compared, therefore, with the electric light obtained between carbon poles, Mr. Edison gets only 10 per cent., showing, therefore, precisely that enormous loss in the division of the light which has been alluded to before as one of the standing difficulties in the way of the practical application of such a system as Mr. Edison is working upon. This is taking simply his apparently rough estimate. For any definite and certain conclusions prolonged and careful experiments, entirely under the control of the investigator, are absolutely necessary."

As regards the durability of Prof. Edison's new lamps, Prof. Morton was not at all sanguine. "Lamps," said he, "in all essential respects identical with these described by Mr. Edison, have been in constant experimental use for several years past, with one invariable result, namely, that while the carbon would operate success-

fully for periods varying from a few hours to several days, it has been found utterly impossible to render them reliably permanent. It is, therefore, in my estimation, here also necessary that experiments of some length, likewise under the entire control of the investigator, should be made in order that a decisive conclusion may be reached. With reference to the confident assertions of success which reach me from various quarters, I must fall back upon my experience of a little over a year ago. Every one remembers how, at that time, Mr. Edison read some remarks of mine by the light of his then brilliantly glowing electric light, and pointed to it as a shining refutation. In turning over some old letters a few days since I came across one from a friend of mine, who is a scientific man of high standing, and was at that time on very intimate terms with Mr. Edison. This letter is dated October —, 1878, and in it I am assured that Mr. Edison's lamp is a perfect success, capable of replacing a gas-burner, and that when I see it I shall, no doubt, be charmed with its simplicity and efficiency. When I reflect that this previous complete success has been since abandoned by
3800 Mr. Edison, I feel that a little caution is needed in accepting the enthusiastic conclusions of his friends, even when they are illuminated by the shining electric lamps which occasion them."

"Can you tell me, Professor," asked the reporter, "what are some of the chief difficulties in the way of the success of Mr. Edison's light"?

"Well," Prof. Morton replied, "the first difficulty of all is the production of a lamp which shall be thoroughly reliable, and neither complicated or expensive. All attempts up to the present lamp in this direction are acknowledged to be failures, and, as I have pointed out, there does not seem to be any novelty, such as would authorize us to hope for a better success in the present one. The next difficulty is in the economical production of small lights by electricity. This is what is commonly meant by the phrase, 'Dividing the electric light.' Up to the present time, and including Mr. Edison's latest experiments, it appears that this involves an immense loss of efficiency. Next comes the difficulty of distributing on any large scale the immense electric current which would be needed, and to provide for their equal action at different points under varying conditions of the number of lights used. In reference to this, as far as I judge from the reports, Mr. Edison has been running not over 50 lights in all, while his 80-horse-power engine ought to supply 800 lights. The small number actually in use does not, therefore, develop this problem in any practical way."

"The question of measuring the current," added the Professor, as the reporter turned to leave, "the loss involved from the necessity of running the machinery without a moment's intermission during the entire time that any light is needed—in other words, the absence of any storing capacity in electricity—and various other matters of detail, while less important than the three principal difficulties which I have given you, are, nevertheless, very serious difficulties in the direction of a successful practical application of electricity for general illumination."

3801 (New York Tribune, Nov. 25th, 1880.)

Electric Lamps in Daily Use.

As easily regulated as gas.

The nature of the new incandescent light—Interest shown in it by scientific men—Points in which it differs from other lights.

Professor Henry Morton, of the Stevens Institute, Hoboken, read a paper at the recent meeting of the National Academy of Sciences on the measurement of new forms of electric lamps operating by incandescence, in which he gave the results of a number of experiments made with the new Maxim lamp. These results were unexpected by those members of the academy who are specially interested in electric lights. Professor Wolcott Gibbs, of Cambridge, expressed his astonishment without reserve, and said that no one had dreamed that the light of incandescence could compete with the light of the arc. Professor George F. Parker, of Philadelphia, who has taken an active interest in the subject from the beginning of Mr. Edison's experiments, said that the statements of Professor Morton certainly marked a year of great progress in electric lighting.

The paper by Professor Morton and the comments it called forth have attracted public attention in no small degree to the electric lamp operating by incandescence, and to the claims that are made for it. Numbers of people daily visit the Equitable building, in Broadway, and examine the lights there. The basement hall is lighted by one or two large arc lamps of about 4,000 candle power each. The public has become so familiar with lamps of this nature that they no longer attract attention. The novelty is the small incandescent lamp, no larger than a gas jet, of which about sixty are kept burning day and night in the rooms and vaults of the Mercantile Safe Deposit Company. The handsomely furnished new reading-room of this company is lighted by a number of these lamps arranged like gas jets. Some are placed upon the walls and
3802 some are clustered in a chandelier. In order not to dazzle
the eyes of readers the brilliancy of the lights in this room is reduced, and it is therefore only in the vaults that the lamp shines with its full strength. The light flickers somewhat, but this defect is probably due to some imperfection in the regulator, which controls the dynamo machines furnishing the electric current. The flickering is not at all marked, and one must look twice to detect it, so that the failure to secure perfect steadiness is not regarded as a serious drawback to the incandescent lamp. The great security vaults of the company, the storage vaults and the rooms, including the large offices and halls, are furnished with the electric light. The larger areas are lighted with the arc lamps, while the incandescent lamps make the smaller rooms as bright as if flooded with sunshine. The electric current is furnished from a single Maxim machine, deriving its power from the engines in the Equitable building. This machine is controlled by a regulator which determines

the force of the electric current required. The lamps are so constructed that they can be turned on and off at will, as gas is managed, with the advantage that the lamps light themselves. There is no waste, because when lamps are turned off the regulator causes the machine to furnish a current of proportionately less strength to the remaining lamps. The lamps now used at the Equitable building have been burning day and night for three weeks, without the failure of a lamp or any perceptible change in the light of a lamp.

An Explanation by Professor Morton.

A "Tribune" reporter received from Professor Morton a few days since a clear explanation of the peculiarities of the Maxim lamp. "This incandescent lamp," said he, "differs from other electric lamps in the respect that it starts with a filament or conductor of carbon made in any way. This filament is placed in a glass globe from which the air has been exhausted, and replaced by the vapor
3803 of gasoline. If there is any weak point or thin part in the
carbon filament, when the current is passed through it, this point or part will become hotter than the rest, and will decompose the gasoline so as to deposit carbon in the form known as coal-gas carbon upon that particular spot. When this spot has been built up to an equal conductivity with the rest of the filament, the current of the machine is increased with the effect of seeking out the next weakest point or thinnest part, and repeating the process just described. In this way the filament becomes glazed with gas carbon. The gasoline is then withdrawn from the globe, and the lamp is ready for use.

"The incandescent lamp differs from the Edison lamp in this regard: Mr. Edison makes a carbon filament and this filament must be perfectly uniform at the start. If any one point happens to be a worse conductor than the rest of the carbon, this point becomes more highly heated than any other point, and if the whole filament is run up to the necessary intensity to give a good light, this point is carried beyond its endurance and vaporizes. As Mr. Edison himself says, it bursts and disappears, and the lamp is destroyed. He has no means of remedying this except by extreme care in selecting material so as to make his filament absolutely uniform; he has no method for correction.

"Another important feature in the Maxim lamp is in the nature of this glazing, as it may be called, or plating of gas carbon—a material which has long been known for its remarkable resisting powers. It is not only incombustible, but it is mechanically strong in a notable degree. In attempting to cut it, the best files and steel saws are soon ruined. Lumps of it may be put into a cupola furnace and they will come out practically unchanged. This would seem, therefore, to be a peculiarly fit material to stand the severe strain to which it is subjected in these electric lamps.

"In determining the economy and efficiency of these and other lamps, it is required to know three things: The amount of light they give as compared with the standard candle, which consumes

two grains of spermaceti per minute; the amount of electric
3804 current flowing through the lamp, and the amount of resistance to the electric current present in the lamp. In order to obtain this knowledge the lamp is placed in the instrument, known as the photometer, where the light it gives is accurately measured by a comparison with that of one or two standard candles, and at the same time by appropriate electric instruments, the amount of the current and the resistance in the lamp are measured. These quantities being known, the power expended by the electric current in overcoming the resistance of the lamp can be calculated by a simple formula. And this is an accurate measure of the work done or the valuable energy expended in the lamp. The candle power is, of course, a measure of the light produced, and that lamp is the most economical which for a given amount of work done or energy expended in it will give us the most light. The work done is expressed in foot pounds per minute, whether it be an electric current or any other form of energy. Thus, a current of 3½ webers passing through a resistance of 5½ ohms would do a work in one minute of about 2,700 foot pounds. A horse power, as everybody knows, is equal to 33,000 foot pounds per minute. Therefore, this amount of work is about one-eleventh of a horse power. The lamp in which this amount of force was being developed or converted into light gave at that time a light of 12 candles; and as evidently 11 such lamps might have been operated by a current developing eleven times the energy of the one used, they would have together produced the light of eleven times twelve candles, or 132 candles, and we would then say the efficiency of this lamp was 132 candles per horse power of electric current. The exact amount of mechanical force in a steam engine or the like required to produce an electric current of one-horse power would vary, of course, with the particular dynamo-electric machine employed and with other conditions, and would, of course, always be notably more than the electric current itself represented."

"What, in a word, would you say the Maxim lamp has accomplished?"

3805 "The system of Maxim is the first one in which has been practically solved the problem of producing a moderately small life with a correspondingly small electric current; or, in other words, of utilizing the small portions of a divided current. There is nothing new, of course, in the idea of dividing the electric current; the practised novelty is in the construction of a lamp that enables us to utilize the portions of the current when it has been divided. What I mean may be made plain by an illustration. Let it be supposed that at one time gas was so little understood that it could not be used except when passed through a burner of not less than 100 candle power, and then let it be supposed that somebody discovered a means by which gas became luminous when used as it now is. The person who, under this supposition, brought gas into general use would have accomplished with gas what the incandescent lamp has done in electric lighting."

3806 In the matter of the litigation now pending between Sawyer & Man and the Edison Electric Light Company.

William Sharp, being duly sworn, testified as follows:

By Mr. Tomlinson:

Q. Please state when you first met Mr. Albon Man, or Mr. Wm. E. Sawyer.

A. I knew Mr. Man for some time prior to the experiments of Sawyer & Man on electric lighting; Mr. Sawyer I met for the first time at the shop of Arnoux & Hockhausen, No. 2 Howard street.

Q. Please state in detail what was the first work done by you for either Mr. Sawyer or Mr. Man relating in any way to electric lighting.

A. I was living in Brooklyn and had a lathe and some tools at my house and did work there. The first work that I did for either Sawyer or Man was done at my house in Brooklyn. Mr. Man brought me some glass globes and some blocks of gas-retort carbon, and stated to me that he desired the carbon filed down and a lamp made. I don't now remember in detail just the character of the lamp. I think I made two lamps, but not more than two. I got pieces of metal and made them in the proper size and shape; as nearly as I can now recollect, the lamp contained a globe of glass about six inches long, and about three or four inches in diameter. I made the supports for the carbon of the lamp and they were inserted through the neck of the lamp globe into the lamp and fastened there by nuts and paper washers. I worked the blocks of carbon down until I had got two pieces of carbon, one of about the size and shape shown in No. 1 of the drawing marked "A," the other a strip of carbon of about the size and shape shown in No. 2 of the drawing marked "A." The circular carbon was, I think, an experiment, and I don't think it was ever put in the lamp. The carbon worked down to the shape shown in No 2, was the size and general shape of the carbon I put in the lamp. These lamps were so made that the carbon could be replaced. I gave the lamps to Mr. Man. Mr. Man, while I was 3807 working on these two lamps, at my house, came at least half a dozen times to my house to instruct me in the work, and occasionally helped me to do the work. I should think I was working on these lamps about a month. I have no knowledge whether while I was making these lamps at my house, anybody else was making lamps for them. I did not know that it was a lamp that I was working on until I went to Mr. Man's office to get my money for it, when he asked me if I knew what I had been making and I told him no; he then told me that it was an electric lamp. I am quite confident that I made but two lamps and two pieces of carbon. The carbon was gas-retort carbon which I worked on, as I have said. About a month after I had delivered this lamp, I saw it for the first time in Sawyer's place, at No. 2 Howard street; I saw it lit at intervals, during a month or two, and I understood that occasionally they would light it and show it. I did not understand that they burned it steadily. They would merely run it to incandescence for a few minutes at a time, and it was their custom to replace the carbon.

Q. When next did you work for Sawyer and Man?

A. I entered their employ while they were at No. 2 Howard street, and remained with them after they were at Elm and Walker streets, leaving them, as nearly as I can now recollect, about May, 1879.

Q. During this time were you at their laboratories or shops during the working hours of each day?

A. Yes, sir.

Q. During this period were you familiar with the work that was done at these laboratories?

A. Yes, sir.

Q. And with the various experiments that were conducted?

A. Yes, sir.

Q. Was any attempt made to conceal from you what was being done, or did you have free access through the laboratory, and were you generally familiar with all that was done while you were in their employ?

3808 A. I had the privilege of seeing anything that was going on and am generally familiar with what was done. I am not an electrician, but am an expert mechanic and was largely employed on mechanical work.

Q. What was the general nature of the work in which you were engaged?

A. Chiefly on the mechanical parts of the lamps that were made; I also worked in forming the carbons to the desired size.

Q. During the time that you were employed by them, what was the general type of lamp on which they were experimenting, or making, as nearly as you now remember?

A. The lamp contained a glass globe about eight inches long by about two inches in diameter. The base of the globe, by nuts and washers, was fastened to glass plates; the glass plate and the globe were clamped together by metal rings. The interior part of the lamp was fastened mechanically to the base of the lamp in different ways. The base of the lamp was then surrounded with melted sealing wax; after this was done the base was placed in a metallic shell and filled with beeswax. The interior of the lamp contained a short pencil of carbon; a disk of soapstone or metal separated the illuminating part of the interior from radiators such as are shown in figure 1 of letters patent 205,144. The shape and character of these radiators, however, differed; some being serpentine and some of other shapes.

Q. From the time that you first were regularly employed by them until the time you left them, which, as nearly as you can recollect, as I understand you, was from September, 1878, to May, 1879, how many completed lamps in all were made by them?

A. I should say a couple of dozen; I am sure that not more than fifty were made.

Q. What was the character of carbon usually employed in these lamps as the incandescent conductor?

A. Usually pencils made from gas-retort carbon.

Q. What was the shape and dimensions of these pencils?

3809 A. Straight pencils, about half an inch in length, varying in diameter from three sixty-fourths to one-sixteenth of an inch.

Q. Were these lamps so constructed that they could be taken apart and new pencils of carbon inserted?

A. They were.

Q. Do you know, and if so, state whether it was their habit to take their lamps apart and replace the pencils which were consumed by new pencils of carbon.

A. I do know that it was their habit so to do.

Q. What is the longest period during which you have known one of their lamps to remain at continual incandescence?

A. Not over an hour; certainly not over two.

Q. Do you ever remember to have been told of a lamp remaining incandescent for over that time?

A. No; I do not remember.

Q. If any lamp had remained incandescent for two or three days at a time, or for a week or two, do you not think you would have been likely to have known of it, or have heard of it?

A. I do.

Q. Did you ever know or hear of a lamp remaining at continual incandescence for as long as a day?

A. I never did.

Q. If one had burned as long as that, would you not have been apt to have known or heard of it?

A. I think I should.

Q. During the entire time that you were there did they make any lamp which you would consider a practical lamp? I mean by that, one that could be made and sold commercially, and actually used for purposes of illumination?

A. No, sir; I think their lamps were merely experiments.

Q. Did you ever know of their making any test of the life of their lamps, or keeping any records as to how long the lamps would burn?

A. No; I don't know anything about that.

Q. Did you ever know of their doing any carbonization while they were at Howard, or at Elm and Walker streets? By 3810 carbonization I mean taking some material such as wood, or paper in its natural state, and making it into carbon by the heat of the furnace?

A. No.

Q. If this had been done to any extent, or if carbons thus made had been used to any extent, would you not have been apt to have known of it?

A. I would.

Q. Then, as I understand you, the carbons which were used, so far as your knowledge goes, were carbons purchased by them and reduced mechanically to the desired size?

A. Yes.

Q. Did you ever know or hear of their carbonizing paper, wood or other substances?

A. I never did.

Q. Did you ever know or hear of their using, or trying in their lamps, carbons made from paper?

A. No, sir.

Q. If this had been done would you have been apt to have known of it?

A. I would, probably.

Q. Did you ever know or hear of their carbonizing any fibrous or textile material?

A. I never did.

Q. If they had done so, would you have been apt to have known of it?

A. I think I would.

Q. Do you know of their using or trying any carbons other than gas-retort carbon, and if so, please state the fact as you understand it?

A. I remember their getting what were called willow charcoal; these were what is generally known as artist's crayons. They were filed down to the desired size. These crayons were always treated by putting a shell of carbon on the outside. The willow crayons are the only kind of carbon, other than gas-retort carbon, which I ever knew them to try or use. I remember some carbons called French carbons, such as are used in arc lights, but these I understand to be gas-retort carbons.

Q. In their laboratories did they have extensive apparatus for the conduct of experiments?

3811 A. They had pretty fair tools, but very little chemical apparatus, as I understand it. The shop more resembled a mechanic's workshop.

Q. Do you know whether they had an air pump of any kind?

A. I never saw one, and I don't think they had one. I think that for a short time they had some sort of apparatus for taking the air out of the globes with water; but they used to send their lamps out. Toward the last they had Mr. Stillman come up to the shop; they then had some apparatus to charge the globes with gas.

Q. Did you ever know of their using in any of their lamps an incandescent conductor as long as two or three inches and as fine as a horsehair?

A. No, sir.

Q. If they had ever used such a conductor while you were with them, would you have known of it?

A. I certainly would.

Q. Did you ever know, or hear, of their experimenting in any way with such a conductor?

A. No, sir; I never did.

Q. Had they ever done so, would you have been apt to have known or seen or heard of it?

A. I certainly would.

Q. If they had had any apparatus for the obtaining of a high vacuum, would you have been apt to have known of it?

A. I think I would.

Q. Did you ever know of their having such an apparatus?

A. I never did.

Q. Who, beside yourself, worked at the shops of Sawyer and Man?

A. Principally—Mr. Meyers, young George Sawyer, William E. Sawyer and William Sawyer, Sr.

Q. Did you ever hear of a Mr. Keating?

A. I believe Keating did some work for them before I went with them. I have heard of him and seen him.

Q. Did you ever know of the interior of their lamp being enclosed in a globe entirely of glass?

3812 A. I never did.

Q. Afterwards did you work with Mr. William E. Sawyer when he was in Ansonia?

A. I did.

Q. Did you assist him in his experiments there?

A. Yes, sir.

Q. Do you know of any lamps being made with a circular carbon, such as shown in the drawing of patent 317,676, while you were in New York?

A. Yes, I did work, myself, on a lamp containing such a carbon. I don't think over two such lamps were made. I think the round carbon was too bothersome. They made many more of the other kind of lamp.

Q. You say you worked with Mr. Sawyer after his separation from Mann, at Ansonia?

A. I did.

Q. What kind of lamp was he then at work upon?

A. The feeder lamp.

Q. Do you know whether he considered that type of lamp better than the lamps he had made in New York?

A. I believe he did. I think he considered it a better style of lamp.

Q Did you ever know of his making a lamp at Ansonia that could be considered practical?

A. I never did.

Q. In the lamps made in New York, were they troubled with blackening of the globe of the lamp?

A. They were; the globe would always blacken if they burned them long enough.

Q. When the globe would blacken, was it their habit to take the lamp apart, clean the globe and put in a new carbon?

A. It was.

Q. When was the first you ever heard of paper carbon being tried by Sawyer, or anybody with whom you were connected?

A. Some time after Sawyer had left Ansonia I knew of Mr. William Wallace, Sr., trying to carbonize a piece of paper, but I don't

3813 think it was ever put in a lamp, as far as I know. He tried to carbonize it, I think, between two pieces of iron. I believe he was led to this by the publication of Edison's experiments.

WILLIAM SHARP.

Subscribed and sworn to before me this 17th day of June, 1886.

JOHN C. TOMLINSON,
Notary Public, N. Y. Co.

The above statement was made by Mr. Sharp in the presence of Mr. James A. Russell and Martin R. Winchell and Mr. J. C. Tomlinson, the witness being interrogated by Mr. Tomlinson, and questions and answers being taken by Mr. Winchell in short-hand.

3814 *Collected Works of Sir Humphrey Davy, Vol. II, London,* 1839, *Pages* 211 *to* 213, *Inclusive.*

An account of some experiments of galvanic electricity made in the Theatre of the Royal Institution.

The apparatus employed in these experiments was composed of 150 series of plates of copper and zinc of four inches square and 50 of silver and zinc of the same size. The metals were carefully cemented into four boxes of wood in regular order after the manner adopted by Mr. Cruickshank and the fluid made use of was water combined with about $\frac{1}{100}$ part of its weight in nitric acid.

The shock taken from the batteries by the moistened hands was not so powerful, but that it could be received without any permanently disagreeable effects. Charges were readily communicated by means of them to connected jars and to a battery, but in this case the effects produced by the electricity were much less distinguished than in the case of immediate application.

When the circuit in the batteries was completed by mean- of small knobs of brass the spark perceived was of a dazzling brightness and in apparent diameter at least one-eighth of an inch. It was perceived only at the moment of the test of the metals and it was accompanied by a noise or snap.

When instead of the metals pieces of well-burned charcoal were employed the spark was still larger and of a vivid whiteness and evident combustion was produced, the charcoal remained red hot for some time after the contact and threw off bright coruscations.

Four inches of steel wire $\frac{1}{170}$ of an inch in diameter on being placed in the circuit became intensely white hot at the point of connection and burned with great vividness, being at the same time red throughout the whole of their extent.

3815 Tin, lead and zinc in thin shavings were fused and burned at their points of contact in the circuit with a vivid light and with a loud hissing noise. Zinc gave a blue flame, tin a purplish and lead a yellow flame at the circumference.

When copper leaf was employed it instantly inflamed at the edges with a green light and vivid sparks and became red hot throughout the whole of its diameter when it did not exceed four inches.

Silver leaf gave a vivid light, white in the centre and green towards the outline with red sparks or coruscations. Platinum in thin slips when made to complete the circuit became white hot and entered into fusion and gave scintillations at the edges, but whether any part was converted into oxide could not be accurately determined.

When gold leaf, attached by gum water to white paper was burned by the spark the light was of a bright yellow and the noise comparatively loud; the gold was converted into an oxide of a purplish brown color which firmly adhered to the paper and by regulating the course of the spark by means of the communicating wire letters and figures were traced by the fusion which appeared somewhat transparent when exposed to the light.

When the galvano-electric spark was taken by means of pieces of charcoal barely covered with cotton, the cotton was readily inflamed; whether in its simple state or sprinkled over with resin or sulphur.

Fulminating mercury and gun pipe were deflagrated by means of the communication of charcoal; and hydrogen and the compound inflam-able gases were readily made to burn when simply in contact with the atmosphere and detonated when mixed with oxygen.

A few only of these results have any claim to originality. On the phenomena of the combustion of bodies by galvanism we have been already furnished with many striking experiments by our own country and by the German and French philosophers. And after the path is once discovered, in researches of this kind, to
3816 pursue it requires but little ability or exertion. An account of common facts under new circumstances particularly when they are accompanied by striking phenomena can, however, never be wholly useless and it sometimes gives a novel interest to the subject and tends to awaken curiosity.

3817 *Collected Works of Sir Humphrey Davy, London, 1839, Vol. II, Beginning at Page 214, under the Title:*

Account of some experiments made in the laboratory of the Royal institution relating to the agencies of galvanic electricity in producing heat and in effecting changes in different fluid substances—

Particularly pages 216–'18–'19–'20.

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3. When two small pieces of well-burned charcoal or a piece of charcoal and a wire were made to complete the circuit in water vivid sparks were perceived, gas was given out very plentifully and the points of the charcoal appeared red hot in the fluid for some time after the contact was made, and as long as this appearance existed elastic fluid was generated with the noise of ebullition. The

sensible phenomena were nearly the same with the volatile and fixed oils, ether and alcohol; and by means of charcoal the sparks could be produced in concentrated and sulphuric and nitric acids, which are among the best of the less perfect conductors.

The gases produced from different fluids by the galvano-electric spark were examined, and as the results were in most cases what might have been expected from theory, the analysis of them was not made with very minute attention.

When water was acted upon by sparks taken from two pieces of charcoal the elastic products evolved were about one-eighth of carbonic acid, one-eighth of oxygen and the remainder an inflammable gas, which required a little more than half its volume of oxygen for its combustion. With gold and charcoal, the gold being on the zinc side, the gas produced appeared to be chiefly a mixture of oxygen and hydrogen, for it diminished $\frac{7}{10}$ by the electric spark.

The gas disengaged from alcohol, the spark being taken by gold
connected with the zinc end and charcoal, was a mixture of
3818 nearly two parts of oxygen and eleven parts of inflammable
gas which appeared to be light hydrocarbonate.

Ether in the same method of operating gave four parts of oxygen and twelve parts of inflammable gas.

From sulphuric acid oxygen and hydrogen was produced very rapidly, the oxygen being more than sufficient for the saturation of the hydrogen by combustion, and the acid became blue.

The gas from nitric acid detonated with great violence by the electric spark and the residuum was oxygen mixed with a little nitrogen.

The products from the acids there is every reason to believe were evolved chiefly in consequence of the decomposition of the water they contained. And in operating upon these substances as well as upon pure water, a portion of the elastic fluid must have been produced at the time of the slightest transmission of the electricity during the momentary interruption of contact. The apparent ignition of the charcoal in the different fluids depended probably in some measure upon its being surrounded at the moment of contact by globules of glass which prevented the heat produced at the points of it from being carried off by the fluid.

When the spark was taken by means of iron wire in phosphorus rendered fluid by heat under a stratum of water, permanent gas was produced from it, but in a quantity too small to be examined after a process that continued an hour. I purpose to repeat the experiment with conductors of dry charcoal.

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5. As the great quantity of electricity by it circulates through perfect conductors by means of the larger apparatus increases their affinity for oxygen more, perhaps, than any known agent, and as charcoal by means of it can be rendered white hot and kept in constant combustion in oxygen gas or atmospherical air, I thought *that* trying the effects of the electrical ignition of this substance upon muriatic acid gas confined over mercury.

This experiment was made by means of a small glass tube con-
taining a slip of platina hermetically sealed into it and hav-
3819 ing a piece of charcoal attached to its lower extremity; a
communication was effected by means of iron wires and the
charcoal was made white hot by the successive contacts continued for nearly two hours. At the end of this time the muriatic acid gas had diminished a very little in volume; much white matter had formed upon the charcoal, which was not sensibly consumed. When the gas was examined $\frac{3}{4}$ of it were instantly absorbed by water and the remainder proved to be inflammable. The process was repeated three times; and when the spark was most vivid a white cloud was always perceived at the moment of its production. I am inclined to attribute this phenomenon and other phenomena to the deposition of the water held in solution in the gas by the charcoal and the mercury adhering to it; and the white matter was probably muriate of mercury. The acid gases are rapidly absorbed by charcoal, and this substance, when well made, will take up more than thirty times its volume of muriatic acid gas; so that in the process of ignition a part of the water and of the acid must have been acted upon in a very condensed state.

The want of success in this experiment, the results of which are very similar to those obtained by Mr. Wm. Henry in his trials with common electricity, prevented me from carrying on the process upon fluoric acid gas as I had at first intended. Many of the compounds of gases that are decomposed by heated charcoal might probably, however, be classed in a very simple manner by means of the ignition of that substance by galvanic electricity; and this mode of operating may be conveniently applied for ascertaining the relations of the affinities of charcoal for the constituent parts of compound gases at very high temperatures.

Apparatus for Taking the Galvanic Electrical Spark in Fluids and Aeriform Substances.

Fig. 1 represents the apparatus for taking the spark in
3820 fluids. A is a tube graduated to grain measure; C is a
platina wire hermetically sealed into the tube and having a
piece of charcoal attached to its top; B is a movable platina wire having charcoal at its top; the effect is produced by making a contact between the pieces of charcoal. In cases when the fluids are very imperfect conductors the wires may be used without the charcoal.

Fig. 2 represents the apparatus for taking the spark in gases; it is used over mercury. A and B are the connecting platina wires to which the charcoal is fastened, and C is the graduated tube in which the gas is acted upon.

3821 *Collected Works of Sir Humphrey Davy, Vol. IV, London,* 1840, *pp.* 109, 110, 111, 112, 221, 231, 232.

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Let two platina wires from the extremities of a battery composed of plates of a foot square be plunged into water, the quantity of gas disengaged from the wires will be nearly the same as from an equal number of plates of an inch square; let the fingers of each hand, moistened with water, be applied to the two extremities of the battery a shock will be perceived, nearly the same as if there had been no connection between the wires and the water. Whilst the circuit exists through the human body and through water let a wire attached to a thin slip of charcoal be made to connect the two poles of the battery, the charcoal will become vividly ignited.

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The first distinct experiment upon the igniting powers of large plates was performed by MM. Fourcroy, Vauquelin and Thenard. But the greatest combination ever constructed for exhibiting the effects of extensive surface was made by Mr. Children; it consists of twenty double plates, four feet by two, of which the whole surfaces are exposed in a wooden trough, in cells covered with cement, to the action of diluted acids. This battery when in full action had no more effect on water or on the human body than one containing an equal number of small plates; but when the circuit was made through metallic wires the phenomena were of the most brilliant kind. A platina wire of $\frac{1}{30}$ of an inch in thickness and 18 inches long placed in the circuit between bars of copper instantly became red-hot, then white-hot; the brilliancy of the light was soon insupportable to the eye, and in a few seconds the metal fused into globules. The other metals were easily fused or dissipated in vapor by this power. Points of charcoal ignited by it produced a light so vivid that even the sunshine compared with it appeared feeble.

3822 * * * * * * *

27. The most powerful combination that exists in each number of alternations *is* combined with extent of surface is that that — constructed by the subscriptions of a few zealous cultivators and patrons of science in the laboratory of the Royal institution. It consists of two hundred instruments connected together in regular order, each composed of ten double plates arranged in cells of porcelain, and containing in each plate thirty-two square inches; so that the whole number of double plates is 2,000, and the whole surface is 128,000 square inches. This battery, when the cells were filled with 60 parts of water mixed with one part of nitric acid and one part of sulphuric acid, afforded a series of brilliant and impressive effects. When pieces of charcoal about an inch long and one-sixth of an inch in diameter were brought near each other (within the thirtieth or fortieth part of an inch) a bright spark was produced, and more than half the volume of charcoal became ignited to whiteness, and by withdrawing the points from each other a constant discharge took place through the heated air in a space equal at least to four inches, producing a most brilliant ascending arch of light, broad and conical in form in the middle. When any substance was introduced into this arch it instantly became ignited; platina melted as readily in it as wax in the flame of a common candle; quartz, the sapphire, magnesia, lime, all entered into fusion;

fragments of diamond and points of charcoal and plumbago rapidly disappeared and seemed to evaporate in it even when the connection was made in a receiver exhausted by the air pump; but there was no evidence of their having previously undergone fusion.

When the communication between the points positively or negatively electrified was made in air rarified in the receiver of the air pump the distance at which the discharge took place increased as the exhaustion was made, and when the atmosphere in the vessel supported only ¼ of an inch of mercury in the barometrical gauge the sparks passed through a space of nearly half an inch,
3823 and by withdrawing the points from each other the discharge
was made through six or seven inches, producing a most beautiful coruscation of purple light, the charcoal became intensely ignited and some platina wire attached to it fused with brilliant scintillations and fell in large globules upon the plate of the pump. All the phenomena of chemical decomposition were produced with intense rapidity by this combination. When the points of charcoal were brought near each other in non-conducting fluids such as oils, ether and oxymuriatic compounds brilliant sparks occurred and elastic matter was rapidly generated; and such was the intensity of the electricity that sparks were produced even in good imperfect conductors such as nitric and sulphuric acids.

V.—*Of Carbon or Charcoal and the Diamond.*

1. The name carbon signifies the pure inflammable part of charcoal, lamp-black and other similar substances. The purest known form in which it can be obtained is by passing oils or spirit of wine through ignited tubes. It even appears as an impalpable black powder; it has no taste or smell; it is a conductor of electricity; it is more than twice as heavy as water. For the common purposes of experiments the charcoal of light wood, such as the alder, that has been exposed to boiling water and afterwards ignited to whiteness is sufficiently pure. Such charcoal, however, rapidly attracts moisture from the atmosphere so as to increase in weight from 12 to 14 per cent. and when dry absorbs several times its volume of any gas to which it may be exposed and it must therefore be employed immediately after ignition and whilst yet warm.

Carbon whether coherent in charcoal or in powder is infusable by any heat that has hitherto been applied. I have exposed it to the powers of intense ignition of different voltaic batteries—that of Mr. Children mentioned on page 109, one of forty double plates of 18 inches square and the battery of 2,000 double plates of four inches both *in vacuo* and in compressed gases on which it had
3824 no power of chemical action. A little hydrogen was given
off from it and it slowly volati-zed in these experiments and the part remaining was much harder than before, so as in one case to scratch glass, and the lustre was greater, but its other properties were unaltered, and there was no appearance of fusion. Its capacity for heat, according to Dr. Crawford, is to that of water as .2631 to 1.

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Page 231.

12. Plumbago or black lead and anthracite or stone coal are both tolerably pure forms of the carbonaceous element. In plumbago the carbon is united either chemically or mechanically to about $\frac{1}{25}$ of iron; in anthracite with small quantities of earthy matter. In the anthracite of Kilkenny in Ireland, the texture is often fibrous and the substance has all the characters of well-burned charcoal. In flaming coal the carbonaceous element is united to bitumen.

13. Few substances are more important in civilized life than the different forms of carbon; in their various uses they are essential to the comforts and well-being of society and are necessary in almost all the useful arts and manufactures.

The inflammable gases produced by the distillation of pit coal have already been successfully used in manufactories for the purposes of affording light, and the application is at once safe and economical.

In nature the carbonaceous element is still active in an important series of operations; it is evolved in fermentation and combustion in carbonic acid; it is separated from oxygen in the organs of plants, is a principal element in animal structure and is found in different forms in almost all products of organized beings.

3825 *Collected Works of Sir Humphrey Davy, Vol. V, London,* 1840, *pp.* 172, 173.

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When small pieces of charcoal from the willow that had been intensely ignited are acted upon by voltaic electricity in a Torricellian vacuum every precaution being taken to exclude moisture from the mercury and the charcoal, the results were very different from those occurring in the case of plumbago.

When plumbago was used after the first spark which generally passed through a distance of about $\frac{1}{8}$ of an inch there was no continuation of light without a contact or an approach to the same distance; but from the charcoal a flame seemed to issue of a most brilliant purple and formed as it were a conducting chain of light of nearly an inch in length at the same time that elastic matter was rapidly formed some of which was permanent. After many unsuccessful trials I at length succeeded in collecting the quantity of elastic fluid given out by half a grain of charcoal; the process had been continued nearly half an hour. The quantity of gas amounted to nearly an eighth of a cubical inch; it was inflammable to the electric spark with oxygen gas and four measures of it absorbed three measures of oxygen and produced one measure and a half of carbonic acid. The charcoal in this experiment had become harder at the point and its lustre where it had been heated to whiteness approached to that of the plumbago.

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Pp. 220, 221, 222.

III.—*Further Inquiries Respecting Carbonaceous Matter.*

On the idea which I have stated that they may consist of the carbonaceous matter combined with a little oxygen I exposed charcoal intensely ignited by voltaic electricity to nitrogen, conceiving it possible that if this body was an oxide containing oxygen
3826 very intimately combined it might part with it in small proportions to carbonaceous matter and give an important result.

The charcoal which had been made with great care was preserved for a quarter of an hour in a state of ignition in which platina instantly fused. It did not appear to change in its visible properties; but a small quantity of black sublimate which proved to be nothing more than finely divided carbonaceous matter collected in an arborescent state upon the platina wire to which the charcoal was attached. The gas had increased in volume $\frac{1}{6}$; but this was owing to the evolution of carburetted inflammable gas from the charcoal; the nitrogen was unchanged in quantity and as far as my examination could go, in quality. The points of the charcoal where the heat had been intense were rather harder than before the experiment.

I have mentioned that charcoal even when strongly ignited is incapable of decomposing corrosive sublimate. When charcoal in a state of ignition is brought in contact with oxymuriatic acid gas the combustion instantly ceases. I electrified two pieces of charcoal in a globe filled with oxymuriatic acid gas which had been introduced after exhaustion of the globe. They were preserved after nearly an hour in intense ignition by the same means that had been employed in the experiment on nitrogen. At first white fumes arose probably principally from the formation of common muriatic acid gas by the action of the hydrogen of charcoal upon the oxymuriatic acid and the combination of the gas so produced with aqueous vapor in the globe; but this effect soon ceased. At the end of the process oxymuriatic acid gas was found unaltered in its properties, copper leaf burned in it with a vivid light. The charcoal did not perceptibly differ from the charcoal that had been exposed to nitrogen. My view in making this experiment was to ascertain whether some new combination of carbonaceous matter with oxygen might not be formed in the process, and I hoped likewise to be able to free charcoal entirely from combined hydrogen and from alkaline and earthy matter supposing they existed in it not fully combined with
3827 oxygen. That hydrogen must have separated in the experiment it is not possible to doubt, and on evaporating the deposit on the sides of the globe, which was in very minute quantity and acted like concentrated muriatic acid, it left a perceptible and saline residuum.

P. 275.

V.—*Some Considerations of Theory Illustrated by New Facts.*

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Muriatic acid gas, as I have shown and as is further proved by the researches of MM. Gay Lassac and Thenard is a compound of a body unknown in a separate state and water. The water, I believe, cannot be decompounded unless a new combination is formed; thus it is not changed by charcoal ignited in the gas by voltaic electricity; but it is decompounded by all the metals; in these cases hydrogen is elicited in a manner similar to that in which one metal is precipitated by another; the oxygen being found in the new compound.

VII.—*Researches on the Oxymuriatic Acid, Its Nature and Combinations, and on the Elements of the Muriatic Acid, with some Experiments on Sulphur and Phosphorus Made in the Laboratory of the Royal Institution.*

P. 285.

In the second volume of the Memoirs d'Arcueil, MM. Gay Lassac and Thenard have detailed an extensive series of facts upon muriatic acid and oxymuriatic acid. Some of their experiments are similar to those I have detailed in the paper just referred to; others are peculiarly their own and of a very curious kind; their general conclusion is that muriatic acid gas contains about $\frac{1}{4}$ of its weight of water; and that oxymuriatic acid is not decomposable by any substance but hydrogen or such as can form triple combinations with it.

3828 One of the most singular facts that I have observed on this subject, and which I have before referred to, is that charcoal, even when ignited to whiteness in oxymuriatic or muriatic acid gases by the voltaic battery, effects no change in them; if it has been previously freed from hydrogen and moisture by intense ignition *in vacuo.*

3829 *Watt's Dictionary of Chemistry, Vol.* 1, *London*, 1863, *pp.* 759 *and* 760.

Carbon.

Wood charcoal.—Wood consists of carbon, hydrogen and oxygen, the two latter being in the proportion to form water. When heated in the open air it burns completely away with the exception of a small quantity of white ash; but if the supply of air is limited only the more volatile ingredients burn away and a greater part of the carbon remains behind. This is the principle of the process of charcoal-burning as it is practiced in countries where wood is abundant, on the Harz mountains in Germany, for instance. A number of billets of wood are built up vertically in two or three rows into a large conical heap which is covered over with turf or moistened charcoal ash, holes being left at the bottom for

air to get in. A hollow space is also left in the middle of the heap to serve as a flue for the gaseous matters which are evolved. The heap is set on fire by throwing burning pieces of wood into the central opening near the top of which, however, a kind of grate made of billets of wood is placed to prevent the burning fuel from falling at once to the bottom. The cumbustion then proceeds gradually from the top to the bottom and from the centre to the outside of the heap; and as the central portions burn away fresh wood is continually thrown in at the top so as to keep the heat quite full. The appearance of the smoke shows how the combustion is proceeding; when it is going on properly the smoke is thick and white; if it becomes thin and especially if the blue flame appears it is a sign that the wood is burning away too fast; the combustion must then be checked by partially stopping up the holes at the bottom or by heaping fresh ashes on the top and sides, and pressing them down well so as to diminish the draft. As soon as the combustion is completed the heap is completely covered with turf
or ashes and left to cool for two or three days. It is then
3830 taken to pieces and the portions still hot are cooled by
throwing water or sand upon them. The quantity of charcoal thus obtained varies with the manner in which the combustion is conducted. 100 parts of wood yield on the average from 61 to 65 parts by measure or 24 parts by weight of charcoal. When the burning is very carefully conducted the quantity may amount to 70 per cent. by measure.

In England a large quantity of charcoal is obtained in the dry distillation of wood for the preparation of acetic acid. For this purpose the wood is heated to redness in cast-iron cylinders whereupon a number of volatile products are given off, including a large quantity of tarry matter and inflammable spirit called wood spirit or wood naphtha and acetic acid; and in the retorts there remains a quantity of charcoal.

For the manufacture of gunpowder charcoal is sometimes prepared by subjecting wood in iron cylinders to the action of overheated steam (Violette, Ann. Ch. Phys. (3) XXIII, 475.)

Wood charcoal is more or less compact according to the kind of wood from which it is formed. The lighter woods such as willow yield a very porous charcoal, having comparatively little power of conducting heat and electricity; boxwood on the contrary yields a very compact charcoal which is a good conductor of heat and electricity, and is admirably adapted for exhibiting a voltaic light. The density and conducting power of charcoal are greatly increased by exposing it in close vessels to a very high temperature. Charcoal retains the form and to a considerable extent the external structure of the wood so that a horizontal section exhibits distinctly the concentric rings and the traces of the medullary rays. When burned it leaves from 1 to 5 per cent. of ash. According to Berthier 1,000 parts of limewood leave 50 parts of ash; of oak, 25; birch 10; fir 8; hornbeam 26; beach 30.

3831 *Watt's Dictionary of Chemistry, London,* 1875, *Second Supplement.*

Carbon.

P. 255.

Carbon allotropic modifications.—Despretz found several years ago that all kinds of carbon heated in the electric arc of a battery of 500 to 600 Bunsen's elements soften and are ultimately converted into graphite. According to Bettendorf (Arch. Pharm., 2, CXLIV, 79), gas coke may be thus transformed by a battery of only 24 elements. When wood (of box, ash, hornbeam, elder, lilac or cork) or flax, hemp, cotton, paper or silk is placed in a porcelain tube, vapor of carbon sulphide passed over it at or during temperatures till all the air is driven out and the tube then slowly and gradually heated to redness for about an hour, the organic substance is found, after cooling, to be converted into a kind of coke, having the ring of steel, silver, &c., and a great power of conducting heat and electricity. When heated it gradually becomes incandescent throughout its whole mass, without taking fire at any particular part, and cools down as soon as the source of heat is removed; it might perhaps be used to form the carbon cylinders of Bunsen's battery. It exhibits metallic lustre on its surface, is denser than wood charcoal, and does not sensibly absorb gases. A kind of carbon which is a good conductor of heat and electricity, and does not absorb gases, is likewise obtained by strongly heating wood in a crucible filled with charcoal powder. Wood spirit, hydrocarbons, &c., likewise act like carbon sulphide in converting wood into elastic and conducting carbon. The wood spirit suffers decomposition at the same time, whereby the interior of the tube becomes coated with silver white threads of carbon about a centimeter long (Sidot. Compt., Rend. LXX, 605).

3832 "*Mechanic's Magazine,*" *Vol.* 44, *pp.* 312–316, *London,* 1846.

King's patent electric light (letters patent for Scotland, dated November 26, 1845; specification enrolled March 25, 1846).

The nature of this invention (a communication from abroad) is described generally as consisting in "the application of continuous metallic and carbon conductors intensely heated by the passage of a current of electricity to the purposes of illumination. The following details would be nearly in the words of the patentee:

Metallic conductors.—The metal most advantageous for the purpose is that which while it requires very high temperature for its fusion has but a feeble affinity for oxygen and offers a great resistance to the passage of an electric current. Platinum, though not so unfusible *is* iridium, has but little affinity for oxygen and offers a great resistance to the passage of the current; and as it is abundant and easily worked into the required form it is deemed prefer-

able to any other metal. The platinum should be worked into those exceedingly thin sheets known by the name of leaf platinum. This may be accomplished by the ordinary process of the gold-beater; but a more accurate method is to place a piece of platinum foil between two thick plates of rolled copper and reduce the whole to a thin sheet by rolling, when on separating the copper pieces the platinum leaf will be found of uniform thickness in every part. In this way it may be obtained so thin that on holding it before a printed page the letters can be distinguished through it. A strip is to be cut from one of those sheets of a width proportionate to the quantity of the current which with Daniel's cells 20 inches high and three inches in diameter is about ¼ of an inch and of a length proportionate to the intensity which, of course, varies with the number of cells. Great care must be taken to cut the platinum strips of an equal width throughout, and with a clean edge, and if
this is not carefully attended to the strip will be unequally
3833 heated and will be fused in one part before the other parts
have obtained a sufficiently high temperature to produce a brilliant light. Platinum strip is now to be suspended between two forceps in an instrument made for the purpose, one form of which is shown in section —— in the engraving annexed and marked No. 1; A is a square brass bar fixed into the wooden stand C, having a binding screw F attached to its lower end. The two arms E D are attached to sockets which slide on this bar so as to admit of their being placed at different distances from each other. They are both bent at right angles, as seen in the figure, and terminated by bright forceps tipped with platinum. These forceps are closed by the milled screws H I; the arm C has a rod N with a screw cut on it, passing through it, and by means of the two nuts B B working on this rod the arm may be adjusted to any required height and the distance between the forceps thus regulated. The rod passes through the stand and is attached to the binding screw G. The socket K is lined with ivory or some other non-conducting substance so as to prevent any metallic connection between the arm E and the bar; S is the strip of platinum leaf which is first clamped in the upper forceps; the arm E is now adjusted to any required height and the lower forceps are closed so as to clamp the lower end of the strip of platinum. It may now be included in the battery circuit by attaching one of the wires to the binding screw at F and the other to that at G. The current should be one of considerable intensity and the distance between the forceps should be sufficient to prevent the platinum being fused. The distance can be lessened by raising the arm E and shortening the strip of platinum until it attains the highest temperature it will bear without fusing; or the same object may be obtained by increasing the intensity of the current. The glass shade R which serves to screen the platinum from currents of air, dust, &c., may then *may* be placed over the apparatus as seen in figure 1.

Carbon conductors.—When carbon is used, it becomes necessary
on account of the affinity this substance has for oxygen at
3834 high temperature to exclude from it air and moisture. To

accomplish this in the most perfect manner it should be enclosed in a Torricellian vacuum. One form of the apparatus for this purpose is shown in section in the figure No. 2; *a*, is a glass tube similar to those used for barometers except that it has its upper end enlarged into a cy-ndrical bulb and a stout platinum wire sealed in at the top. A small cup for holding mercury is fixed on the top of this wire whose lower end screws in the iron piece *d*, to this piece the forceps *f* are attached and it is connected with a similar piece at *h* by a porcelain rod *i*. The forceps are attached to *h*, and clamped to the lower end of the carbon piece *c* which is its upper end, held by this at *f*; *n* is a copper wire which is fixed into the piece at *h* and extends to the bottom of the tube; the tube is filled with mercury in the same manner as a barometer, the usual precautions being taken to expel the air; its length independent of the bulb should be about thirty inches so that when it is inserted in a cup of mercury a vacuum will be formed in the bulb. The instrument is included in the battery circuit by connecting one of the wires from the battery with the cup fixed on the wire *e* and the other with the wire which passes into the mercury in the cup at the bottom of the tube. The circuit is thus completed by the column of mercury, and when it is depressed in the tube by the formation of vapor of the mercury in the bulb the action is preserved by the copper wire *n*; that form of carbon on the interior of coal-gas retorts which have long been used is well suited for this purpose and it may be worked into the form of either small pencils or thin plates by the aid of the saw and file. As carbon will bear a very high temperature without fusion or volatilization a much more intense light can be produced by this means than by platinum.

When an intermittent light for light-houses is required it may be obtained by breaking the circuit at intervals by clock-work; to effect this one of the wires from the battery is connected with a spring which is made to press on the circumference of a metallic wheel fixed on one of the arbors of the clock having certain
3835 portions of its surface cut away so as to break and close the
circuit at any required intervals. When the apparatus is suitably sealed it may be applied to submarine lighting and also to the lumination of places where it is necessary to guard against the inflammation of highly combustible or explosive compounds; as in powder magazines, mines, &c. When a current is of sufficient intensity two or more lights may be made in the same circuit, care being taken to regulate the power by increasing or diminishing the number of cells—if a voltaic battery is the source of electricity, or the number of armatures of a magneto-electric machine be used—so that the united resistance of the strips of platinum or carbon shall be sufficient to prevent the passage of such a quantity of electricity as would destroy them.

Claim.—"The application of continuous metallic and carbon conductors intensely heated by the passage of a suitably regulated current of electricity to the purposes of illumination as before mentioned."

Note by the Editor.

We fear that the project of lighting by electricity—now a very favored one with ingenious speculators and well deserving, doubtless, of every encouragement—is now likely to be much advanced by the present scheme. Both platinum and carbon have been before proposed to be employed as the illuminating bodies or media and both found objectionable—the former as yielding too feeble a light, and the latter a light which though brilliant is uncertain and, at best, of short duration. We subjoin two paragraphs from our common-place book which may suffice to show not only the want of novelty in Mr. King's imported invention but the point at which the labors of men of science in this department have arrived.

"1845, November 8, M. de la Rive is stated in the Moniteur Industriel to have succeeded in obtaining a brilliant light for lighting mines by the galvanic battery. His pile is composed of
3836 several concentric cylinders of copper or platina separated by
porous cylinders and forming a series of four or five couples. An amalgam of liquid zinc or potassium the positive metal; and a solution of sulphate of copper for copper cylinders and chloruret of platina for platina ones. The difficulties in maintaining a constant light have been overcome by employing small, hollow cylinders of coke similar to those used in Bunsen's pile but smaller and arranged like the wicks of a lamp and rings or discs of metal around these. The electric current passes between the two. The current must be made to pass from the coke cylinder that the particles of carbon which are carried off may fall again by their own weight. The whole is placed in a glass globe which must be hermetically sealed. There is no occasion to form a vacuum in it as the small portion of oxygen is soon absorbed; but it must be carefully excluded from the outer atmosphere. The pile is fitted with two metallic wires—one connecting with the cylinder of charcoal and the other with the metallic conductor."

1845, December 7.—Professor Groves soon after the publication of his nitric-acid battery was struck by the facility and constancy with which the voltaic arc could be obtained by that combination as compared with any previous one and made many attempts to reduce it to practical form for the purposes of illumination with, however, only limited success; charcoal as in M. de la Rive's experiment formed the terminals of the voltaic pile. Sometimes he could keep a constant light for four or five hours but it was never sure; from some unseen defect in the charcoal it would become suddenly extinct; the glass also became dull from carbon vapor which settled upon it; it was costly and not sufficiently portable. There were difficulties which he could not overcome and he proceeded to experimentalize on another method which struck him as likely to be more applicable to lighting mines; he substituted the voltaic ignition of a platinum wire for the disruptive discharge in place of the charcoal arrangement. The light from the platinum is doubtless inferior to

the carbon yet it is too intense for the naked eye to sup-
3837 port and employ sufficient for the miner to work by. His plan was to ignite a coil of platinum wire as near the point of fusion as practicable in a closed vessel of atmospheric air or other gas and by the light of which he states he has experimented and read for hours and the apparatus he used was as follows: At each end of a coil of platinum wire is affixed a copper wire of convenient length the lower ends of which are to be well varnished and inserted either through the bottom of a glass vessel or bent up along its sides and connected to each end of a nitric acid battery; water is then poured into the vessel and another glass inverted over the coil and its supports which the water thus hermetically seals and an ignited wire now gives a steady light without an alteration or inconvenience as long as the battery continues constant—the length of time being of course dependent on the quantity of electrolyte in the battery cells. The spirals of the coil should approximate as near as possible as each aids by its heat that of its neighbor and it should be as long as the battery is capable of igniting to a full incandescence. The helix form offers the advantages that the cooling effects being lessened a much longer wire can be ignited by the same battery; by this increased length of wire the battery fuel is economized while a greater light is afforded; by the increased heat the resistance is still further increased and the consumption still further diminished; so that contrary to the usual result the increment of consumption decreases with the exaltation of effect produced. The very necessity of enclosing the coil in a glass recipient also augments the heat, the light and the resistance. In experiment on the effect of different gases on radiant heat he found by filling the vessel with hydrogen, the coil was not even visible in the dark; an increase of volume by expansion took place from 35 to 43; in carbonic acid cherry red by daylight increased from 35 to 43; in oxygen by daylight 35 to 45; nitrogen the same; and atmospheric air the same as in oxygen. These appear important and satisfactory results, but actual practice on a larger scale can alone test their efficiency.

3838 (The Mining Journal) p. 348.

King's Patent Electrical Light.

SIR: In your last number are some remarks appended to the specification of Mr. King's patent for an electrical light where it appears to me you have overlooked the distinctive feature of this arrangement.

All the early attempts that have been made to effect this important and interesting object were founded on the well-known experiment of producing an arch of flame between two charcoal points forming the termination of the conducting wires of a battery; but they have failed in consequence of the difficulty of rendering the light permanent; for it is found that the substance of one of the points is carried away and deposited on the other which ultimately destroys the essential conditions of success, besides which the light frequently ceases without any apparent cause so that it cannot be depended upon with any degree of certainty even for a few minutes.

Mr. Starr (the inventor of this patented arrangement) has overcome the difficulty by using continuous metallic and carbon conductors sufficiently thin to be intensely heated by the passage of electricity through them. This every electrician will allow, differs essentially from the disruptive discharge taking place through the air as in the experiment with the charcoal points which was performed by Sir Humphrey Davy, and of which M. de la Rive's arrangement is only a slight modification.

The experiment of Professor Grove is without doubt the same in principle as that claimed by the patentee, the only difference (when the platinum is used) being in the form of the conductor which, however, affects the result as regards the quantity of the light produced very considerably. The experiment of Professor Grove was first made public on December 1st, 1845; but Mr. King's patent was sealed for England November 4th of the same year; so that the priority is unquestionable, as is also the novelty of the
3839 principle of obtaining light for the useful purposes from intensely heated continuous conductors. The claim is not for a new substance for producing the electrical light but for a new method. Carbon has long been used for the terminal points between which the light passes, but its application as a conductor itself to be rendered luminous by the passage of the electricity through it is unquestionably new. Respecting the utility of the invention it would at present be premature to offer any remarks, as it must be tried on a scale of magnitude similar to that which will be required for its ultimate application in order to fairly test it. This will very shortly be done as Mr. Starr is at present engaged in fitting up apparatus which will fully demonstrate it.

I may, however, observe that the light produced by the platinum in this arrangement is by no means favorable, for it exceeds in power any light at present used. That from the carbon is still more brilliant than the platinum and is not in the least degree uncertain; nor is there any reason to believe from the experiments already made that any change will take place in its substance, however long it may continue in operation. I hope shortly to be able to communicate definitely the results of these experiments and of others which are about to be made, as they will be found very interesting not only on account of their useful application but as affording very beautiful illustrations of the laws of electrical action and eliciting some new and important facts.

Yours respectfully, WILLIAM WILLIAMS.

1 Francis street Regents square, May 1st, 1846.

3840 DEFENDANT'S EXHIBIT PHILOSOPHICAL TRANSACTIONS, PAPER No. 1. W. T. F., Spec. Ex'r.

Philosophical Transactions of the Royal Society of London for the Year 1809.

Volume 9, Part I. Printed by W. Bulmer & Co., Cleveland road, St. James, London, England. Pages 32 to 38, inclusive.

II.—An account of some experiments performed with a view to ascertain the most advantageous method of constructing a voltaic apparatus for the purposes of chemical research, by John George Children, Esq., F. R. S.

Read November 24, 1808.

The late interesting discoveries by Mr. Davy having shown the high importance of the voltaic battery as an instrument of chemical analysis, it became a desirable object to ascertain that mode of constructing it by which the greatest effect may be produced with the least waste of power and expense.

For this purpose I made a battery on the new method with plates of copper and zinc connected together with leaden straps soldered on the top of each pair of plates; which are 20 in number, and each plate four feet high by two feet wide. The sum of all the surfaces being 92,160 square inches, exclusive of the single plate at each end of the battery. The trough is made of wood with wooden partitions well covered with cement to render them perfectly tight so that no water can flow from one cell to another. The battery was charged with a mixture of three parts fuming nitrous and one part sulphuric acid diluted with thirty parts of water and the quantity used was 120 gallons.

In the presence and with the kind assistance of Messrs. Davy, Allen and Pepys the following experiments were made:

Experiment 1. 18 inches of platina wire of one-thirtieth of an inch were completely fused in about twenty seconds.

3841 Exp. 2. Three feet of the same wire were heated to a bright red, visible by strong daylight.

Exp. 3. Four feet of the same wire were rendered very hot, but not perceptibly red by daylight. In the dark it would probably have bright red throughout.

Exp. 4. Charcoal burnt with intense brilliancy.

Exp. 5. On iron wire of about one-seventieth of an inch diameter the effect was strikingly feeble. It barely fused ten inches and had not power to ignite ten feet.

Exp. 6. Imperfect conductors were next submitted to the action of the battery and barytes mixed with the red oxide of mercury and made into a paste with pipe clay and water was placed in a circuit, but neither on this nor on any other similar substance was the slightest effect produced.

Exp. 7. The gold leaves of the electrometer were not affected.

Exp. 8. When the cuticle was dry no shock was given by this battery, and even though the skin was wet it was scarcely perceptible.

Before I offer any observations on the inferences to be drawn from these experiments I shall mention some others performed for the sake of comparison with the foregoing with an apparatus very different in size and number of plates from the one just described.

This second battery was precisely the Couronne des Tasses of Sig. Volta, consisting of 200 pairs of plates, each about two inches square, placed in half pots of common queensware, and made active by some of the liquor used in exciting the large battery to which was added a fresh portion of sulphuric acid equal to about a quarter of a pint to a gallon.

To state as shortly as possible the effects produced by this battery.

Experiment 1. It decomposed potash and barytes readily.

Exp. 2. It produced the metallization of ammonia with great facility.

Exp. 3. It ignited charcoal vividly.

3842 Exp. 4. It caused considerable divergence of the gold leaves of the electrometer.

Exp. 5. It gave a vivid spark after being in action three hours. At the expiration of twenty-four hours it retained sufficient power to metallize ammonia and continued with gradually decreasing energy to produce the same effect till the end of forty-one hours, when it seemed nearly exhausted.

From the results of the foregoing experiments which though simple and not numerous, I trust are satisfactory, we see Mr. Davy's theory of the mode of action of the voltaic battery confirmed. He says (in his paper on some chemical agencies of electricity, section 9, after having shown the effect of induction to increase the electricity of the opposite plates): "The intensity increases with the number and the quantity with the extent of the series."

That this is so, the effects produced on the platina and iron wires in the first and fifth experiments with the large battery and the subsequent experiments on imperfect conductors with the small apparatus sufficiently proved. The platina wire being a perfect conductor and not liable to be oxydated presents no obstacle to the free passage of the electricities through it, which, from the immense quantities given out from so large a surface evolved on their mutual annihilation heat sufficient to raise the temperature of the platina to the point of fusion.

With the iron wire of one-seventieth of an inch diameter, the effect is very different, which is explained by the low state of the intensity of the electricity (sufficiently proved by its not causing any divergence of the gold leaves of the electrometer), which being opposed in its passage by the thin coat of the oxide formed on the iron wire at the moment the circuit is completed, a very small portion only of it is transmitted through the wire. To the same want of intensity is to be attributed the total inability of the large battery

to decompose the barytes and its general weak action on bodies
which are not perfect conductors. The small battery on the
3843 contrary exerts great power on imperfect conductors, decom-
posing them readily, although its whole surface is more than thirty times less than that of the great battery; but in point of number of plates it consists of nearly ten times as many as the large one. The long-continued action of the small battery proves the utility of having the cells of sufficient capacity to hold a large quantity of liquor by which much trouble of emptying and filling the troughs is avoided, and the action kept up without intermission for a long space of time, a circumstance in many experiments of material consequence. Besides this advantage with very large combinations a certain distance between each pair of plates is absolutely necessary to prevent spontaneous discharges which will otherwise ensue accompanied with vivid flashes of electric light as I have experienced with a battery of 1,250 four-inch plates on the new construction. And here I beg leave to mention an experiment which though not directly in point cannot be considered as foreign to the subject of this paper. It has been urged as one proof of the non-identity of the common electricity and that given out by the voltaic apparatus that in the latter there is no striking distance. That objection, however, must cease. I took a small receiver open at one end, through perforations in the opposite sides of which were placed two wires with platina points well polished. One was fixed by cement to the glass, the other was movable by means of a fine screw through a collar of leathers, and the distances between the points was ascertained by a small micrometer attached. This receiver was inverted over well-dried potash over mercury, and suffered to stand a couple of days to deprive the air it contained as thoroughly as possible of moisture. The 1,250 plates being excited precisely to the same degree as the great battery mentioned in the beginning of this communication, and the little receiver placed in the circuit, I ascertain its striking distance to be one-fiftieth of an inch. That I might be certain that the air in the apparatus had not become a conductor by increase of temperature, I repeated the experiment several times
with fresh cool air and always with the same result; but
3844 perhaps it will be objected that the striking distance was so
small as not to afford a satisfactory refutation of the argument alluded to when it is considered to how very great a distance comparatively the spark of the common electrical machine can pass through air. The answer to this is obvious. Increase the number of the plates and the striking distance will increase, for we see throughout the intensity proportioned to the number, and it probably may be carried to such an extent as even to pass through a thicker plate of air than the common spark. The great similarity of the appearance of the electric light of this battery *in vacuo* and that of the common machine might also be urged as an additional proof of the identity of their nature.

The effect of this large combination on imperfect conductors was, as may be supposed, very great. Of the same platina wire of which the four-feet plates fused eighteen inches, this battery melted but half an inch, though had the effect been in the ratio of their surfaces it should have fused nearly fourteen inches.

The absolute effect of a voltaic apparatus, therefore, seems to be in the compound ratio of the number and size of the plates, the intensity of the electricity being *at* the former, the quantity given out as the latter; consequently regard must be had in its construction to the purposes for which it is designed. For experiments on perfect conductors very large plates are to be preferred, a small number ot wicks will probably be sufficient; but where the resistance of imperfect conductors is to be overcome, the combination must be great, but the size of the plates may be small, but if quantity and intensity be both required, then a large number of large plates will be necessary. For general purposes four inches square will be found to be the most convenient size.

Of the two methods usually employed, that of having the copper and zinc plates joined together only in one point and movable is much better than the old plan of soldering them together through the whole surfaces and cementing them into the troughs, as 3845 by the new construction the apparatus can be more easily cleaned and repaired and double quantity of surface is obtained. For the partitions in the trough glass seems the substance best adapted to secure a perfect insulation; but the best of all will be troughs made entirely of Wedgewood's ware, an idea I believe first suggested by Dr. Babington.

3846 DEFENDANT'S EXHIBIT PHILOSOPHICAL TRANSACTION PAPER No. 2. W. T. F., Spec. Ex'r.

Philosophical Transactions of the Royal Society of London for the Year 1815.

Volume 15, part I. Printed by W. Bulmer & Co., Cleveland road, St. James, London, England. Pages 363 to 374, inclusive.

XX.—An account of some experiments with a large voltaic battery by J. G. Children, Esq., F. R. S.

Read June 15, 1815.

In 1809 I presented to the society a short account of some experiments performed with a voltaic battery of unusually large plates, which has been honored by publication in the philosophical tranactions for that year. Since that period I have constructed another of still larger dimensions, the effects of which form the subject of the present communication. The copper and zinc plates of this apparatus are connected together in the usual order by leaden straps; they are six feet long by two feet eight inches broad, each plate presenting thirty-two square feet of surface. All the plates are attached to a strong wooden frame suspended by ropes and pulleys, which, being balanced by counterpoises is easily lowered and lifted so as to immerse the plates in the acid or raise them out of it at pleasure. The first trials of the power of this instrument were made in July, 1813, in the presence of several philosophical friends, but the effects then fell very short of my expectations, arising, as I afterwards found, from a defect in the construction, which has been since remedied and another copper plate added to each member of the series, so that every cell now contains one zinc and two copper plates, and each surface of zinc is opposed to a surface of copper. This was done at the suggestion of Dr. Wollaston and has very considerably increased the power of the battery. From some comparative experiments which I made with a small apparatus 3847 the increase in quantity of electricity thus effected is at least one-half. The cells of the battery are twenty-one in number and their united capacities amount to nine hundred and forty-five gallons. To each pole of the battery a lead pipe about three-quarters of an inch in diameter is attached by solder and the opposite end of each pipe immersed in a basin of mercury (a separate basin for each pipe), by means of which the circuit is completed and a perfect contact ensured. The first experiments I shall mention were made on the comparative facility with which different metals are ignited when placed in the electrical circuit. For this purpose in each experiment two wires of dissimilar metals were taken of equal diameter and length; one end of each was in contact with one of the basins of mercury communicating with the poles of the battery, and the other end bent to an angle and the wires connected continuously by hooking them together. The length of each wire was eight inches and the diameter one-thirtieth of an inch. The battery was moderately excited by a charge of one part acid diluted with forty parts of water.

Exp. 1. A platina and a gold wire being thus connected and introduced into the electrical circuit, the platina was instantly ignited, the gold remained unaffected.

Exp. 2. A similar arrangement of gold and silver wire. The gold was ignited, the silver not.

Exp. 3. The same with gold and copper. No perceptible difference in the state of ignition; both metals were heated red.

Exp. 4. Gold and iron. The iron was ignited; the gold unchanged.

Exp. 5. Platina and iron. The iron ignited instantly at the point of contact next the pole of the battery. Then the platina became ignited through its whole extent. After this the iron became more intensely heated than the platina and the ignition of the latter decreased.

Exp. 6. Platina and zinc. The platina was ignited. The zinc was not, but melted at the point of contact. In a subsequent experiment the zinc did not melt, but the platina ignited as before.

3848 Exp. 7. Zinc and iron. The iron was ignited; the zinc bore the heat without fusing.

Exp. 8. Lead and platina. The lead fused at the point of contact.

Exp. 9. Tin and platina. The tin fused at the point of contact. No ignition of either wire took place in the last two experiments.

Exp. 10. Zinc and silver. The zinc was ignited before it melted. The silver was not ignited.

The results in every case were the same to whichever pole of the battery either wire was presented. I varied these experiments by introducing several alternations of different wires continuously connected into the circuit and obtained in every instance analogous results. Thus:

Exp. 11. Alternations of platina and silver three times repeated; all the platina wires were ignited and none of the silver.

Exp. 12. One zinc wire between two platina; both the platina wires were ignited, the zinc not.

Exp. 13. One iron between two platina. Both the latter first ignited; then the iron, which soon became most heated and fused.

It is unnecessary to enter into a farther detail of these experiments; it will be sufficient to say generally that when wires of several different metals were introduced at once into a circuit the order of their ignition was precisely that of the former experiments. In one experiment with copper and gold, the copper was decidedly most heated.

I feel some difficulty in attempting an explanation of the preceding phenomena, and offer the following conjecture with diffidence. When a perfect communication is established between the poles of the battery, the electricity circulates without producing any visible effect; but if it meet with resistance in its passage it manifests itself by chemical action by the evolution of heat or both. Thus, if a bar of metal be connected with one pole of the battery and its extremity immersed in a basin of mercury connected with the other pole, at the instant the surfaces come in contact heat 3849 and light are evolved, which cease as soon as the bar, if it be of sufficient size, is fairly plunged beneath the surface of the quicksilver. If the circuit be completed by two pieces of charcoal, the evolution of heat and light is permanent as long as their surfaces remain in contact, because that contact can never be so perfect as to oppose no resistances to the electricity; whereas, in the case of the bar of metal and the mercury it soon became complete and the current is then uninterrupted. Resistance, therefore, appears to occasion the development of heat (whatever may be the ultimate cause of the phenomenon), and as this must be inversely as the conducting power when any two of the wires connected continuously are placed in the circuit, that which is the worst conductor must be most heated, and thus platina having the lowest conducting power is ignited before all the rest; and silver which conducts best is not heated red when connected with any of the other metals. Should it be objected that if the electricity meet with greater resistance in one body than in the other, equal quantities cannot be transmitted in equal times by the two substances (a circumstance essential to electrical action), I answer that a body may be propelled through two media of different densities with equal velocity if the propelling forces be proportionate to the resistances; and it is a necessary consequence that whatever effect the passage of the body was capable of producing in the least resisting medium it will produce it in a still greater degree in the most resisting; and if that effect be heat the greater portion will be developed in the latter instance. In the case in question, indeed, there is but one propelling force; but as it is sufficient to overcome the greater resistances the energy is unshaken. That the ignition of the wire is generally first perceptible at the point of contact next the pole of the battery (to whichever pole it be presented), is in favor of the hypothesis. I once thought the phenomenon might be owing to the joint effect of difference of conducting power and inequality of the different metals for heat; but the experiments of Crawford, Leslie, Dalton, Irvine and others, militate against that 3850 idea; for, according to them, the capacities of the iron and platina exceed those of all the other metals, whereas on the supposition alluded to they ought to be inferior. From the foregoing results the order of the conducting powers of the metals tried is silver, zinc, gold, copper, iron and platina. Tin and lead fuse so immediately at the point of contact that they cannot be placed. Between gold and copper the difference is trifling; and with regard to platina and iron their relations to each other in this circumstance seem to be affected by elevations of temperature. It may be observed that the order of the above metals as conductors of electricity nearly follows that of their powers to conduct heat.

In an experiment in which equal lengths of two platina wires of unequal diameter (the larger being one-thirtieth the smaller one-fiftieth of an inch), were placed together in the circuit parallel to each other, the thicker wire was ignited because it conveyed more electricity without proportional increase of cooling surface. When connected continuously the order of ignition was reversed. These two results were foreseen by Dr. Wallaston who suggested the experiments.

The experiments which I now proceed to mention were made with the battery in a high state of excitation; and I consider them as representing nearly the maximum of effect which it is capable of producing. As the quantity of acid was increased from time to time and that previously added often almost spent before fresh was put in, it is not easy to say exactly what proportion it bore to the water; perhaps the largest may be stated to be about one-twentieth. On this as on former occasions, I found a mixture of nitrous and sulphuric acids to produce the most powerful and permanent effects.

Exp. 1. Five feet six inches of platina wire, $\frac{11}{100}$ of an inch in diameter, were heated red throughout visible in full daylight.

Exp. 2. Eight feet six inches of platina wire, $\frac{44}{100}$ of an inch in diameter, were heated red.

3851 Exp. 3. A bar of platina one-sixth of an inch square and two and a quarter inches long was also heated red and fused at the end, and,

Exp. 4. A round bar of the same metal $\frac{276}{1000}$ of an inch in diameter and two and one-quarter inches in length was heated bright red throughout.

Exp. 5. Fine points of boxwood charcoal intensely ignited in chlorine neither suffered any change nor produced any in the gas. The result was similar when heated in azote.

I next tried the power of the battery to fuse several refractory substances. The subject of experiment was placed in a small cavity made in a piece of well-burnt boxwood charcoal floating on the surface of the mercury in one of the basins above mentioned and the circuit completed by another piece of charcoal communicating by stout copper wire with the other basin.

Exp. 1. Oxide of tungsten, which (as well as all the other metallic oxides operated on) had been previously intensely ignited in a charcoal crucible in a powerful furnace fused and was partially reduced. The metal grayish white, heavy, brilliant and very brittle.

Exp. 2. Oxide of tantalum. A very small portion fused. The grains have a reddish-yellow color and are extremely brittle.

Exp. 3. Oxide of uranium; fused but not reduced.

Exp. 4. Oxide of titanium; fused, not reduced, when intensely heated it burned, throwing off brilliant sparks like iron.

Exp. 5. Oxide of cerium; fused, and when intensely heated it burnt with a large vivid white flame, and was partly volatilized, but not reduced. The fused oxide on exposure for a few hours in the air fell into a light-brown powder containing numerous shining particles of a silvery lustre interspersed amongst it, and exhaled an odor similar to that of phosphuretted hydrogen.

Exp. 6. Oxyde of molybuena; readily fused and reduced. The metal is very brittle, of a steel-gray color, and soon becomes coated with a thin coat of purple oxide.

3852 Exp. 7. Compound ore of iridium and osmium; fused into a globule.

Exp. 8. Pure iridium; fused into an imperfect globule not quite free from small cavities and weighing 7.1 grains. The metal is white, very brilliant, and in its present state its specific gravity is 18.68 which must be much too low on account of porous state of the globule. In the minutes of the experiments in July, 1813, mention is made of the fusion of a small portion of pure iridium into a globule weighing $\frac{62}{100}$ of a grain which had been previously submitted to the action of a battery of 2,000 plates of four inches square without melting.

Exp. 9. Ruby and sapphire were not fused.

Exp. 10. Blue spinel ran unto a slag.

Exp. 11. Gadolinite fused into a globule.

Exp. 12. Magnesia was agglutinated.

Exp. 13. Zircon from Norway was imperfectly fused.

Exp. 14. Quartz, silex, and plumbago were not affected.

In the year 1796, M. Clouet, converted iron into steel by cementation with the diamond with the view of confirming the nature of that substance and of ascertaining the exact state in which the carbon exists in steel. Clouet had also previously formed steel by cementation with carbonate of lime. Mr. Mushet repeated this experiment, using instead of the carbonate caustic lime, and obtained also what he considered to be cast steel; whence he concluded that the carbon necessary to convert the iron into steel had not been fur-

nished as Clouet supposed by decomposition of the carbonic acid, but that it had found its way from the ignited gases of the furnace to the iron. This result occasioned suspicions of the accuracy of the deductions from the experiment with the diamond; and Mr. Moshet accordingly at the suggestion of the editor of the Philosophical Magazine repeated the experiment made at the Polytechnic School only keeping out the diamond. The results (for he made several experiments) uniformly gave him good cast steel, whence he concludes that we are still without any satisfactory or conclusive proof of the steelification of iron solely by means of the dia-
3853 mond; and adds that he doubts whether the diamond afforded even one particle of carbon to the iron. The details of both Clouet's and Mushet's experiments may be found in the fifth volume of the Philosophical Magazine. Sir George M'Kenzie repeated both Clouet's experiments, and those of Mr. Mushet and obtained results confirming the conclusions of the French chemists. The labors of this gentleman, indeed, seems sufficiently conclusive; but if a doubt should remain, it occurred to Mr. Pepys that the battery would afford an *experimentum crucis* on the subject; and his ingenuity readily suggested a mode of making it every way unobjectionable. He bent a wire of pure soft iron so as to form an angle in the middle in which part he divided it longitudinally by a fine saw. In the opening so formed he placed diamond powder securing it in its situation by two finer wires laid above and below it and kept from shifting by another small wire bound firmly and closely around them. All the wires were of pure soft iron and the part containing the diamond powder was enveloped by thin leaves of talc. Thus arranged the apparatus was placed in the electrical circuit when it soon became red hot and was kept so for six minutes. The ignition was so far from intense that few who witnessed the experiment expected, I believe, any decisive result. On opening the wire, however, Mr. Pepys found that the whole of the diamond had disappeared; the interior surface of the iron had fused into numerous cavities notwithstanding the very moderate heat to which it had been exposed; and all that part which had been in contact with the diamond was converted into perfect blistered steel. A portion of it being heated red and plunged into water became so hard as to resist the file and to scratch glass. This result is conclusive, for as the contact of any carbonaceous substance except the included diamond was effectually guarded against, to that alone can the change produced in the iron be referred. This experiment will also probably be deemed fatal to the opinion of those mineraleogists (if they do still maintain that opinion), who class the diamond with substances of siliceous genus.

3854 When dry caustic potash was exposed to the intense heat between the two pieces of charcoal, it fused and appeared to decompose, throwing off a large volume of the peculiar purple-red color that attends the combustion of potassium. When moist caustic potash was placed in the circuit the water only was decomposed.

I endeavored to ascertain if there be any difference in the degree of heat produced at either pole of the battery by placing two small earthenware cups, each containing an equal weight of mercury in the circuit and connected together by a platina wire of such size and length as to be kept constantly ignited. The mercury in the cup connected with the zinc end of the battery attained in twenty minutes the temperature of 120°; that in the other cup, 112°.

The battery, even in its most active state, communicated no charge to the Leyden foil.

I give the following experiment, the last with which I shall occupy the time of the society without comment.

I separated all the zinc from the copper plates by dividing the leaden straps that united them; and then by means of other leaden straps I connected all the zinc plates together as one plate, and all the copper plates in the same manner; thus reducing the whole battery to only two plates, each presenting a surface of 1,344 square feet, reckoning the copper surface as only equal to the zinc. When the plates thus arranged were suspended quite out of contact with the acid a communication was made between the two metallic surfaces by means of a platina wire $\frac{1}{5000}$ of an inch diameter and about $\frac{1}{30}$ of an inch long with every possible attention to ensure a perfect contact; but, although the experiment was made in the dark, not the slightest appearance of ignition was perceptible in the minute wire by which these extensive surfaces were connected. It is known, I believe, to almost every member of this society that Dr. Wollaston has shown with the delicate apparatus invented by him that the platina wire of the same dimensions as that just mentioned is instantly ignited by a single pair of plates one inch square on
3855 being immersed in a diluted acid. The ratio of the areas of
the plates of the respective batteries is 1 to 48,384. When the plates of the larger battery in the usual order of arrangement were immersed in mere pump water previous to any acid having been put into the cells, they ignited one-fourth of an inch of platina wire, $\frac{1}{200}$ of an inch diameter, and fused the end of it into a perfect globule.

3856 Defendant's Exhibit Philosophical Transactions, Paper No. 3. W. T. F., Spec. Ex'r.

Philosophical Transactions of the Royal Society of London.

Volume 20, published in London in 1820, under section 2, page 21—title, Comparative Experiments on the Illuminating and Heating Powers of Olefiant Coal and Oil Gases and on some General Properties of Radiant Matter, at pages 26 and 27.

10. There are certain substances, the chemical relations of which are singularly affected by the influence of direct solar rays. Among these the mixture of chlorine and hydrogen is most remarkable: If kept in common daylight but out of direct sunshine, the gases do not act upon each other; but the moment the mixture is placed in the sunshine the muriatic acid begins to be formed. I therefore hoped that this property might be applicable in certain photomet-

rical experiments. I exposed a mixture of equal volumes of chlorine and hydrogen in a tube inverted over water capable of holding about four cubical inches and blown into a thin bulb at its upper extremity to the brilliant effects produced by a large olefiant gas flame; it was exposed for 15′, but underwent no other change than a slight increase of bulk, acting as an air thermometer.

11. It now occurred to me to try how far any effect would be produced by the more intense light of the voltaic battery, and I placed the tube containing the mixed gases in a darkened room within about an inch of the charcoal points connected with an apparatus of 100 pairs of plates highly charged; upon making the contact the effect of the light upon the mixed gases was very remarkable; fumes of muriatic vapor were instantly produced, the water rose in the tube in consequence of the production of muriatic acid, and in about five minutes the absorption was entire; but the most curious circumstances was that in two instances an explosion of the gases took place the moment they felt the impulse of the electric light.

3857 DEFENDANT'S EXHIBIT PHILOSOPHICAL TRANSACTIONS, PAPER NO. 4. W. T. F., Spec. Ex'r.

Philosophical Transactions of the Royal Society of London for the Year 1821.

Part I, volume 21, pages 425 to 439, inclusive.

XXIX.—Farther researches on the magnetic phenomena produced by electricity; with some new experiments on the properties of electrified bodies in their relations to conducting powers and temperature, by Sir Humphrey Davy, bart., F. R. S.

Read July 5, 1821.

I. In my letter to Dr. Wollaston on the new facts discovered by M. Oersted, which the society has done me the honor to publish, I mentioned that I was not able to render a bar of steel magnetic by transmitting the electrical discharge across it through a tube filled with sulphuric acid; and I have likewise mentioned that the electrical discharge passed across a piece of steel through air rendered it less magnetic than when passed through a metallic wire; and I attributed the first circumstance to the sulphuric acid being too bad a conductor to transmit a sufficient quantity of electricity for the effect; and the second to the electricity passing through the air in a more diffused state than other metals.

To gain some distinct knowledge on the relations of the different conductors to the magnetism produced by electricity, I instituted a series of experiments which led to very decisive results, and confirmed my first views.

II. I found that the magnetic phenomena were precisely the same whether the electricity was small in quantity and passing through good conductors of considerable magnitude; or whether

the conductors were so imperfect as to convey only a small quantity of electricity; and in both cases they were neither attractive of
each other nor of iron filings, and not affected by the mag-
3858 net; and the only proof of their being magnetic was their
occasioning a certain small deviation of the magnetized needle.

Thus, a large piece of charcoal placed in the circuit of a very powerful battery being a very bad conductor compared with the metals, would not affect the compass needle at all unless it had a very large contact with the metallic part of the circuit; and if a small wire was made to touch it in the circuit, only in a few points that wire did not gain the power of attracting iron filings; though when it was made to touch a surface of platinum foil coiled around the end of the charcoal a slight effect of this kind was produced. And in a similar manner fused hydrate of potassa, one of the best of the imperfect conductors, could never be made to exert any attractive force on iron filings; nor could the smallest filaments of cotton moistened by a solution of hydrate of potassa placed in the circuit be made to move by the magnet; nor did steel needles floating on cork on an electrized solution of this kind placed in the voltaic circuit gain any polarity; and the only proof of the magnetic powers of electricity passing through such a fluid was afforded by its effect upon the magnetized needle when the metallic surfaces plunged in the fluid were of considerable extent. That the mobility of the parts of fluids did not interfere with their magnetic powers as developed by electricity, I prove by electrifying mercury and Newton's metal fused in small tubes. These tubes, placed in a proper voltaic circuit, attracted iron filings and gave magnetic power to needles; nor did any agitation of the mercury or metal within either in consequence of mechanical motion or heat, alter or suspend their polarity.

III. Imperfect conducting fluids do not give polarity to steel when electricity is passed through them; but electricity passed through air produces this effect. Reasoning on this phenomenon and on the extreme mobility of the particles of air, I concluded, as M. Arrago had likewise done, from other considerations that the voltaic current in air would be affected by the magnet. I failed in my first
trial, which I have referred to in a note to my former paper,
3859 and in other trials made since, by using too weak a magnet;
but I have lately had complete success; and the experiment exhibits a very striking phenomenon.

Mr. Pepys having had the goodness to charge the great battery of the London institution, consisting of 2,000 double plates of zinc and copper, with a mixture of 1,168 parts of water, 108 parts of nitrous acid and 25 parts of sulphuric acid, the poles were connected by charcoal so as to make an arc or column of electrical light varying in length from one to four inches, according to the state of rarefication of the atmosphere in which it was produced; and a powerful magnet being presented to this arc or column having its pole at a very acute angle to it, the arc or column was attracted or repelled with a rotary motion, or made to revolve by placing the poles in different positions according to the same law as the electrified cylinders of platinum described in my last paper, being repelled when the negative pole was on the right hand by the north pole of the magnet, and attracted by the south pole and *vice versa*.

It was proved by several experiments that the motion depended entirely upon the magnetism and not upon the electrical inductive power of the magnet, for masses of soft iron or of other metals produced no effect.

The electrical arc or column of flame was more easily affected by the magnet, and its motion was more rapid when it passed through dense than through rarefied air; and in this case the conducting medium or chain of aeriform particles was much shorter.

I tried to gain similar results with currents of common electricity sent through flame and *in vacuo*. They were always affected by the magnet; but it was not possible to obtain so decided a result as with voltaic electricity, because the magnet itself became electrical by induction and that whether it was insulated or connected with the ground.

(FOOT-NOTE.—I made several experiments on the effects of currents of electricity simultaneously passing through air in different states of rarefication in the same and different directions, both from
the voltaic and common electrometers; but I could not es-
3860 tablish the fact of their magnetic attractions or repulsions
with regard to each other, which probably was owing to the impossibility of bringing them sufficiently near.)

IV. Metals, it is well known, readily transmit large quantities of electricity, and the obvious limit to the quantity which they are capable of transmitting seems to be their fusibility or volatilization by the heat which electricity produces in its passage through bodies.

Now, I had found in several experiments that the intensity of this heat was connected with the nature of the medium by which the body was surrounded; thus, a wire of platinum which was readily fused by transmitting the charge from a voltaic battery in the exhausted receiver of an air pump, acquired in air a much lower degree of temperature. Reasoning on this circumstance, it occurred to me that by placing wires in a medium much denser than air, such as ether, alcohol, oils or water, I might enable them to transmit a much higher charge of electricity than they could convey without being destroyed in air, and thus not only gain some new results as to the magnetic state of such wires, but likewise perhaps determine the actual limits to the powers of different bodies to conduct electricity and the relations of these powers.

A wire of platinum of three inches in length was fused in air by being made to transmit the electricity of two batteries of ten zinc plates of four inches, with double copper strongly charged; a similar wire was placed in sulphuric ether and the charge transmitted through it. It became surrounded by globules of gas, but no other change took place, and in this situation it bore the discharge from twelve batteries of the same kind exhibiting the same phenomena. When only about an inch of it was treated by this high power in ether it made the ether boil and became white hot under the globules of vapor, and then rapidly decomposed the ether, but it did not fuse. When oil or water was substituted for the ether, the length of the wire remaining the same, it was partially covered with small globules of gas, but did not become red hot.

3861 Though, on trying the magnetic powers of this wire in water, they were found to be very great, and the quantity of iron filings that it attracted was such as to form a cylinder round it of nearly the tenth of an inch in diameter.

To ascertain whether short lengths of fine wire, prevented from fusing by being kept cool, transmitted the whole electricity of powerful voltaic batteries, I made a second independent circuit from the ends of the battery with silver wires in water, so that the electrical decomposition of the water indicated a residuum of electricity in the battery. Operating in this way, I found that an inch of wire of platinum of one two hundred and twentieth, kept cool by water, left a great residual charge of electricity in a combination of twelve batteries of the same kind as those above mentioned, and after making several trials I found that it was barely adequate to discharge six batteries.

V. Having determined that there was a limit to the quantity of electricity which wires were capable of transmitting, it became easy to institute experiments on the different conducting powers of different metallic substances, and on the relation of this power to the temperature, mass, surface or length of the conducting power and to the conditions of electro-magnetic action.

These experiments were made as nearly as possible under the same circumstances, the same connecting copper wires being used in all cases, their diameter being more than $\frac{1}{10}$ of an inch and the contact being always preserved perfect; and parts of the same solutions of acid and water were employed in the different batteries and the same silver wires and broken circuit with water were employed in the different trials, and when no globules of gas were observed upon the negative silver wire of the second circuit it was concluded that the metallic conducting chain or the primary circuit was adequate to the discharge of the combination. To describe more minutely all the precautions observed would be tedious to those persons who are accustomed to experiments with the voltaic apparatus, and unintelligible to others; and after all, in researches of
this nature it is impossible to gain more than approxima-
3862 tions to true results, for the gases disengaged upon the plates
the different distances of the connecting plates and the slight difference of time in making the connections all interfere with their perfect accuracy.

The most remarkable general result that I obtained by these researches and which I shall mention first, as it influences all the others, was that the conducting power of metallic bodies varied with the temperature and was lower in some inverse ratio as the temperature was higher.

Thus a wire platinum of $\frac{1}{220}$ and 3 inches in length when kept cool by oil discharged the electricity of two batteries or of twenty double plates; but when suffered to be heated by exposure in the air, it barely discharged one battery.

Whether the heat was occasioned by the electricity or applied to it from some other source, the effect was the same. Thus, a wire of platinum of such length and diameter as to discharge a combination without being considerably heated, when the flame of a spirit lamp was applied to is so as to make a part of it red hot, lost its power of dischargiug the whole electricity of the battery as was shown by the disengagement of abundance of gas in the secondary circuit, which disengagement ceased as soon as the source of heat was withdrawn.

There are several modes of exhibiting this fact so as to produce effects which, until they are witnessed, must almost appear impossible. Thus, let a fine wire of platinum of four or five inches in length be placed in a voltaic circuit so that the electricity passing through it may heat the whole of it to redness and let the flame of a spirit lamp be applied to it so as to heat that part to whiteness, the rest of the wire will instantly become cooled below the point of visible ignition. For the converse of the experiment let a piece of ice or stream of cold air be applied to a part of the wire, the other parts will immediately become much hotter, and from a red will rise to a white heat. The quantity of electricity that can pass through that part of the wire submitted to the changes of temperature is so much smaller when it is hot than when it is 3863 cold that the absolute temperature of the whole wire is diminished by heating a part of it, and *vice versa* increased by cooling a part of it.

In comparing the conducting powers of different metals, I found much greater difference than I had expected. Thus, six inches of silver wire of one two hundred and twentieth discharged the whole of the electricity of 65 pairs of plates of zinc and double copper made active by a mixture of about one part of nitric acid of commerce, and 15 parts of water. Six inches of copper wire of the same diameter discharged the electricity of 56 pairs of the same combination, six inches of tin of the same diameter carried off that of 12 only, the same quantity of wire of platinum that of 11, and of iron that of 9. Six inches of wire of lead of $\frac{1}{200}$ seemed equal in their conducting powers to the same length of copper wire of $\frac{1}{220}$. All the wires were kept as cool as possible by immersion in a basin of water.

(FOOT NOTE.—Water is so bad a conductor that in experiments of this kind its effect may be neglected altogether; and these effects were equal in all the experiments.)

I made a number of experiments of the same kind, but the results were never precisely alike, though they sometimes approached very near to each other. When the batteries were highly charged so that the intensity of the electricity was higher, the differences were less between the best and worst conductors, and they were greater when the charge was extremely feeble. Thus, with a fresh charge of about one part of nitric acid, and nine parts of water wires of $\frac{1}{220}$ of silver and platinum of 5 inches long discharged respectively, the electricity of thirty and seven double plates.

Finding that when different portions of the same wire plunged in a non-conducting fluid were connected with different parts of the same battery equally charged, their conducting powers appeared in the inverse ratio of their lengths; so when 6 inches of wire of platinum of $\frac{1}{220}$ discharged the electricity of ten double plates, 3
3864 inches discharged that of 20, $1\frac{1}{2}$ inch, that of forty, and 1
inch that of sixty; it occurred to me that the conducting powers of the different metals might be more easily compared in this way, as it would be possible to make the contacts in less time than when the batteries were charged, and, consequently, with less variation in the charge.

Operating in this way, I ascertained that in discharging the electricity of 60 pairs of plates, 1 inch of platinum was equal to about 6 inches of silver, to $5\frac{1}{2}$ inches of copper, to four of gold, to 3.8 of lead, to about $\frac{9}{10}$ of palladium, and $\frac{8}{10}$ of iron, all the metals being in a cooling fluid medium.

I found, as might have been expected, that the conducting power of a wire for electricity in batteries of the size and number of plates just described, was nearly directly as the mass; thus, when a certain length of wire or platinum discharged one battery, the same length of wire of six times the weight discharged 6 batteries; and the effect was exactly the same, provided the wires were kept cool, whether the mass was a single wire or composed of six of the smaller wires in contact with each other. This result alone showed that surface had no relation to conducting power, at least for electricity of this kind, and it was more distinctly proved by a direct experiment; equal lengths and equal weights of wire of platinum, one round and one flattened by being passed transversely through rollers so as to have six or seven times the surface, were compared as to conducting powers. The flattened wire was the best conductor in air, from its greater cooling powers, but in water no difference could be perceived between them.

VI. I tried to make a comparison between the conducting powers of fluid menstrua and charcoal and those of metals. Six inches of platinum foil $1\frac{1}{5}$ inches broad were placed in a vessel which could be filled with any saline solution, and a similar piece of platinum
placed opposite at an inch distant; the whole was then made
3865 part of a voltaic circuit, which had likewise another termina-
tion by silver wires in water, and a solution of salts added till gas ceased to be liberated from the negative silver wire. In several trials of this kind it was found that the whole of the surface of six inches, even with the strongest solutions of common salt, was insufficieut to carry off the electricity even of two pairs of plates only, whereas an inch of wire of platinum of $\frac{1}{220}$ (as has been stated) carried off all the electricity of sixty pairs of plates. The gas liberated upon the surface of metals when they are placed in

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(Foot Note.—A foot of this wire weighed 1.13 grains. A foot of the other 6.7 grains).

fluid renders it impossible to gain accurate results, but the conducting power of the best fluid conductors, it seems probable from this experiment, must be some hundreds of thousand times less than those of the worst metallic conductors.

A piece of well-burnt compact boxwood charcoal was placed in the circuit, being $\frac{3}{10}$ of an inch wide by $\frac{1}{10}$ thick, and connected with large surfaces of platinum. It was found that 1 inch and $\frac{2}{10}$ carried off the same quantity of electricity as 6 inches of wire of platinum of $\frac{1}{220}$.

VII. I made some experiments with the hope of ascertaining the exact change of ratio of the conducting powers dependent upon the change of the intensity and quantity of electricity, but I did not succeed in gaining any other than the general result, that the higher the intensity of the electricity the less difficulty it had in passing through bad conductors, and several remarkable phenomena depend upon this circumstance.

Thus in a battery where the quantity of the electricity is very great and the intensity very low, such as one composed of plates of zinc, zinc and copper are arranged as to act only as single plates of from 20 to 30 feet of surface each and charged by a weak mixture of acid and water. Charcoal made to touch only in a few points is almost as much an insulating body as water and cannot be ignited, nor can wires of platinum be heated when their diameter is less than $\frac{1}{80}$ of an inch and their length 3 or 4 feet, and a foot of platinum wire of $\frac{1}{30}$ is scarcely heated by such a battery, whilst the
same length of silver wire of the same diameter is made red
3866 hot, and the same lengths of thicker wires of platinum or
iron are intensely heated.

The heat produced where electricity of considerable intensity is passed through conductors must always interfere with the exact knowledge of the changes of their conducting powers, as is proved by the following experiment. A battery of twenty pair- of plates of zinc and copper plates ten inches by six was very highly charged with a mixture of nitric acid and water, so as to exhibit a considerable intensity of electrical action, and the relative conducting powers of silver and platinum in air and water ascertained by means of it. In air six inches of wire of platinum of $\frac{1}{80}$ discharged only four double plates, whilst six inches of silver wire of the same diameter discharged the whole combination; the platinum was strongly ignited in this experiment, whilst the silver was scarcely warm to the touch. On cooling the platinum wire by placing it in water, it was found to discharge ten double plates. When the intensity of the electricity is very high, however, even the cooling powers of fluid media are of little avail; thus, I find that fine wire of platinum was fused by the discharge of a common electrical battery under water; so that the conducting power must always be diminished by the heat generated in a greater proportion as the intensity of the electricity is higher.

It might at first be supposed that when a conductor placed in the circuit left a residu-m of electricity in any battery increase of the power of the battery or of its surface could not enable it to carry through any additional quantity. This, however, is far from being the case.

When saline solutions were placed in the circuit of a battery of twenty plates, though they discharged a very small quantity only of the electricity when the troughs were only one-quarter full, yet their chemical decomposition exhibited the fact of a much larger quantity passing through them when the cells were filled with fluid.

And a similar circumstance occurred with respect to a wire
3867 of platinum, of such a length as to leave a considerable residuum
in a battery when only half its surface was used; yet, when the whole surface was employed it became much hotter and nevertheless left a still more considerable residuum.

VIII. I found long ago that in increasing the number of alternations of similar plates, the quantity of electricity seemed to increase as the number, at least as far as it could be judged of by the effects of heat upon wires; but only within certain limits, beyond which the number appeared to diminish rather than increase in quantity. Thus, the 2,000 double plates of the London institution when arranged as one battery would not ignite so much wire as a single battery of ten plates with double copper.

It is not easy to explain this result. Does the intensity mark the rapidity of the motion of the electricity, or merely its diminished attraction become less in proportion as the circuit through which it passes or in which it is generated contains a greater number of alternations of bad conductors?

Mr. Children in his account of the experiments made with his battery of large plates has ingeniously referred the heat produced by the passage of electricity through conductors to the resistance it meets with and has supposed what proves to be the fact that the heat is in some inverse ratio to the conducting power. The greatest heat, however, is produced in air, where there is reason to suppose the least resistance; and as the presence of heat renders bodies worse conductors another view may be taken—namely, that the excitation of heat occasions the imperfection of the conducting power. But till the causes of heat and of electricity are known, and of that peculiar constitution of matter which excites the one and transmits or propagates the other, our reasoning on this subject must be inconclusive.

I found that when equal portions of wires of the same diameter, but of different metals, were connected together in the circuit of a powerful voltaic battery acting as two surfaces, the metals were heated
in the following order: Iron most, then palladium, then plat-
3868 ina, then tin, then zinc, then gold, then lead, then copper,
and silver least of all. And from one experiment in which similar wires of platinum and silver joined in the same circuit were placed in equal portions of oil, it appeared that the generation of heat was nearly inversely as their conducting power. Thus the silver raised the temperature of the oil only 4°, whilst the platinum raised it 22°. The same relations to heat seem to exist whatever is the intensity of the electricity; thus, circuits of wire placed under

water and acted on by the common electrical discharge were heated in the same order as by the voltaic battery, as was shown by their relative fusion; thus iron fusing before platinum, platinum before gold and so on.

If a chain be made of wire of platinum and silver, in alternate links soldered together the silver wire being four or five times the diameter of the platinum, and placed in a powerful voltaic circuit, the silver links are not sensibly heated, whilst those of the platinum become intensely and equally ignited. This is an important experiment for investigating the nature of heat. If heat be supposed a substance, it cannot be imagined to be expelled from the platinum, because an unlimited quantity may be generated from the same platinum, *i. e.*, as long as the electricity is excited or as often as it is renewed. Or if it be supposed to be identical with or an element of electricity, it ought to bear some relation to its quantity, and might be expected to be the same in every part of the chain or greatest in those parts nearest the battery.

IX. The magnetism produced by electricity. though with the same conductors, it increases with the heat, as I mentioned in my last paper, yet with different conductors I find it follows a very different law. Thus, when a chain is made of different conducting wires and they are placed in the same circuit, they all exhibit equal magnetic powers and take up equal quantities of iron filings, so that the magnetism seems directly as the quantity of electricity which they transmit. And when in a highly powerful voltaic battery, wires of the same diameters and lengths, and of 3869 which the best conducting is incapable of wholly discharging the battery, are made separately and successively to form the circuit, they take up different quantities of iron filings in some direct proportion to their conducting powers.

Thus, in one experiment two inches of wire of $\frac{1}{30}$ of an inch being used, silver took up 32 grains, copper 24, platinum 11, and iron 8.2.

3870 DEFENDANT'S EXHIBIT PHILOSOPHICAL TRANSACTIONS, PAPER No. 5. W. T. F., Spec. Ex'r.

Philosophical Transactions of the Royal Society of London for the Year 1839.

Part I, vol. 39, page 89. Fifth letter on voltaic combinations, with some account of the effects of a large constant battery. Addressed to Michael Faraday, Esq., D. C. L., F. R. S., Fullerian prof. chem., Royal institution, &c., &c., &c. By J. Frederick Daniell, Esq., F. R. S., prof. chem. in Kings college, London. Received April 11. Read May 30, 1839.

MY DEAR FARADAY: In my last letter to you which the Royal society have done me the honor to publish in the Philosophical Transactions for 1838, I observed that the "principal circumstance which might be supposed to limit the power of an active combination within a conducting sphere in any given electrolyte is the resistance of that electrolyte which increases in a certain ratio to its depth or thickness." The superficial measure of the conducting sphere and the distance of the generating metal or the depth and resistance of the electrolyte are in fact vari-ble conditions in a voltaic combination upon which its efficiency depends; and their relations require further investigation before we shall be able to determine what may be the proper proportions for the economical application of the power to useful purposes. I shall venture, therefore, to trouble you with results of some further experiments upon the subject and upon different combinations of the constant battery before I proceed to communicate some observations upon electrolysis which I trust you will find not without interest and to which according to my plan my attention has been lately exclusively directed.

3871 Looking for a moment upon the affinity which circulates in the battery as a radiant force, it seemed desirable to ascertain what would be the result of intercepting the rays by the conducting surface nearer to their centre than in the arrangements which have been previously described as the relation of the generating and conducting metals to each other might be thereby more clearly ascertained.

For this purpose, I constructed a battery of ten cylinders of copper 19 inches in length by 1½ inches in diameter. As the quantity of acid and sulphate of copper which the cylinders could contain was too small it was necessary to provide for the perpetual renovation of the charge as the zinc became dissolved and the copper precipitated. This was effected by connecting all the membranes which held the acid and the zinc rods at their lower end with a pipe terminating in a stop-cock. Their upper ends were fixed in a cistern from which they could be gradually supplied with fresh acid as the saturated acid flowed out below. All the exterior cells formed between the membrances and the copper cylinders also terminated below in a common reservoir surrounding the former pipe by which their exhausted contents could be drawn off as a fresh supply of sulphate of copper was furnished from above by an exterior cistern holding the solution. When the battery was in action a saturated solution of sulphate of copper thus supplied from the top could be drawn off almost colorless at the bottom; and it remained constant for a considerable time.

The effect produced was 4½ inches of mixed gases per minute measured in the vol*l*ameter formerly described.

I compared this result with that obtained from a battery of ten cylinders 20 inches in length and 3½ inches in diameter which gave in the same vol*l*ameter 11 cubic inches per minute. The surfaces of the conducting cylinders were respectively 89.5 square inches and 220 square inches; and the products of gases in equal times were nearly in the same proportion as the surfaces. The zinc rods were 1½ inches in diameter in both cases.

3872 I next proceeded to compare two small hemispheres of copper with the large hemisphere of brass of 9½ inches in diameter, formerly described. They were fitted up as before as single circuits with a zinc ball of 1 inch diameter first placed in the membranes below the surface of the solution of copper. The measure made use of was the calorific galvanometer; the first was 4 inches diameter and produced a permanent effect of 45° upon the thermometer. The second of 2½ inches diameter produced an effect of 29°. The effect of the large hemisphere was 90°. Here it will be observed that the action was by no means proportioned to the surfaces of the conducting hemispheres, but approximated more nearly to the simple ratios of their diameters.

Hence, it would appear that the circulating force of both a simple and compound voltaic circuit increased with the surface of the conducting plate surrounding an actual centre; but the experiments are not sufficient to determine the law of the increase.

I now constructed a battery of ten larger cylinders of four inches diameter, the arrangement in everything being the same as before; I found that the action was reduced to one-half the amount of mixed gases in the vol*t*ameter per minute being only 5½ cubic inches. The experiments were repeated several times, and the action maintained for several hours and always with consistent results. This extraordinary and sudden decline of force requires further investigation; and indeed the only conclusion which we can at present draw from the experiments which I have just detailed, but which is of considerable practical importance, is that cylinders of 3½ inches diameter form much more effective producing plates in a voltaic arrangement than cylinders of either greater or less diameter. It must, however, be borne in mind that this has only been proved by a series of ten cells; for it is highly probable that the limits of efficiency may change with the number of the series.

The following experiments with the different combinations which may be made with twenty cylinders throw some light on the 3873 question of the influence of the numbers of a series, the diameter of the numbers of which is limited to 3½ inches. The cylinders were 20 inches in height and the zinc rods were ⅝ of an inch in diameter. The electrolyte consisted of eight parts of water and one part of oil of vitriol by measure, and in the exterior divisions of the cells was a saturated sulphate of copper. The temperature was about 65°; the duration of each experiment was one minute.

First Set of Experiments.

No. of cells	1	2	3	4	5	10	15	20
Cubic inches of gas	0	Just visible.	1⅛	3⅞	6	12¼	15⅓	17¼

Second Set of Experiments.

	All cells direct.	1 inverted.	2 invert.	3 invert.
Cubic inches of gas	17½	15½	12¾	10½

	4 invert.	5 invert.	6 invert.	7 invert.	8 invert.
Cubic inches of gas	8½	5½	3½	15⅛	1⅛

	9 invert.
Cubic inches of gas	Just visible.

Third Set of Experiments.

Number of double cells	5	10
Cubic inches of gas	11	20

Fourth Set of Experiments.

	5 triple cells.	5 quadruple cells.
Cubic inches of gas	14½	15⅔

When a series of 5 single cells was connected with a series of 5 double cells and the same voltameter employed the amount of gas was 15⅔ cubic inches. Each double series alone gave 11 cubic inches.

From these experiments it appears that the most advantageous adjustment of active force and resistance is in the series of ten single cells when they are of the diameter of 3½ inches, and that the largest amount of work which can be derived from twenty such cells is when they are arranged in two series of ten; for

3874

Cells.	Cubic in.	Cells.	Cubic in.	Cells.	Cubic in.
10 give	12½	5 give	6	4 give	3⅞
	2		4		5
20	25	20	24	20	19⅜

20 in single series give 17½ cubic inches. 10 double cells give 20 cubic inches.

Cells.	Cubic in.	Cells.	Cubic in.
5 double give	11	5 quadruple give	15⅔
	2		
20	22	20	15⅔

I now combined in a single series a battery of 70 cells of the same dimensions and charged in the same manner for the purpose of observing chiefly the effects of light and heat produced by the current, in a state of high intensity and constant action. The interior cells were formed of light porous earthenware and answered their purpose perfectly, offering no more obstruction to the current than the membranes and being much more convenient in use.

The quantity of decomposition per minute from a voltameter with the usual charge of dilute acid was only 17 cubic inches; while with distilled water the passage of a current was scarcely indicated by a few bubbles of gas which arose from the electrodes.

The flame between charcoal points was of considerable volume and formed a continuous arch when the points were separated to about three-quarters of an inch. This striking distance did not appear to be increased in the flask exhausted by the air pump. The light and radiant heat were most intense and proved highly injurious — the eyes of many of the party who did me the honor of assisting me in my experiments. In my own case, although protected by dark gray glasses of double thickness, a high state of inflammation was produced, which it required very active medical treatment to subdue; and as you well know in others even the application of leeches was found to be necessary. The whole of my face was also scorched and inflamed as if it had been exposed for

many hours to a bright midsummer sun. When reflected
3875 from an imperfect parabolic metallic mirror in a lantern the
rays were collected into a focus by a glass lens and readily
burnt a hole in paper at many feet from their source. The heat was quite intolerable to the hand when held near the lantern.

Paper steeped in nitrate of silver and afterwards dried was speedily burnt brown in the light; and when a piece of fine wire gauze was held before it the pattern of the latter appeared in white lines corresponding to the parts which it protected.

The phenomenon of the transfer of the charcoal from one electrode to the other, which I believe was first remarked by Dr. Hare, was abundantly produced. The transfer took place from the zincode (or positive pole, or charcoal connected with the last copper cylinder of the battery) to the platinode (the negative pole, or charcoal connected with the last zinc rod of the battery).

(FOOT-NOTE.—I have so strongly felt the want of some distinctive names for the two poles of the battery consistent with the principles of nomenclature which you have adopted, that I have ventured to propose those mentioned above and have constantly used them in my lectures. The anode and cathode have relations to the surfaces of the electrolyte, and if we distinguish the electrodes themselves as the anelectrode and the cathelectrode confusion is apt to arise; I find practically that students easily recollect that the zincode is that electrode which in the regular battery would be constructed of zinc and the platinode of platinum.)

And in the former a sharp well-defined cup-like cavity was produced and on the latter a corresponding protuberance or nipple. The carbon of the latter proved to be very hard and had the rough mammillated structure of the carbon which is found coating the interior of gas retorts. When a platinum rod was substituted for the charcoal at the platinode the transfer of the charcoal from the zincode still took place, and the metal became coated with carbon
which was beautifully molded at its extremity. When this
3876 arrangement was reversed and the zincode was formed of
platinum, and the platinode of charcoal, particles of platinum were transferred and the charcoal became covered with distinct and numerous globules of the fused metal.

The transfer of matter of such dissimilar kinds in this definite direction renders it probable that it is essential to the disruptive discharge and is entirely analogous to the transfer of matter which has been observed by Fusineri in all cases of the Leyden discharge, and of the discharge of atmospheric electricity by lightning.

As connected with this subject, I may recall to your recollection the attempts which were made to produce a spark before contact and in which we reduced the resistance between two platinum wires connecting the two ends of the battery to the utmost possible degree with success. Even when the wires were heated in the flame of a blow-pipe no passage was established. At the suggestion of Sir John Herschel, I adjusted two brass poles connected with the two ends of the battery within a very minute distance of each other, and while in this situation I passed a spark of a small Leyden jar between them and immediately the battery current was established and the brass poles which were hollow were burnt. Is it not probable that the Leyden discharge in this case transferred the conducting matter which was essential to the existence of the voltaic flame, and which was afterwards supplied by its own energy?

The arch of flame between the electrodes was found to be attracted or repelled by the poles of a magnet according as one or other pole was held above or below it, as was first ascertained by Sir H. Davy; and the repulsion was at times so great as to extinguish the flame. When according to the suggestion of Mr. Gassiot the flame was drawn from the pole of the magnet itself included in the circuit it rotated in a very beautiful manner.

(FOOT-NOTE.—This modification of Sir H. Davy's experiment was first made, as I am informed, by Mr. Sturgeon.)

3877 & 3878 When the zincode was connected with the marked pole and the platinode was held over it, the rotation was from west to east, or in the contrary direction to the motion of the hands of a watch; but when the arrangement was reversed and the zincode was connected with the unmarked pole, the rotation was reversed. The flame was also made to rotate by the induction of the magnetism of the earth upon a poker of iron held in the direction of the dip.

The experiment was again varied by leading the current through a spiral twisted round a horseshoe bar of soft iron, and causing the flame to rotate under the influence of its own magnetic force.

The heating power of the battery was very great and the greater intensity of the heat on the side of the zincode than on that of the platinode extremely remarkable. Mr. Gassiot first pointed out to me that when two stout copper wires of $\frac{1}{5}$ of an inch in diameter were connected with the extremities of the battery, and held across each other so that the flame passed between them, the wire at the zincode became red hot while the other remained comparatively cool. A bar of platinum $\frac{1}{8}$ of an inch square freely melted and dropped in large globules in the former situation, but showed no signs of fusion at the platinode.

When the zincode was formed of hard carbon taken from the gas retorts and a cavity ground in it, the most infusible metals placed in it were melted in considerable quantities.

Pure rhodium immediately ran into a perfect globule and burnt with scintillations and a blue light. The native alloy of ir*r*idium and osmium as well as pure ir*r*idium were also completely melted. These metals were kindly supplied to me for the experiments by Mr. Johnson.

Titanium fused instantly and burnt with scintillations very much resembling those from iron.

The native ore of platinum was completely fused, but the mass when cold proved to be very brittle.

After four hours' constant action the power of the battery was found to be undiminished and the amount of the zinc consumed was very small.

3879 In conclusion, I shall briefly describe the results of some experiments on the evolution of the mixed gases from water in a confined space and under constant high pressures which I made from July to October, 1837, and which I intended to have further extended. My objects were to ascertain first, in what manner conduction would be carried on supposing that the tube in which the electrodes were introduced were quite filled with the electrolyte and there were no space for the accumulation of the gases; secondly, whether decomposition having been effected recombination would take place at any given pressure; and thirdly, whether any reaction on the current force of the battery would arise from the additional mechanical force which it would have to overcome.

The first apparatus which I made use of was a stout glass tube into the lower end of which a platinum wire was inserted to form an electrode. This end was hermetically closed and the upper end drowned and fitted with a platinum valve pressed upon by a lever which could be loaded with weights to any required amount. From this valve a wire projected into the tube to form the other electrode. The tube was accurately filled with the standard dilute acid and placed in the battery circuit with a voltameter by which the rate of work and the quantity of the gases disengaged could be ascertained. The battery made use of consisted of ten large cells with the usual charge. Before pressure was applied the rate of work was always ascertained with the tube and voltameter in their places. I tried many experiments with this arrangement; but it will only be necessary to describe the general results.

The pressure was carried up to 98 lbs. upon a circular area of $\frac{3}{4}$ inch diameter, the apparatus appeared to be quite tight for a long time and bubbles of gas evolved from the two wires when the circuit was complete. The liquid became hazy and bubbles of gas seemed to line the tube. The stream of oxygen from the upper wire was projected downward into the liquid as if with considerable force. The liquid ultimately oozed out between the edge of the tube
3880 and the valve, and the experiment was stopped. When the
pressure on the valve was removed a puff of gas took place and the liquid slowly effervesced for a considerable time but was not projected with any violence. The compression tube felt warm to the hand, but not very hot. The quantity of gas which first escaped seemed to bear but a small proportion to that which was indicated by the voltameter included in the circuit and the rate of decomposition was not at all altered by the accumulation of the elastic force.

To carry the experiment as far as the resistance of the glass could conveniently admit of, I caused a compression tube to be made of $\frac{1}{8}$ inch in thickness of the capacity of $1\frac{3}{10}$ cubic inch. Two platinum plates were sealed into its lower end; one cubic inch of standard acid was poured into it, and it was then hermetically sealed at the top. It was placed securely in the battery circuit with a voltameter and the progress of the experiment was watched from a safe distance.

The evolution of the gas which was measured at short intervals took place with perfect regularity and did not appear to be in the slightest degree affected by the gradual increasing compression. In four and one-half minutes, when 19 cubic inches had been collected, the compression tube burst with a loud explosion and the fragments which were very small were scattered all over the laboratory.

If we were to calculate that 19 cubic inches were compressed into the $\frac{3}{10}$ of a cubic inch space unoccupied by the liquid this would be a compression of 63 into 1, and the pressure would amount to nearly 940 pounds upon the square inch; but if — were to reckon, as was probably the case, that two cubic inches of the gases were kept down by the solvent power of the liquid at this high pressure, then the compression would have amounted to 56 into 1, and the pressure to 840 pounds upon the square inch.

It is probable that the means here pointed out might be applied
with advantage to the compression of some of the gases whose
3881 liquefaction you have already affected; and I purpose when
my avocations will permit to return to the experiments with
this view.

I remain, my dear Faraday, your faithful friend,

J. F. DANIELL.

Kings college, London, April 9, 1839.

3882 DEFENDANT'S EXHIBIT PHILOSOPHICAL TRANSACTIONS, PAPER NO. 6. W. T. F., Spec. Ex'r.

Philosophical Transactions of the Royal Society of London for the Year 1832.

Part I, volume 32, at page 292.

XIII.—Experimental researches in voltaic electricity and electro-magnetism by the Rev. William Ritchie, LL. D., F. R. S., prof. of natural and experimental philosophy in the Royal Institution of Great Britain, and professor of natural philosophy and astronomy in the University of London.

Read January 19, 1832.

PART III.

Application of the Preceding Principles to Further Developments in Voltaic Electricity.

20. There are only three substances which can be regarded as good conductors of voltaic electricity: viz: The metals, charcoal, and acidulated water. The metals when employed as conductors seem to have been the only substances whose deflecting energy on the needle has been carefully examined. It appeared to me worth an experiment to ascertain if charcoal deflected the needle and that

too with the same energy as metal conducting an equal quantity of voltaic electricity. This was ascertained with the following arrangement. Exp. VIII. A piece of charcoal about 1½ inches long was placed between two slips of copper fixed perpendicularly in a piece of wood and an astatic needle suspended by a fibre of silk brought over the middle of the charcoal.

Fig. 6 will exhibit this arrangement.

(Here insert Fig. 6.)

3883 In which A B is the charcoal *c c′* slips of wires *w w′* wires soldered to the copper slips. When the wires were connected with an elementary or with a compound battery the needle was deflected in the same manner as by a metallic wire. When one of the slips of copper was placed below the needle and at the same distance as before the needle was equally deflected. The needle is therefore deflected by the quantity of electricity conducted without any regard to the nature of the conducting substance.

Since charcoal, therefore, deflects the needle, it might be made to rotate about a magnet agreeably to the laws as established by the ingenious experiments of Mr. Faraday. This was accomplished as follows:

Exp. IX. A thin slip of copper having a small cup soldered on the middle and two short tubes on the end to hold pieces of charcoal was placed on the point of a needle on the pole of a horseshoe magnet, the points of charcoal being made to dip into the mercury contained in the wooden cup as in the experiment for the rotation of a wire. The charcoal was now made to conduct voltaic electricity from a battery of a hundred pair- of plate- when it revolved rapidly as a metallic wire would have done in similar circumstances.

21. The French philosophers have introduced a distinction between the current of voltaic electricity passing along a metallic conductor and that transmitted by a liquid conductor which seems to me entirely groundless. This distinction may be given in the words of Mr. Cumming in his translation of Demonferrand's Manuel of Electro Dynamics: "In the present state of science, it is perhaps expedient to consider electrical currents in another point of view, namely, as being continuous or discontinuous. The first are those which are transmitted by perfect conductors, and whose intensity varies insensibly in two consecutive instants, as in the thermo-electric or in the common galvanic circuits. When the conductors are imperfect the currents are discontinuous. For bodies of this description permit the electricity to accumulate for a certain time after which the insulating force being overcome it passes
3884 with an explosion; and if the electro-motive power continues to act there ensues a second accumulation and explosion as before, and so on successively. The distinctive character of such currents is that they are incapable of producing a deviation in the magnetic needle" (Cumming's Translations of Demonferrand's Electro Dynamics, page 116).

From the manner in which this distinction is laid down by the

French writers, I had always taken it for granted that a needle suspended above the liquid part of a conductor of voltaic electricity was feebly deflected, and should probably have remained in this belief had I not entered on the present experimental investigation.

This assertion I put to the test of experiment as follows:

Exp. X. Having cemented a glass tube about an inch in diameter and four inches long into two wooden boxes A, B, as in figure 7,

(Here insert Fig. 7.)

and filled the whole with water, I placed two plates of copper *c c'*, having copper wires soldered to each opposite the ends of the glass tube T. The wire proceeding from *c'* after extending about a foot upwards was bent towards the left at D and then made to descend at E, and pass parallel to the needle N, S, and thence to the end of a battery. The other wire *w* was connected with the other end of the battery. It is obvious from this arrangement that the effects of the electricity arranged in the cylinder of water and those of the horizontal branch of the wire above the needle would be to turn the needle in opposite directions. When the branch G, H, was further from the needle than the axis of the tube represented by the dotted line the needle was deflected in obedience to the cylinder of water; but when the wire was brought nearest the needle it was deflected in the opposite direction.

3885 When the wire was placed at the same distance from the needle as the axis of the cylinder the needle remained perfectly stationary. When a disc of zinc was substituted for one of the copper plates and the wires connected so as to form an elementary battery the needle was deflected with the same force by the column of water as by the metallic part of the circuit. Hence, it is obvious that a cylindrical column of water conducting voltaic electricity deflects the needle with the same energy as a metallic wire passing along its axis and forming a part of the same circuit.

22. To complete this part of the enquiry, I was anxious to make a hollow column of water revolving about the pole of a magnet. This was accomplished as follows:

Exp. XI. Having procured two thin hollow cylinders of wood, the one about two inches and a half in diameter, and the other about an inch and a half, I cemented the one within the other at the bottom. Two flat rings of copper were then fixed parallel to each other at the bottom and top of the cylindrical box, the space between them being for the reception of the water or diluted acid. This annular space was divided into two compartments by thin slips of wood placed perpendicularly to prevent the water revolving without carrying the box along with it. Two small metallic points were made to pass from the lower copper ring through the bottom of the box for the purpose of dipping into a cup for holding mercury. The opposite sides of the upper ring were connected by a wire, to the middle of which was soldered a metallic point to dip into a small metallic cup for holding mercury at the top of the magnet. The whole arrangement will be obvious from the simple inspection of figure 8.

(Here insert Fig. 8.)

In which the cylinder C is seen in perspective with the metallic point to dip into the mercury contained in the wooden cup
3886 which is used for the common rotation of a wire, and N, the magnet. The box is partly suspended by an untwisted thread T, so that the metallic point may not rest on the bottom of the cup on the top of the magnet, but simply dip into the mercury.

When the wire *w*, from the cup on the top of the magnet is connected with one end of a powerful battery and the wire from the wooden cup into which the metallic point dips connected with the other, the water in the box is rapidly decomposed, and the whole revolves about the pole of the magnet. By changing the poles the box and its contents are made to turn round in the opposite direction. I was now anxious to make the hollow cylinder of water revolve whilst the vessel in which it was contained remained stationary. This was accomplished by the following arrangement.

Exp. XII. Two glass cylinders were cemented into grooves in a circular piece of wood, through the centre of which the magnet was made to pass, as in the preceding experiment. The circular rims of copper were fixed as in the wooden cylinder, the breadth of the upper ring being considerably less than that of the lower. The inspection of figure 9 will render the whole obvious.

(Here insert Fig. 9.)

In which A, B, is a section of the glass cylinders N the magnet W, the wire connected with the lowest copper ring *w*, that connected with the other, and reaching to the ends of the battery; V represents a wooden vane having two vertical branches immersed in the conducting fluid and balanced on a fine point resting on the top of the magnet.

When the wires are connected with a powerful battery the water begins to revolve forming a real vortex and carrying the wooden vane along with it. When bodies of the same specific gravity as that of the fluid are thrown into it, the rotation is rendered obvious without the wooden vane. When the lower ring is con-
3887 nected with the negative end of the battery, the bubbles of hydrogen as they ascend wind around in a spiral direction till they reach the surface of the fluid.

These experiments demonstrated that the action of magnets is entirely on the electric arrangement without any relation to the ponderable substances with which it combines; and they may yet enable us to assign the cause of currents in the ocean which have not received a satisfactory explanation.

23. In examining the changes which took place in water placed between the platinum poles of a powerful galvanic battery, I was struck with the difference of temperature which I observed in the water at the two poles. The phenomena which thus presented themselves appearing to me new and highly interesting I was induced to examine the subject by careful experiments and investigation. The following arrangement presented itself and brought out new and unexpected results which seem to open a wide field for future inquiry.

Exp. XIII. Having made a small rectangular box, I divided it into three compartments by diaphragms of bladder as in figure 10.

(Here insert Fig. 10.)

In which A, B, C, are the three chambers and the box nearly filled with common water. The copper wires *w w′*, being connected with the ends of a powerful battery, the water was rapidly decomposed through the moist bladder. After decomposition had gone on for eight or ten minutes, the temperature of the water in the three cells was examined, when it was found that the temperature of the water in each of the cells had risen during the experiment, that the temperature of the water at the positive pole had risen several degrees higher than that in the negative cell; but what seemed most remarkable was the fact that the water in the
middle cell had risen several degrees higher than the water
3888 in the positive or hottest chamber. The cause of this curious
result soon presented itself.

The general rise of temperature in the conducting fluid is undoubtedly caused by the same agency which raises the temperature of a metal where performing the same office as the fluid. The difference of temperature in the extreme cells depends on the specific heats of the gases disengaged. The specific heat of oxygen is nearly the same as that of hydrogen. But there being twice as much hydrogen given off at the negative pole as oxygen at the positive it will absorb nearly twice as much heat from the water in that chamber as the oxygen does from the water in the other. The temperature of the water in the negative chamber must, therefore, be kept lower than that in the other compartment. If liquids could conduct voltaic electricity without suffering decomposition, the diameter of the whole mass between the poles would have its temperature equally elevated in every point; but the two unequal cooling processes going on in the extreme chambers occasion the striking inequality of temperature in the three divisions. But this experiment appears to me to establish another point of vast importance in the theory of voltaic electricity. If the hydrogen which is set at liberty at the negative pole traversed the fl/uid between the two poles, it is obvious it must have acquired its specific heat at the positive pole, and consequently could not have lowered the temperature in the negative cell. The oxygen, then, which is disengaged at the positive pole must have belonged to the film of water in contact with the negative pole. There appears, therefore, to be no actual transfer of the component parts of the water, but agreeably to the views of M. Grotthus, a continued series of decompositions and recompositions along the whole chain of acqueous particles between the two poles.

24. The explanation now given of this curious phenomenon receives the strongest confirmation from the decomposition of other substances besides water. When a solution of sulphate of copper
was placed between the poles of a powerful battery, and the
3889 temperature of the cells examined as before, it was found
that a much greater difference between the temperatures of

the extreme chambers took place; but the temperature of the negative chamber was now higher than that of the positive. In some of my experiments the temperature of the negative cell rose 8 or 10° above that of the positive, whilst the middle chamber was nearly of the same temperature with the negative compartment. The same striking difference was observed when a solution of acetate of lead was employed.

The cause of this change of temperature depends as in the case of water on the specific heats of the elements separated at the two poles. When a metallic salt is decomposed by the agency of voltaic electricity, the pure metal is separated at the negative pole whilst the oxygen appears at the other pole. Now, the specific heats of metals are exceedingly small. The change of state, then from the liquid to the solid which took place in the negative chamber must have raised the temperature, while no such change of state took place in the positive compartment. Hence the temperature of the negative cell must be higher than that of the positive. It is unnecessary to multiply examples. If we know the specific heats of the substances set at liberty in the extreme chambers we can tell *a priori* which of the compartments will have the highest temperature—which affords the most satisfactory evidence of the accuracy of the explanation given of this interesting phenomena.

3890 DEFENDANT'S EXHIBIT PUBLISHED DESCRIPTION OF LADIGUIN'S ELECTRIC LIGHT. W. T. F., Spec. Ex'r.

Journal of the Society of Arts, London, 1872–'3, *Vol.* 21, *August* 22, 1873.

P. 779.

The electric light.

It will be in the recollection of the readers of the "Journal" that in April last an analogy was pointed out between sunlight and the electric light, and that certain conditions were therein indicated as being most favorable to that particular development of light which would best bring out the separation of the power producing the light from the place of its manifestation. Those conditions were the employment of magneto electricity and the use of a closed incandescent conductor in an atmosphere which would not oxidize or otherwise affect the durability of the light-producing material. From the quotation from the Russian paper "Galos" which follows it will be seen that the results anticipated are even now in the course of realization, and all that practical men can do is to wish the plan the success it seems to deserve, and to wait the result of the further exhibitions of its power in London and other places more accessible to the western nations tha*t* St. Petersburg:

"On Tuesday, the 8–20 of May, a most interesting trial was made for the first time in public at the Admiralty house in St. Petersburg, under the auspices of Messrs. S. A. Kosloff & Co., the proprietors of the patent of a new system of lighting by electricity, the invention of Mr. A. Ladiguin of that town.

"Owing to the restricted space in the hall made use of on this occasion, the number of spectators was necessarily limited, but still they consisted of more than a hundred specialists from different
countries, representatives of science, honorable visitors, and
3891 many reporters, who were all deeply interested, and unanimously decided that the trial was really successful.

"Up to the present time, as is well known, the electric light has been used only for light-houses, as an electric sun illumination for signals, or on the stage where a strong light may be required without regard to cost; but thus far it has been impossible to employ it for lighting streets or houses.

"By the old method the electric spark was passed between two points of charcoal, each attached to a copper wire connected with an electro-magnetic machine.

"The disadvantages attending this mode consisted in the facts that for each light a separate machine was required and that the light so obtained, although very powerful, was impossible to be regulated, besides being non-continuous, owing to the rapid consumption of the charcoal points from exposure to air.

"All the difficulties Mr. A. Ladiguin has tried and apparently overcome most successfully.

"By his newly invented method only one piece of charcoal or other bad conductor is required, which being attached to wire connected with an electro-magnetic machine is placed in a glass tube from which the air is exhausted and replaced by a gas which will not at a high temperature combine chemically with the charcoal. This tube is then hermetically sealed, and the machine being set in motion by means of a small steam engine, the charcoal becomes gradually and equally heated, and emits a soft, steady and continuous light, which by a most simple contrivance can be strengthened or weakened at the option of those employing it; its duration being dependent solely on the electric current, which of course will last as long as the machine is kept in motion.

"Taking into consideration the fact that one machine worked by a small three-horse-power engine is capable of lighting many hundreds of lanterns, it is evident what an enormous advantage and profit could be gained by the illumination of streets, private houses,
public buildings and mines with the new electric light. In
3892 the latter it must prove invaluable, as no explosion need ever
be feared from it, and these lanterns will burn equally as well under water as in a room.

"Without mentioning the many advantages this mode of illumination has over gas, which by its unpleasant odor and evaporation is slowly poisoning thousands of human beings, and from which explosions are frequent, we can state that by calculations made this electric light can be produced at a fifth of the cost of coal gas.

"We hope shortly to place before the public more complete particulars, as well as reports of further experiments which are proposed to take place in Vienna, Paris and London."

See the Russian paper "Galos," No. 129, of May 11–23, 1873.

3893 DEFENDANT'S EXHIBIT VIOLETTE PAPER. W. T. F., Spec. Ex'r.

American Journal of Science and Arts, Vol. 16.

G. P. Putnam & Sons, New York, 1853 (p. 270).

Overheated Steam Applied to the Carbonizing of Wood.

For several years past overheated steam has been used in numerous industrial operations, and we may say generally that it may be applied in all processes in which a temperature between 100° and 500° C. is required. Among these processes is the extraction of wood spirit, the continuous baking of bread, the preparation of sea biscuit, the drying of wood, the preservation of meats, the extraction of volatile substances insoluable in water, the purification of fatty acids by MM. Leplay and Dubrunfaut, the extraction of the mercury from the residues of zinc amalgam by M. Violette, and finally the carbonizing of wood by the same chemist.

M. Violette is a member of the commission on powder and saltpeter, and in this situation he has turned his attention to the ingredients of powder, the manufacture of which still admits of much improvement. The charcoal employed in this manufacture is of a quality intermediate between wood and ordinary charcoal; it is called red charcoal (charbon roux), and is produced at 300° C.; at a higher temperature it becomes black charcoal, and at a lower the carbonization is incomplete.

By the old process of heating in closed cylinders, 10,000 kilogrammes of wood furnish 2,000 kil. of black charcoal, and 1,300 of red. The new process with steam yields a better article in larger quantity for 10,000 kil. of wood give 4,000. The wood immersed in the vapor is readily carbonized, and as it is easy to regulate the
temperature of the vapor charcoal may be obtained of a con-
3894 stant and uniform character. It has some use since, though
overheated steam was first adopted in this process by M. Violette, and now the red charcoal, before employed only for the finest powder, is in general use for the cheaper kinds, so simple and certain is its production by means of steam.

M. Violette communicates to the academy some new results. He shows that the change to charcoal takes place differently with different woods, and that the products of the same temperature differ in elementary constitution. Exposed to moist air the charcoals absorb more water the lower the temperature to which they are exposed and the —— is of their power of conducting heat and electricity. Charcoal made at 1,500° C. conducts much better than the charcoal of gas retorts, and serves perfectly for electric illumination. The density increases in the same proportion. When lighted charcoals remain ignited for a time, which decreases as the temperature of carbonization increases. The charcoal made at 260° C. burns more easily and longer; that made between 1,000° and 1,500° C. will not ignite or burn.

The most inflam-able of all charcoals is that of an agaricus. It takes fire spontaneously at 300° C. Other charcoals prepared at the temperature 300° C. take fire in the air spontaneously between 360° and 380° according to the wood that is afforded, though the charcoals of the lighter woods burning the most readily.

When charcoals are mixed with sulphur they are inflamed at a temperature much below that required when alone; the mixture of the two prepared between 150° to 400° C. is wholly consumed at 250° C. On the contrary, when the charcoal employed has been prepared at 1,000° or 1,500° C. only the sulphur burns.

To decompose saltpeter, the charcoals require a higher temperature; and heat of 400° C. is needed for charcoals prepared between 150° and 432°, and a red heat for those made between 1,000° and 1,500°.

Sulphur decomposes saltpeter at a higher temperature than charcoal requires, viz., at 432°. The sulphur alone inflames in common air at 250° C. and not at 150°, as stated in treatises on chemistry.

3895 The deflagration of powder takes place at 250°, but this combustibility varies with the charge and the size of the grain. The powder in grains burns between 270° and 320°, while powder pulverized burns between 265° and 270°.

In view of the facts M. Violette concludes that it is necessary to revise the charges employed, taking into consideration the actual position of the charcoal. Trials made with this in view upon hunting powder with charges calculated according to the actual position of the charcoal have given a range much beyond the standard rate obtained with the ordinary powder.

3896 EDISON EXHIBIT NO. 3.

(Book No. 67. Pages 1 to 15, inclusive.)

Record of Lamps.

No. 142. Resistance, 150 ohms. } 1880. Jan. 2.
Has burnt at least 200 hours. } 12 noon.

This lamp is hung on the two main wires over the pumps.

Jan'y 5, measured resistance; no change.

Hours.		
200.00.	Jan. 2.	
19.30.	3.	
9.58.	4.	
20.50.	5.	
3.47.	5.	
20.26.	6.	
12.15.	7.	
22.00.	8.	
9.00.	9.	Till 5 o'clock.
360.00.	Total.	

Jan. 9. 6.50.
Jan. 10. 19.15.
Jan. 11. 7.00.
Jan. 12. 11.00. Total, 405.05, up to noon.

Bu-sted Jan. 13, 2 a. m.

No. 159. Hung on leading, over pumps:

Resist., 153 ohms. } Jan. 2, 1880,
Has burnt 200 hours. } noon.

Jan'y 5, measured resistance; no change.

Hours.
Jan. 2. 200.00.
3. 19.30.
4. 9.58.
5. 20.50.
5. 3.47.
6. 20.26.
7. 12.15.
8. 22.00.

3897

Jan. 9. 9.00. Total time, 360.12. Jan. 9, 5 p. m.
Jan. 8. Resistance same.
9. 6.50.
10. 19.15.
11. 7.00.
12. 11.00. Total, 404.05 up to 12 o'clock.
12. 9.30.
13. 11.00. " 424.35 " 12 "
13. 11.30.
14. 22.30.
15. 11.30. " 480.30 " 12 "

No. 189. Chandelier in top room nearest pumps:

Resist., 149. } Jan. 2, 1880, noon.
Has run 13 hours. }

Hours.
Jan. 2. 13.00.
3. 19.30.
4. 9.58.
5. 20.50.
5. 3.47.
6. 20.26.
7. 12.15.
8. 22.00.
9. 9.00. Total time burned 173.12 at 5 o'clock p. m.
9. 6.50.
10. 19.15.
11. 7.00.
12. 11.00. Total time burned 217.17 up to noon.

Bu-sted at 8.40.

No. 285. Second chandelier, top room :

Resist, 142. } Jan. 2, 18*00*.
Has run 13 hours. } 12 noon.

Has run since 8.21, total running.

Broke by vibration in taking off, and on ¼ in. above center (Edison saw this Jan. 2, 1880, 8 p. m.) Edison says not quite sure about this.

3898 No. 255. Second chandelier, top room :

Resist., 200. } Jan. 2, 1880.
Has run 13 hours. } 12 noon.

Jan. 3.	19.30.	
4.	9.58.	
5.	20.50.	
5.	3.47.	
6.	20.26.	
7.	12.15.	
8.	22.00.	
9.	9.00.	Total time burned 173.12 at 5.00 p. m.
9.	6.50.	
10.	19.15.	
11.	7.00.	
12.	11.00.	“ “ “ 217.17 up to 12 o'c.
12.	9.30.	
13.	11.00.	“ “ “ 237.47 “ “ “
13.	11.30.	
14.	22.30.	
15.	11.30.	“ “ “ 294.17 “ “ “

Bu-sted.

223. Third chandelier, top room :

Resist., 140. } Jan. 2, 1880,
Burnt 13 hours. } noon.

Jan. 3.	19.30.	
4.	9.58.	
5.	20.50.	
5.	3.47.	
6.	20.26.	
7.	12.15.	
8.	22.00.	
9.	9.00.	Total time burned 143.12 at 5 p. m.
9.	6.50.	
10.	19.15.	
11.	7.00.	
12.	11.00.	“ “ “ 187.17 up to noon.
12.	9.30.	
13.	11.00.	“ “ “ 207.47 “ “ “
13.	11.30.	
14.	22.30.	

3899

Jan. 15. 11.30. Total time burned 262.17 up to noon

Bu-sted.
Bu-sted.

193. Chandelier, near organ:

Resist., 154. } Jan. 2, 1880,
Burnt 13 hours. } noon.

Jan. 3.	19.39.
4.	9.58.
5.	20.50.
5.	3.47.

Taken out on Jan. 9, 1880, to put in street lamps replaced by 376 experiment.

162. Chandelier, near organ:

Resist., 147. } Jan. 2, 1880,
Burnt 13 hours. } noon.

Jan. 3.	19.39.
4.	9.58.
5.	20.50.
5.	3.47.

Taken out on Jan. 9, 1880, replaced by 375 experiment bent on end of tip taken to Cornishes, where it burnt 102.00 total. Brought up for diver light.

167. Third chandelier, top room, north side:

Resist., 136. } Jan. 2, 1880,
Burnt 13 hours. } noon.

Saw this burst at 3 p. m., Jan. 2. Inside glass broke. Total length of burning, 15 hours.

204. Flammer's bench:

Resist., —. } Jan. 2, 1880,
Burning 13 hours. } noon.

January 2, 1880, taken out by Edison and 5 pr. given Upton to make test for rupture.

Total burning, sixteen hours.

203. Flammer's bench:

142 resist. } Jan. 2, 1880,
Burnt 5½ hours. } noon.

After burning a total of 17½ hours it broke.

3900 155. Over Carman's desk, office:

Resist., 126 ohms. } Jan. 2, 1880,
Burnt 50 hours. } noon.

Jan. 3.	19.30.	
4.	9.58.	
5.	20.50.	
5.	3.47.	
6.	20.26.	
7.	12.15.	
8.	22.00.	
9.	9.00.	Total time burned, 160 hours up to 5.00.
9.	5.50.	
10.	19.15.	
11.	7.00.	
12.	11.00.	" " " 204.05 up to noon.
12.	9.30.	
13.	11.30.	" " " 224.35 " " "
13.	11.30.	
14.	22.30.	
15.	11.30.	" " " 280.05 " " "

201. Over Carman's desk, office:

Resist., 147. } Jan. 2, 1880,
Burnt 50 hours. } noon.

Jan. 3.	19.30.	
4.	9.58.	
5.	20.50.	
5.	3.47.	
6.	20.26.	
7.	12.15.	
8.	22.00.	
9.	9.00.	Total time burned, 160 h'rs up to 5 p. m.
9.	6.00.	
10.	19.15.	
11.	7.00.	
12.	11.00.	" " " 204.05 up to noon.
12.	9.30.	
13.	11.00.	" " " 224.30 " "
13.	11.30.	
14.	22.30.	
15.	11.30.	" " " 280.00 " "

3901 164. Office chandelier near door:

Resist., 182. } Jan. 2, 1880,
Burnt 50 hours. } noon.

Jan. 3.	19.30.
4.	9.50.
5.	20.50.
5.	3.47.

Jan. 6.	20.26.	
7.	12.15.	
8.	22.00.	
9.	9.00.	Total time burned, 160 h'rs up to 5 p. m.
9.	6.50.	
10.	19.15.	
11.	7.00.	
12.	20.00.	" " " 204.05 up to noon.
13.	22.30.	
14.	22.30.	" " " 224.05 " "
15.	11.30.	" " " Correct total. 322.13 " "

172. Chandelier over Griff's desk :

Resist., 135. } Jan. 2, 1880,
Burnt 50 hours. } noon.

Jan. 3.	19.30.	
4.	9.50.	
5.	20.50.	
5.	3.47.	
6.	20.26.	
7.	12.15.	
8.	22.00.	
9.	9.00.	Total time burned, 160 h'rs up to 5 p. m.
9.	6.50.	
10.	19.15.	
11.	7.00.	
12.	11.00.	" " " 204.15 up to noon.
12.	11.30.	
13.	22.30.	
14.	11.30.	" " " 259.45 " "

3902

Edison's Exhibit No. 7.

Extracts from Records of Experiments, Book No. 85.

"All pumps give a great deal of trouble at F where a contraction is made so that the air in G may be forced out from H.

" B. This stop-cock placed too far from the main reservoir so that the tube near it caught air. This could be worked out by letting the Hg work up and down. The McLeod should not be used until a high vacuum has been attained. For if this has not been done the Hg sticks in the side tube. Last evening a vacuum was obtained so that the spark jumped five inches outside of the tube rather than across $\frac{1}{4}$ inch in vacuum. The changes in vacuum were extremely rapid from green to preventing a small spark in a few seconds and then in a few minutes to stopping the large spark. The finely divided copper and sulphuric acid may have had a strong influence on this F, the tube contracted here so that a pressure can be obtained in G to drive the air out through the stop-cock H.

"The enlargement of the tubes at L and L^1 is a mistake, as a bubble of air collects here and is drawn up into the pump. Making stop-cock D with tube to left inclined upwards may be a mistake, as the Hg collects above the cock and stops the Geissler. Pure black rubber tube placed inside of white rubber to prevent soiling Hg."

3903 & 3904 EDISON EXHIBIT NO. 8.

(New York Sun, December 22d, 1879.)

Electrician Sawyer's Challenge to Electrician Edison.

If a party possesses an interest in something that he considers valuable, he is not very likely to part with it, especially if it be something in the line of electric lighting, where what may nominally be $1 may really be $1,000. Therefore, when Mr. Edison sells out all his interest in his electric light there is a reasonable chance for a suspicion that he considers his invention worth very little.

Mr. Edison's reputation before the public is founded upon the newspaper publications about: 1. The quadruplex telegraph; 2. The telephone; and 3. The phonograph.

As to the quadruple telegraph, I may say that it was an adaptation of the French and German systems. When Mr. Edison took hold of the 4-plex there were already known five systems of 2-plex, three of 4-plex, and three of 6-plex and 8-plex.

The 4-plex of Edison was a failure. A modest young gentleman, assistant electrician of the Western Union Telegraph Company, whom I have not seen for several years (Mr. Gerritt Smith), made it a success, and some day he will get the credit for this invention; for he, and not Edison, is the genius in this case.

As to the telephone, Mr. Edison is not the inventor. Andrew Graham Bell is the inventor of the telephone.

As to the phonograph, which really made Mr. Edison's reputation, it is of no earthly value, and the manufacture by Bergman has practically been dropped. The real inventor of the phonograph will never be known, in all probability, for I understand that Mr. Edison anticipates a Western man but three days in priority of invention.

3905 Now, all that remains for Mr. Edison is electric light. He is going over the same ground that Bouliguine, Lodygreine, Kosloff, Koun, Starr King, myself, and others have traversed—first, iron; second, platinum; third, carbon in different shapes. And Edison has failed, in my opinion. To show that I mean what I say, I deny every one of his allegations made at the Saratoga convention of the American Society for the Advancement of Science, and, specifically, I challenge him:

First. To maintain a vacuum in his lamps.

Second. To run his carbonized-paper lamp three hours. (In practice, in a perfect vacuum, it will last twenty minutes.)

Third. To consolidate platinum by heating electrically in the Sprengel vacuum, as he claims.

Fourth. To prove that his dynamo-electric machine develops not ninety, but even forty-five per cent. of the feet pounds applied to it.

Fifth. To show that he can obtain a light of twenty-five candles from platinum with less than three horse power.

Sixth. To show that platinum or iridium will not disintegrate in twenty hours' actual running.

Seventh. To prove that with his carbonized-paper lamp he can obtain two lights of ten candles each per horse power.

Eighth. To show that the effect of the oxide of magnesium is to harden his wire, and make it more refractory.

And I further allege that all Mr. Edison's statements are erroneous, and I offer $100 as a prize for him to prove each of the above allegations. Let him run one of his lamps three hours, and the public will be satisfied that I am correct.

W. E. SAWYER.

78 Walker street, New York, Dec. 21.

3906 CONSOLIDATED E. L. CO.
vs.
MCKEESPORT L. CO.

EDISON EXHIBIT NO. 11. W. T. F., S. E.

EDISON EXHIBIT NO. 11. W. H. M., Notary Public, N. Y. Co.

From Note Book No. 74, pgs. 1, 2, 5, 7, 8, 9, 10, 11, 12, 13, & 14.

Record of Lamps.

No. 159. Hung on leading wires over pumps first—over pumps nearest to chandelier. Place.

Res., 153 ohms. } Jan. 2, 1880,
Has burnt 200 h. } noon.

Jan. 2.	200.	
“ 3.	19.30	
“ 4.	9.58.	
“ 5.	20.50.	
“ 6.	20.26.	
“ 7.	12.15.	
“ 8.	22.00.	
“ 9.	15.50.	Res. the same. Total h., 310.12.
“ 10.	19.15.	
“ 11.	7.00.	
“ 12.	20.30.	Total hours burned, 381.57.
“ 13.	22.30.	
“ 14.	22.30.	
“ 15.	11.30.	“ “ “ 437.
“ 16.	23.00.	
“ 17.	11.	“ “ “ 471.

Jan. 17.	8.		
" 18.	2.		
" 19.	8.	489.	
" 19.	11.		
" 20.	11.	509.	Over.
Jan. 20.	Up to 509.		
" 20.	11.		

3907

Jan. 21.	9.15.	
22.	15.45.	
23.	8.00.	Total, 553.10.
23.	5.00.	
24.	18.30.	
25.	6.00.	
26.	10.00.	" 592.40.
27.	10 40.	Total, 614.20.
27.	11.00.	
27.	10.25.	H'rs, 614.20.
28.	11.00.	635.40.
28.	10.00.	
29.	11.00.	656.45.
29.	11.00.	
30.	16.00.	
	27.00.	

Bu-sted at eight o'clock. Total hours, 683.45.

223. Third chandelier, top room in laboratory:

Res., 140. } Jan. 2, 1880,
Burnt 13 hours. } noon. Place.

Jan. 3.	32.30.			
4.	9.58.			
5.	23.47.			
6.	20.26.			
7.	12.15.			
8.	22.00.			
9.	15.50.	Total time burned,	173.12.	
10.	19.15.			
11.	7.00.	" " "	217.17.	Noon.
12.	20.00.			
13.	22.30.	" " "	237.47	"
14.	22.30.			
15.	11.30.	" " "	294.17	"
15.	11.00.			
16.	22.00.			
17.	11.00.	" " "	339.17	"
18.	18.			
18.	2.			
19.	8.00.	" " "	367.17.	Total time.

3908

One clamp red hot; poor vacuum.
Bu-sted at —.

155. Over Carman's desk, office:

Res., 126 ohms. } Jan. 2, 1880,
Burnt 50 hours. } noon. Place 31.

Jan. 2.	50.			
3.	69.58.			
4.	9.50.			
5.	23.47.			
6.	20.26.			
7.	12.15.			
8.	22.00.			
9.	15.50.	Total time burned,	173.12.	
10.	19.15.			
11.	7.00.	“ “ “	217.17.	Noon.
12.	20.00.			
13.	22.30.	“ “ “	237.47	“
14.	22.30.			
15.	11.30.	“ “ “	271.47	“
15.	11.00.			
16.	22.00.			
17.	19.00.	“ “ “	389.17	“
18.	8.00.			
18.	2.00			
19.	19.00.			
20.	11.00.	“ “ “	377.17	
20.	11.00.			
21.	9.15.			
22.	15.45.			
23.	8.00.	“ “ “	416.17	“
24.	5.00.			
24.	18.30.			
25.	6.00.			
26.	10.30.	“ “ “	450.17	“
26.	10.40.			
27.	11.	“ “ “	471.57.	Over.
27.	10.25.			
28.	11.00.	Total,	507.	Noon.
28.	10.00.			

3909

Jan. 29.	11.00.	Total, 538.14.
30.	12.00.	
31.	11.00.	

Bu-sted at clamp or post 1. 562.14.

201. Over carman's desk (office):

Res. 147. } Jan. 2, 1880. Place 30.
Burnt 50 hours. } Noon.

Jan.	3.	19.30.	
	4.	9.58.	
	5.	23.47.	
	6.	20.26.	
	7.	12.15.	
	8.	22.00.	
	9.	15.50.	
	10.	19.15.	
	11.	7.00.	
	12.	20.00.	
	13.	22.30.	
	14.	22.30.	
	15.	11.30.	Total hours burned 322.13 noon.
	15.	11.00.	
	16.	22.00.	
	17.	11.00.	" " " 372.10 "
	17.	8.00.	
	18.	2.00.	
	19.	19.00.	
	20.	11.00.	" " " 412.13 "
	20.	11.00.	
	21.	9.00.	
	22.	15.45.	
	23.	8.00.	" " " 456.13 "
	23.	5.00.	
	24.	18.30.	
	25.	6.00.	
	26.	10.30.	" " " 496.13 "
	26.	10.40.	
	27.	11.00.	" " " 517.53 " over.
	27.	10.00.	
	28.	11.00.	538.14 noon.
	29.	22.00.	

3910

Jan.	30.	22.00.	
	31.	22.00.	
Feb.	1.	6.00.	
	2.	9.00.	Total 608.14.
	3.	11.00.	619 hours.
	3.	10.00.	
	4.	9.00.	638 hs.

Bu-sted March 21.

164. Office chandelier near door:

Res. 182. } Jan. 2, 1880. Place 28.
Burnt 50 hours. } Noon.

Jan. 3.	19.30.			
4.	9.50.			
5.	20.47.			
6.	20.26.			
7.	10.15.			
8.	22.00.			
9.	15.00.			
10.	19.15.			
11.	7.00.			
12.	20.00.			
13.	22.30.			
14.	22.30.			
15.	11.30.	Hours burnt	322.13	noon.
15.	12.00.			
16.	11.00.	" "	367.13	"
17.	11.00.			
17.	8.00.			
18.	21.00.			
19.	19.00.			
20.	11.00.	" "	418.13	"
20.	11.00.			
21.	9.15.			
22.	15.45.			
23.	8.00.	" "	462.13	"
23.	5.00.			
24.	18.30.			
25.	6.00.			
26.	10.30.			
26.	10.40.	" "	502	"

3911

27.	11.00.	Hours burnt	523.43	noon.
27.	10.25.	Over.		
Jan. 28.	11.00.	Total	537.14	5 p. m.
28.	10.00.			
29.	11.00.		538.14	
29.	11.00.			
30.	22.00.			
31.	22.00.			
Feb. 1.	6.00.			
2.	9.00.			
2.	9.00.	"	610.14	
3.	11.00.			
3.	10.00.			
4.	9.00.	"	640.14	noon.

172. Chandelier over Griff's desk :

Res., 135. } Jan. 2, 1880.
Burnt 50. }

Jan.	3.	19.30.					
	4.	9.58.					
	5.	23.47.					
	6.	20.26.					
	7.	12.15.					
	8.	22.00.					
	9.	15.50.					
	10.	19.15.					
	11.	7.00.					
	12.	20.00.					
	13.	22.30.					
	14.	22.30.					
	15.	11.30.	Total	hours	burned	322.13	noon.
	15.	11.00.					
	16.	22.00.					
	17.	11.00.					
	17.	8.00.	"	"	"	367.13	"
	18.	2.00.					
	19.	19.00.					
	20.	11.00.	"	"	"	418.13	"
	20.	11.00.					
	21.	9.15.					
	22.	15.45.					
3912							
	23.	8.00.	Total	hours	burned	246.13	noon.
	23.	5.00.					
	24.	18.30.					
	25.	6.00.					
	26.	10.30.	"	"	".	502.13	"
	26.	10.40.					
	27.	11.00.	"	"	"	523.43	
	27.	10.25.					
Jan.	28.	11.00.	"	"	"	544.15	
	28.	10.00.					
	29.	11.00.				538.15	
	29.	11.00.					
	30.	22.00.					
	31.	22.00.					
Feb'y	1.	6.00.					
	2.	9.00.				610.15	noon.
	2.	9.00.				619.15	"
	3.	10.00.					
	4.	9.00.				638.15	"

Taken to Edison's parlor.
158.

CONSOLIDATED E. L. CO.
vs.
MCKEESPORT L. CO.

3913 CONS. E. L. CO.
vs.
MCKEESPORT CO.

DEFENDANT'S EXHIBIT NO. 25. W. T. F., S. E.

EDISON'S EXHIBIT NO. 25. W. H. M., Notary Public, N. Y. Co.

Mr. Edison Challenged by Mr. Sawyer.

To the editor of the Sun.

SIR: Notwithstanding the assertion that one of Mr. Edison's electric lamps has been running for 240 hours, I still assert, and am prepared to back up my assertion, that Mr. Edison cannot run one of his lamps up to the light of a single gas jet (to be more definite, let us call it twelve candle power) for more than three hours. To be still more definite, I offer to Mr. Edison, at 226 West Fifty-fourth street, in this city, an opportunity to prove what he says. From the private residence in that street wires are run to a circuit of 1,000 feet Mr. Edison shall have every facility; he shall use my wires; he shall have any dynamo machine or other generator of electricity he may prefer; and all I ask is that the power of his light shall be measured by a photometre; that, once in place, it shall not be interfered with; and that a committee of gentlemen, preferably nominated by the editors of the New York press, shall be present and certify to the facts of the test.

Furthermore, I will place one of my lamps side by side with Mr. Edison's; it shall be run at the power of twenty-five candles; it shall outlast the entire forty lamps at Menlo Park run at the power of twenty-five candles; my lamp to stand as it is put up, and Mr. Edison to put up a fresh lamp as fast as the preceding lamp shall have burned out.

3914 I am anxious for this test; and if Mr. Edison has really run one of his horseshoe lamps 240 hours he will not refuse to accept my offer, for he will be treated with the utmost courtesy, and shall have everything his own way.

I adhere in every particular to my original challenge to Mr. Edison.

W. E. SAWYER,
78 Walker Street, New York.

Jan. 4.

The Sun, Monday, January 5th, 1880.

3915 Letters patent, for fifteen years, taken out July 12th, 1876, by Mr. Gauduin (Octave), of Paris, Rue de la Roquette, No. 130, and which was granted to him by order of the minister of agriculture and commerce, under date September 16th, 1876, for a carbon intended for the manufacture of utensils of chemistry and physics, etc.

Letters patent No. 113,706.

Certain utensils of chemistry and physics, like the crucibles intended for the reproduction of precious stones or for chemical laboratories, the pencils intended for the production of electric light, etc., should be made of chemically pure carbon. Now, the dust of retort carbon ("retort charcoal"), though containing but a small proportion of foreign matters, is not sufficiently pure for these uses, and its employ presents difficulties. The washings with acids or with alkali- to which the carbonaceous (coaly) matters can be subjected, with the object of taking out the impurities which they contain, are costly and insufficient; soot is sufficiently pure, but high priced and difficult to use, and I had to look for another source of pure carbon for the economical fabrication of these objects.

I manufacture pure carbon at a low price by decomposing, by heat, in closed vessels, dry or liquid pitch, tar, rosin, bitumen, natural or artificial essences and oils, organic matters capable of yielding sufficiently pure carbon after their decomposition by the heat. The apparatus which I employ to effect this decomposition are closed retorts or crucibles of cast iron, iron, refractory clay, but preferably of graphite (plumbago). They are arranged in a furnace capable of heating them to clear red heat. The upper part of the retort is furnished with two tubes, the one for the escape of the gases and volatile matters, the other for the introduction of the raw material.

(Here follows diagram marked p. 3917.)

Figure 1 will explain this arrangement. The volatile products of the decomposition may be conducted under the grate of
3916 the hearth and burned to heat the retort, but it is more advantageous to lead them into a condensing chamber, then into a serpentine ("serpentine pipe") of copper, lead, tin, or pottery, and, after condensation. to collect the tar, oils, essences, and carburets of hydrogen, which are produced by this operation. I utilize these different products for the manufacture of my carbon utensils, and, as they are not met with in the trade in a state sufficiently pure for my industry, they are exceedingly useful to me.

It is indispensable to avoid (using), for condensing or preserving these products, vessels of iron, cast iron, zinc, or other materials susceptible to their attacks, for their whole value lies in their purity.

Whatever the raw material is that is used in the manufacture of my carbon, the decomposition by heat may be operated slowly or quickly, according to the nature of the secondary products which I wish to obtain.

To operate slowly I fill a retort two-thirds full and I heat it gradually to clear, red heat, avoiding, as much as possible, the swelling (puffing) of the material. To operate rapidly, I first heat the empty retort to a good red heat, and I cause the raw material to arrive at the bottom of the retort in small portions, either in a small stream, if it is liquid, or in small pieces if it is solid.

The slow distillation produces more tar, heavy oils and little gas; the quick distillation produces more light essences and gas. I employ the one method or the other, according to the products which I need.

When the raw material has been suitably selected, there remains in the retort pure carbon, more or less compact; I pulverize it as fine as possible, and I agglomerate it, either alone or mixed with a certain quantity of soot, by means of pure carburets of hydrogen obtained as secondary products. Thus prepared these bodies are completely free from iron and are greatly preferable to those met with in trade, not only for the agglomeration of the carbon, but also for the impregnation of the manufactured articles, an operation which, while stopping up their pores, introduces into them oxide of iron when it is performed with the products of commerce.
3918 Nevertheless, I reserve the right of exclusive use of carburets of hydrogen, pitch, tar, oils or essences of coal, etc., found in commerce, to agglomerate or impregnate the objects which I manufacture, as appears from the certificate of addition to my patent No. 87569.

The articles made of agglomerated carbon are, taking the same kind of carbon, more combustible as they are more porous, and more porous as they have been molded at less pressure. I use molds of bronze, cast iron or steel capable of resisting the greatest pressure of a strong hydraulic press. Figure 2 shows a crucible mold, a simple examination of which will cause the mechanism to be understood.

Although the draw-plate ("draw-plate" is a literal translation of the term filière) or molding apparatus, long used in the manufacture of the pencils of carbon, soot, plumbago (graphite), etc., intended for writing or drawing, might serve, without any modification, for the manufacture of pencils for electric lighting, I have made certain improvements in this apparatus, the exclusive use of which I desire to reserve. Instead of causing the pencils to go out from top to bottom, going vertically, I place the — (there has evidently been some omission here on the part of the copyist in France) or the orifices of the mold on the side, and in such a manner that the pencils pass out, forming with the horizon a descending angle from 20 to 70 degrees. They are guided along their whole length by tubes or channels (grooves). This arrangement enables one to empty out all the material contained in the mold without interrupting the work, and, as the pencils are constantly supported they no longer break under their own weight, which often happens when they pass out downwards. It is above all useful in the manufacture of thick and long pencils intended to be used as positives in electro-chemical decompositions; these carbon positives replacing advantageously the platinum.

Figure 3 represents a pencil mold with outlet pipe on the side.

(Signed) GAUDUIN.

Paris, July 12th, 1876.

3919 FRENCH REPUBLIC.

Ministry of commerce and industry.

Patents.

Descriptive account accompanying:

The certificate of addition, taken out 12 June, 1877, by Mr. Gauduin, represented by Mr. Rouart, in Paris, Rue Oberkampf 151, and relating to letters patent, for 15 years, taken 12 July, 1876, for a carbon intended for the manufacture of utensils of chemistry and physics, etc. * * * The said certificate of addition being granted, by order of the minister of agriculture and commerce, on the 13th September, 1877.

Certif. of Add. to Let. Pat. No. 113,706.

(Here follows diagram marked p. 3920.)

Fig. 1 represents the vertical section, and Fig. 2 the plan of a tubular furnace permitting the baking ("burning"), continuously, of pots, (crucibles), pencils for electric lighting and for electro-chemistry, and other utensils of carbon which I manufacture.

It is composed of a frame-work of bricks (iron bands) held on the exterior by strong iron-work. The tubes G, G, of refractory material, traverse it through and through and are closed at the two ends only by clay plugs, which can be easily removed for the charging and discharging (placing and removing) of the objects to be baked.

These are enclosed in cylindrical boxes of sheet iron represented in Fig. 3. They can glide easily in the refractory tubes. When the boxes and their contents have attained a sufficient (degree of) temperature, they are taken from the tubes and replaced by others. The charging and discharging are thus performed very easily, without stopping the working of the furnace, and without a noticeable cooling off.

H H, draught chimney.

J J, hearth.

K, grate.

L, ash pit.

3921 It is evident that the tubes might be arranged in a furnace either completely vertical or completely horizontal, with no great inconvenience. So also the relative dimensions might be changed, within certain limits. What I consider as my property is the idea of heating tubes in any suitable furnace, and baking in them objects of carbon, enclosed or not in movable boxes.

I have found that a mixture of albumen and sugar, dissolved in water, in suitable proportions, can communicate certain useful properties to the objects of carbon. I reserve for myself the use of this syrup for agglomerating and impregnating the utensils of carbon, crucibles, pencils, etc. The albumen may be replaced by the other albumenoid substances.

The drying of the objects formed may be performed in the open air or in a suitably heated drying chamber. These means are rather slow. It is more expeditious to enclose the objects in a hermetically closed receiver, in which a vacuum can be produced by means of a pneumatic pump. It is well to intercalate, between the receiver and the pump, a vessel containing lime, chloride of calcium, or other materials capable of absorbing the vapors as they are produced.

To recapitulate—

I claim by the present certificate of addition:

1. The exclusive use of tubular furnaces for the baking of crucibles, pencils for electric lighting and for electro-chemistry, and other utensils of carbon.
2. The agglomeration and impregnation of the different varieties of carbon by a syrup of albumen and sugar.
3. The rapid drying of the manufactured objects by the employ of the vacuum, either alone or aided by materials capable of absorbing the vapors emitted.

Paris, 12 June, 1877.

(Signed) OCTAVE GAUDUIN.

3922 Certificate of addition, taken out April 7th, 1877, by Mr. Gauduin, Octave, at Paris, Rue de la Roquette 130, and which relates to letters patent, for fifteen years, taken out 12th July, 1876, for a carbon intended for the manufacture of utensils of chemistry and physics, etc., . . . the said certificate of addition granted by order of the minister of agriculture and commerce, on June 22d, 1877.

Certificate of Addition to Letters Patent No. 113,706.

I have succeeded in giving to my carbon the definite form which it is to preserve, and in simplifying considerably the moulding and the forming of the objects which I manufacture by the following process:

I form the crucibles, vessels, pencils for electric lighting or for electro-chemistry, etc., with dry wood, suitably selected, by all the methods proper to working in wood. I convert this wooden object into a hard and compact carbon, conserving its primitive ("original") form by drying it suitably, impregnating it with tar, pitch, bitumen, rosin, essences and oils of coal, any carbon of hydrogen, sugar, caramel or other matter possessing analogous properties.

I distil it slowly so as to expel the volatile bodies; I impregnate it anew and redistil it as many times as necessary, and finally I heat it to a high (degree of) temperature in a reductive atmosphere.

For objects which need a very pure carbon, like the pencils for electric lighting, it is good to wash the carbon object when it is still porous with acids and alkalies, so as to dissolve the impurities which it may contain, and to rinse it afterward in plenty of water.

I can also heat it to red heat and submit it during a certain time to the action of chloride of carbon, hydrochloric and hydrofluoric gaseous acids. I finish by vapors of carburet of hydrogen capable of stopping the pores by depositing carbon in them.

3923 I also manufacture articles of carbon from cotton, hemp, flax, cellulose in any state, kneaded and impregnated with pitch, tar, etc., and formed so as to give it the desired shape. I finish them as if the object were of impregnated wood.

To recapitulate:

By the present certificate of addition I claim the manufacture of crucibles, pencils for electric lighting and electro-chemistry, vases and utensils of any kind, by converting the wood and the cellulose into carbon by the means described above, or by analogous means.

Paris, 7th April, 1877.

(Signed) OCTAVE GAUDIN.

Comptes Rendus LXX, 605; *Paris*, 1870.

Action of carbon sulphide and carburetted gases upon wood charcoal.

M. SIDOT.

In a preceding work I showed that carbon sulphide was decomposed by charcoal, that the latter increased in weight and that sulphur was liberated. While pursuing those researches I examined how carbon sulphide acts upon certain organic bodies of vegetable or animal origin.

Into a tube of porcelain I introduce small bundles of wood, over which I pass cold vapor of carbon sulphide, so as to expel all air from the tube. This result obtained, I heat the tube slowly and gradually to a red heat, for about one hour.

After cooling we find in the tube rings of a carbon different from ordinary carbon in physical properties. The essences of the most divers wood, ash, box, hornbeam, lilac, elder and cork may give rise to this new carbon.

What particularly distinguishes it is its sonority, like that of bodies called the most sonorous, such as steel, silver, alumin-
3924 ium, glass, etc. I have the honor to submit to the eyes of the academy some specimens of these sonorous carbons.

When we suspend them by a string and strike upon them, they give a metallic sound.

Wishing to obtain a sonorous instrument with this carbon, I turned a bell of ash, and I submitted it to the action of carbon sulphide after the process just described. This piece of ash became a bell, which also I present to the academy; it gives a sound comparable to that of a metallic bell of the same diameter. I conclude that it would be easy to reproduce a gamut with a xylophone of carbon, and to construct a harmonicon of carbon bells.

Very hard woods seems to give the purest and most harmonious sounds.

These same carbons, distinguished so clearly from ordinary ones, by their elasticity, also differ widely by their great conductivity of heat and electricity. I think they might replace the carbons in the Bundsen cell.

The pencils made of them give an electric light far more intense than the light obtained with carbons from gas retorts.

This carbon conductor heats up like a metal and becomes progressively incandescent in the whole mass, without igniting at one point, like ordinary carbon; it cools as soon as it is removed from the fire. It may be characterized from a point of view of conductivity as wood charcoal transformed into coke.

I have obtained similar results from flax, hemp, cotton paper and silk.

The carbon obtained from wood has a metallic lustre, but this lustre is only superficial.

It has a greater density than wood carbon.

It does not perceptibly absorb gases. I should mention in this connection, that by heating the wood to a high temperature in crucibles filled with finely pulverized cinders, we obtain likewise a carbon deprived of absorbent qualities, and besides a good conductor.

3925 Carbon sulphide is not the only agent for this remarkable change of wood into sonorous conductive carbon. Wood spirit, hydrocarbons, etc., similarly change wood into elastic conductive carbon.

More than this; I assured myself that by passing vapor of methylic alcohol over wood heated red, this vapor was decomposed, and the interior walls of the tube were carpeted with a very singular carbon at the same time.

This carbon, in fact, presents itself in the form of filaments, one centimetre in length, constituting a kind of silky and frothy coke of a silvery white. These filaments seem to be formed of small juxtaposed balls.

3926

CONSOLIDATED E. L. CO.
vs.
McKEESPORT L. CO.

DEFENDANT'S EXHIBIT PROF. CROSS' REPORT OF 1881 (No. 1). April 20, 1887. W. F. F., S. E.

MASS. INST. OF TECHNOLOGY, BOSTON, *June 23d*, 1881.

F. H. Betts, Esq.

DEAR SIR: I have examined the American patents and the various works on electric lighting with reference to the matter of the resistance of incandescent lamps previous to the date of Mr. Edison's patent. I have not yet looked at the English patents, preferring not to delay longer before writing to you. I will look them over to-morrow or next day.

From all the statements that I can find, or calculations that I can make, based upon these statements, I should say that the lamps previous to Mr. Edison's patent had a resistance of not over five ohms, and generally much less than this. I infer this from the statements made regarding the size of carbons, in which they are called "pencils," "small rods," &c.; also from the measured dimensions as given in the drawings of said lamps. In Sawyer's book on lighting by incandescence, p. 90, the resistance of his lamp is stated to be twenty-five one-hundredths ohms.

The only statement regarding higher resistance is in Sawyer's book, and also in his patent No. 205,303 (distribution of lamps), the resistance of lamp is called 10 ohms when hot, "practically *nil*" when cold, "practically *nil*" being, I suppose, one-quarter ohm.

But the effect of heat on carbon (unlike its effect on metals) is to diminish its resistance, this diminution being, according to Mathieson, about 12 per cent. when the carbon is raised to incandescence. The increase of resistance from heating of the metallic conductors could not be great in any lamp that could be practically used, so
that I am inclined to think that the number, 10 ohms, is
3927 stated at a venture. Mr. Edison could probably solve this
question immediately from his practical knowledge.

By the way, can the Sawyer patent, No. 205,303, for distribution of lamps, be held? The principle on which any resistance should be arranged for maximum effect has been familiar to every scientific man for the last forty years.

Compared with all these actual resistances (up to 5 ohms), that of the Maxim lamp is certainly "high" beyond a question. The only point regarding which an objection could be made is that one hundred ohms is the lowest resistance mentioned in the Edison patent. On the other hand, Mr. Edison here describes for the first time (if I am right) a process by which a carbon filament can be made practically. No carbon rod of, say 20 ohms resistance upward, could readily be made to emit light by incandescence by any current that could be practically and economically employed. At least this, I should judge, to be the case. Hence, is not Mr. E. justified in claiming that even 20 ohms would be a high resistance. If only 5 ohms as a maximum were used before, if Mr. Edison's process is a new one, giving the possibility of making high-resistance carbons, it seems to me that even though the ratio of 5 to 20 is the same as 20 to 100, the claim can readily be held. Here your suggestion that the possibility of using lights in multiple arc is an index of their high resistance in the terms of the patent, might be available. But the Maxim lamp has a resistance of 40 ohms.

As to the sealings of the Maxim lamp. I have entrusted an analysis of the blue and black substances used in sealing to a competent chemist, who will give me his report by the close of this week or first of next. Meanwhile, I will say that from a careful examination of fragment of the material after cutting it, we are pretty well convinced that it is a glass or an enamel. The blue is probably colored with copper, the black with iron (?) and manganese. The chemist thinks it may be a borax glass for easy 3928 fusion. He thinks the only possible claim that could be made is that it is "enamel," which is a kind of glass. As to this last point, I have not looked up the chemistry of glass, thinking it hardly necessary just yet. The Encyclopedia Britannica and Appleton's Encyclopedia both speak of enamel as a glass, and the latter classifies it under the kinds of glass! The conducting wires are sealed into the glass, as in Edison's lamp. It seems to me, then, that the Maxim lamp and Mr. Edison's are substantially the same thing.

I believe that I have touched upon all the points mentioned by you. I will write again as soon as I have heard from my chemist.

I am yours very truly, CHAS. R. CROSS.

(Endorsed.)

16. 19074. 16.

JUNE 23, '81.

Prof. Chas. R. Cross to F. H. Betts, giving result of investigations in resistances of lamps prior to Edison's lamp in American patents.

3929

CONSOLIDATED E. L. CO.
vs.
MCKEESPORT L. CO.

DEFENDANT'S EXHIBIT PROF. CROSS' REPORT of 1881 (No. 2). April 20, 1889. W. F. F., S. E.

BOSTON, *June 24th*, 1881.

F. H. Betts, Esq.

MY DEAR SIR: I have to-day looked over the various English patents relating to electric lighting by incandesence. I find nothing to change my opinions as expressed in my letter to you. The only light about whose very low resistance there is any question is Werdermann's, but in this incandescence proper as distinct from a very minute voltaic arc is distinctly disclaimed.

Very truly yours, CHAS. R. CROSS.

(Endorsed.)

17. 19074. 17.

JUNE 24, '81.

C. R. Cross to F. H. Betts: Have examined English patents and find nothing to change conclusions arrived at in letter of 23d inst.

3930 (*French Patent Records, 2d Series, Vol.* 16, *p.* 223.)

4606.

Patent for fifteen years.

Dated Jan. 31st, 1849.

To Mr. Le Molt, of Paris.

For improvements applicable to the apparatus suitable for electric lighting.

A first improvement relates to the elements of the pile, another to a double movement which is given to the carburetted material that serves for the production of the electric light.

One of the elements of the pile is a carbonized material, in the form of a cylinder or of a plate, more or less thick and hardened by compression. This material may be composed of—

Ashes of gas retorts..................................	4	parts.
Liquid tar..	1	"
Ashes of retorts..	2	"
Charcoal...	2	"
Liquid tar..	1	"
Coke...	2	"
Tar of bitumen...	1	"

All these substances, pulverized, sifted, and mixed with the liquid tar, are brought, by a powerful trituration, to the state of a hard and consistent paste, and to this paste any desired form is given, by compression and in a mould; then it is covered by a thick syrup of sugar or molasses. These moulded pieces are placed in a retort, almost closed, and which is gradually raised to the temperature of a high furnace; after twenty or thirty hours they are withdrawn to be used.

The inventor has had the idea of galvanizing the carbon element, that is to say, of covering it with a coating of metal so as to connect the two carbon and zinc elements by a metallic handle.

On plate XXIX, Fig. 1, may be seen a carbon element and 3932 a zinc element, connected by a metallic handle.

The metallic elements of the pile are covered with a varnish which preserves all the non-acting portions of the elements from oxidation; copal varnish will suit very well.

(Here follows diagram marked p 3931.)

The vessels containing the acid liquors which are to act on the elements have curved sides, as shown in figure 3, so as to avoid the projection of the liquids outside of the vessels.

Figure 5 shows the arrangement of the element in the vessels.

1, carbon element;

2, porous vessel filled with nitric acid;
3, zinc element;
4, exterior vessel filled with sulphuric acid, more or less diluted.

As electrodes, the inventor employs any carbonated matter in the form of disks. The two disks are kept a suitable distance apart and turning on metallic axis placed in communication with the poles of the generating apparatus. At each turn the two disks approach each other a little so that, on account of the part that is burned, they remain constantly at the same distance.

Figure 4 represents an apparatus of rotation and of joining combined.

A, A, A, wheels, with pulleys and grooves of metal, fixed to the carbon disk, and serving to give them a rotary movement with the aid of the two endless chains, C, C.

B, B, axis of the carbon disk.

D, insulating materials.

E, E, contacts, one of them with roller, to facilitate the approaching of the disks.

F, double approaching wheel with eccentric rims. This is also a toothed wheel, causing the disks to turn.

3933 *Certificate of Addition.*

Dated July 24th, 1849.

This addition consists in employing a metallic wire placed in connection, at its two ends, with the conductors ending at the poles of the battery, and brought to a very high degree of incandescence, which produces an illumination. This wire is usually of platinum or of iridium, arranged in more or less drawn-out spirals, and admitting, besides, of any other arrangement.

Certificate of Addition.

Dated 14th September, 1849.

For carbon elements, charcoal alone may be used, or coke mixed with tar.

3934 COMPLAINANT'S EXHIBIT SCIENTIFIC AMERICAN ARTICLE No. 2.

Published in the "Scientific American," in New York, on December 7, 1878.

The Sawyer-Man Electric Lamp.

The practical usefulness of the electric light for illuminating open spaces and wide areas has been amply demonstrated by the various devices for using the electric arc already widely employed. Hitherto, however, it has not been found economical, or even possible, as we understand it, to construct a lamp or candle, based on the electric arc, that would answer the requirements of ordinary, domestic and industrial lighting, where a moderate amount of light, well distributed, easily manageable, and of perfect steadiness and softness is needed. The electric arc seems, from its very nature, to present insuperable obstacles to the economical production of a large number of small lights in a circuit; in other words, such lights as we require in our dwellings, offices, factories, shops and the like. And if there were no other means of obtaining light from electricity, the probability of the displacement of gas by it for the purposes of general illuminating would hardly be worth considering.

The production of light through the incandescence of a pencil of carbon or metal, forming part of an electric circuit and highly heated by its internal resistance to the passage of the electric current, offers an entirely different field for exploration; and though it has long been apparently closed by the failure of early attempts to obtain an electric light by such means, the achieved success of Messrs. Sawyer and Man, not to speak of the reported success of Mr. Edison, clearly indicates that this is the line along which the practical solution of the problem of household illumination by electricity is to come. The lamp, to be described further on, lacks
3935 only the practical demonstration of its economy by protracted
use on a large scale, to compel acceptance as a successful solution of the problem.

So long ago as 1845, an American inventor, Mr. King, patented here and in England a lamp (said to have been invented by J. W. Starr) involving this principle. His light was produced in a vacuum, to prevent the oxidation of his incandescent carbon or metal, and was extremely promising for its beauty, brilliancy and steadiness. But it failed to be permanent and economical from various defects and deficiencies, some of which have been removed by the increased power and economy of modern dynamo-electric machines, and by recent advances in the art of subdividing the electric current, but the most of them by the inventions and discoveries covered by Messrs. Sawyer and Man's patents.

The economical division of the current, or more correctly the light produced by a single current—popularly believed to be very difficult if not practically impossible—has been successfully worked out by several American investigators. As long ago as 1875, Mr. Moses G. Farmer, now electrical superintendent of the U. S. Naval torpedo station, at Newport, R. I., subdivided the electric current produced by a small machine, into forty-two different branches, putting a light to each branch. Mr. Sawyer's system appears to be able to do the same indefinitely through the maintenance of a uniform resistance throughout the circuit and equal resistances in the several parts of the circuit, as will be shown further on.

The adaptability of this form of electric lighting to the needs of household illumination is indicated in Fig. 1. The light produced is pure, strong, and yet soft, like sunlight. It is, moreover, steady and cool. It is not influenced by air currents; and it does not vitiate the air by poisonous products of combustion, nor by withdrawing the vitalizing oxygen. The lamp takes up less room than

the glass shade of a gas jet, and no more than the chimney of an oil lamp. To a limited extent, also, it is portable, and may be used as a drop light. The general appearance of the lamp is
3936 shown Fig. 2 (page 354). The light is produced by the incandescence of the slender pencil of carbon placed as shown in the engraving. The light-giving apparatus is separated from the lower part of the lamp by three di-phragms, to shut off downward heat radiation. The copper standards lower down are so shaped as to have great radiating surface, so that the conduction of heat downward to the mechanism of the base is wholly prevented. The structure of the base, full-size, is shown in Fig. 3 (page 355). No detailed description of this portion will be required, further than to say that the electric current enters from below, follows the line of metallic conduction to the "burner," as shown by the arrows, thence downward, on the other side, connecting with the return circuit. The light-producing portion is, of course, completely insulated, and also sealed at the base, gas tight.

A fatal defect in all previous lamps depending on incandescent carbon has arisen from what has been called the "vaporizing" of the carbon. This Mr. Sawyer holds to be an absurdity, since the carbon is not even fused. The wastage of the carbon in mercurial vacuums, and in atmospheres of compound gas, is due, he holds, to chemical decomposition. Many gases, indifferent to carbon at ordinary temperatures, attack it destructively at temperatures obtained in the electric lamp; and the process is continuous, the carbon taken from the burner being redeposited on the glass case, and the gas left free to continue its depredation. Mr. Sawyer claims to have overcome this difficulty by his method of charging the lamps with pure nitrogen, and by providing for the fixing of any residual oxygen left in the lamp. In this way an unwasting carbon is secured. Another stumbling block on which other workers in this field have come to grief, has been the crumbling or disintegration of the carbon burner, due to sudden heating when the lamp is lighted. This is avoided in the Sawyer-Man lamp by an ingeniously devised switch, shown in Fig. 4. By this means it is impossible to turn the current on or off suddenly, to the disruption
3937 of the carbon. This, however, is not the only nor the chief advantage of the switch. It is, indeed, the key to the entire problem, the indispensable condition, Mr. Sawyer holds, of practical electrical distribution.

It is well known that an electric current will exactly and readily divide among circuits of equal resistance. Accordingly, if the resistance of a subcircuit be maintained constant, no matter what may be going on it, whether a lamp is not lighted at all, or lighted to a mere taper, or to any intermediate stage up to full brilliancy, it is obvious that no other lamp or lamps in that circuit will be affected. The operation of the switch, in securing such uniform resistance, is shown in the accompanying diagram, Fig. 5 (page 355).

The lamp has, let us say, a resistance of 0·95 of an ohm. Therefore if one lamp is out there should be a resistance of 0·95 of an ohm in its stead This is the shunt resistance, B. The current enters at the " + " point, and leaves at the " — " point. The contact piece, A, bearing upon the two studs 1, 1, all the current passes out by way of B. When A is moved to the studs, 2, 2, the current divides, $\frac{1}{4}$ going through the lamp, the other $\frac{3}{4}$ by way of B, and the resistance of the combined circuit is $0{\cdot}31\frac{2}{3}+0{\cdot}95=1{\cdot}26\frac{2}{3}$ in the shunt; and $1.9+0{\cdot}38+25\frac{1}{3}+18\frac{2}{21}+0{\cdot}07\frac{5}{12}+0.06\frac{1}{3}+$ (the lamp) $0{\cdot}95=3.8$. The resistance of the circuit is, therefore, $\frac{1{\cdot}26\ 2{\cdot}3\ 1/3{\cdot}8}{1{\cdot}26\ 2{\cdot}3+3\ 8}=0{\cdot}95$ of an ohm, and so on. In short, the resistance of the cirucit is constant at 0.95, no matter what may be the change in the proportion of the current given the lamp, as may be seen by making the required calculation for each pair of studs. The varying resistances required to give the best effect have been worked out by practical trial. The effect of $\frac{1}{4}$ the current through the lamp is to make the carbon a dull red. On studs 3, 3, one-half the current passes through, and the carbon becomes a bright red. On studs 4, 4, the lamp gets $\frac{5}{8}$ of the current and becomes white hot. On 5, 5, the lamp gets $\frac{3}{4}$ of the current, and begins to assume the intense limpid incandescence of the sun; and the light increases rapidly with subsequent changes until the whole current goes through the lamp.

3938 Thus it is seen that the greater part of the illumination is the product of a small part of the current. When the light is well on, a very slight increase in the current increases the light enormously. It is here that the great loss occasioned by dividing a fixed current among several lamps finds its explanation. A current that suffices in one lamp to produce a light, say of 100 candles, will, if divided between two lamps, give in each perhaps no more than ten candles, or even 5, making a loss of 90 candles in the sum total. But if the current be doubled, each lamp will give a light of 100 candles and the sum total will be 200 candles instead of 10. Having brought a candle or a system of candles up to the point of feeble incandescence, a (proportionally) small addition to the current will make them all brilliant. If at 6,000° Fah., a given carbon will produce a light of 3 candles, at 12.000° it will give 9 candles, and at 24,000° it will give 81 candles; the illuminating power increasing with vastly greater rapidity than the temperature.

The wires supplying the current may be run through existing gas pipes, each lamp being provided with a switch placed conveniently in the wall; and by simply turning a key the light is turned up or down, off or on. So long as the house is connected with the main it makes no difference to the producer whether all the lights are on or off, since the resistance of the entire (house) circuit must be overcome; though it will to the consumer, since a meter records the time that each lamp is on, and the charge is rated accordingly. If the Dynamo-Electric Light Company can supply the illuminating force so cheaply that the constant and brilliant illumination of all the rooms of a house can be secured at no greater cost than the partial and intermittent illumination now had from gas, it is obvious that the electric light will score an important point. The cost of lamps and switches, it is claimed, will not exceed that of gas fixtures.

The meter above referred to is shown in Fig. 6. It is a simple clock arrangement, with an attachment designed to throw
3939 the dial hands into connection when a light is on. From each switch a pair of conducting wires are run to opposite studs on the wooden disk shown at the top of the figure. When no current passes through the lamp the revolving spring shown in front of the studded disk turns without making any record. When the current is on, one electric connection at each revolution is made through the pins assigned to the particular lamp, the armature of the magnet is moved, and the recording wheel is advanced one notch. This meter does not measure the quantity of electricity passing, but only the time a lamp is on. If two or any larger number of lamps are on, an equal number of connections are made at each revolution of the wheel, and the record wheel is advanced to correspond. This registration is, of course, a mere matter of business detail. In view of the well-founded popular dislike to gas meters, however, it would seem to be desirable to dispense with such devices entirely; and the nature of electric distribution appears to favor other and less objectionable modes and means of determining the financial relations of producers and consumers.

Figs. 7 and 8 indicate the method proposed for general distribution. Where the main is tapped for a subcircuit, a shunt is introduced so as to throw so much of the current as may be needed into the derived circuit. The resistance of say 100 added lamps will be about 100 ohms. By giving to the shunt a resistance of one ohm, 1–100 of the current will be diverted, and the lamps supplied. When a large number of lamps are required in a circuit, a combination of the two plans indicated is employed.

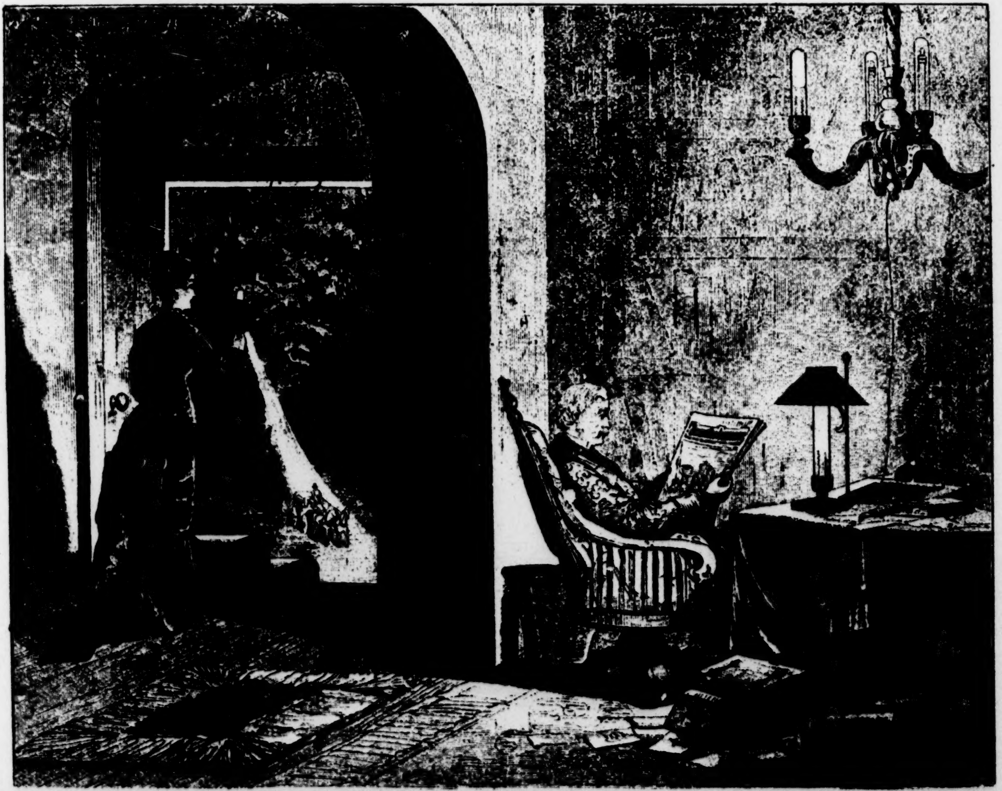
The diversion of any portion of the electric supply into an added circuit, whether one house or a group of houses, necessarily increases the aggregate resistance of the electric district, and calls for more work from the generator. To meet such contingencies automatically, Messrs. Sawyer and Man have invented and patented a regulator, which responds instantly to any increase or diminution in the demand, thereby securing an absolutely uniform volume of current.

(Here follow diagrams marked pp. 3940, 3941, 3942, & 3943.)

3944 This regulator so controls the steam or other power actuating the generator of electricity, that the amount of power supplied is increased or diminished in exact proportion to the demand, either by changing the volume of steam produced, or by coupling on or detaching different generators or parts of a single generator in circuit.

With regard to the cost of this mode of electric lighting no positive figures can be given. It is claimed to be entirely demonstrated that one norse power will give by the Sawyer-Man system of incandescence a light of 30 five-foot gas burners an hour. Where large powers are employed the cost of steam power, every item included,

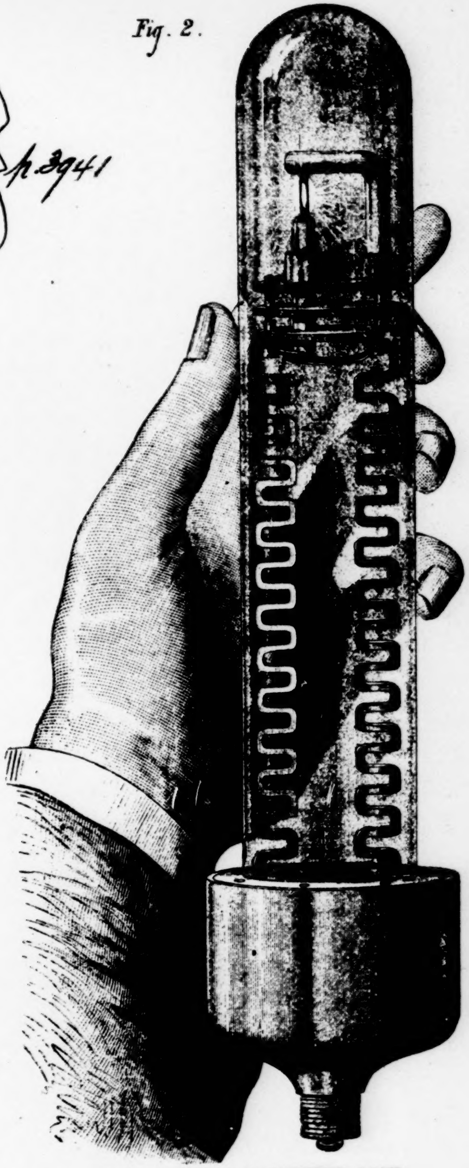
No. 286.
A. Light
v.
W.H. Light.
p. 3940



THE SAWYER-MAN ELECTRIC LIGHT.

No. 286.
C.E. Light Co.
v.
McK. Light Co.
p. 3941

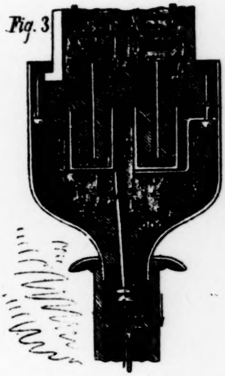
Fig. 2.



THE SAWYER-MAN ELECTRIC LAMP.

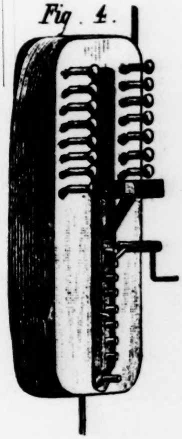
No. 286.
C. E. Light Co.
v.
McK. Light Co. } p. 3942

Fig. 3



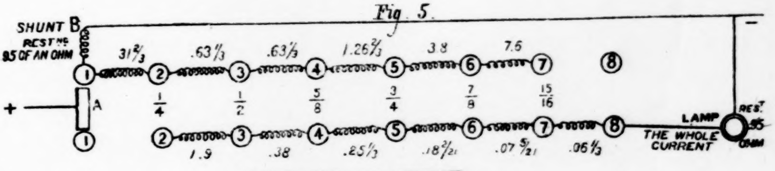
BASE OF SAWYER-MAN LAMP.

Fig. 4.



THE SWITCH.

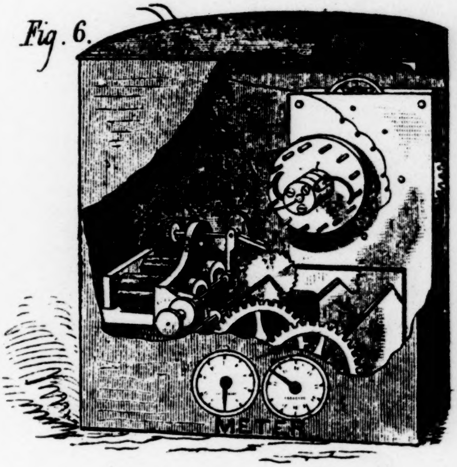
Fig. 5.


SHUNT B
RESTNG .95 OF AN OHM
31⅔
.63⅓
.63⅓
1.26⅔
3.8
7.6
1
2
3
4
5
6
7
8
−
+
A
1/4
1/2
5/8
3/4
7/8
15/16
1
2
3
4
5
6
7
8
1.9
.38
.25⅓
.18 2/21
.07 5/21
.06⅓
LAMP
THE WHOLE CURRENT
REST. .95 OHM

PRINCIPLE OF SWITCH.

No. 286.
C.E. Light Co.
v.
McK. Light Co. } p. 3943

Fig. 6.



THE SAWYER-MAN METER.

Fig. 7

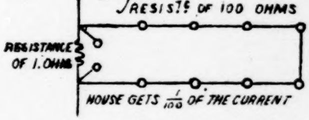

RESIST^S OF 100 OHMS
RESISTANCE OF 1. OHMS
HOUSE GETS 1/100 OF THE CURRENT

Fig. 8.

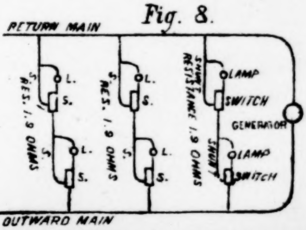

RETURN MAIN
S.
L.
S.
RES. 1.9 OHMS
SHUNT RESISTANCE 1.9 OHMS
LAMP
SWITCH
GENERATOR
SHUNT
OUTWARD MAIN

Fig. 7.—DERIVED CIRCUIT. Fig. 8.—BRANCHED CIRCUIT.

is commonly rated at one cent per horse power per hour. The cost of 150 feet of gas at New York rates is 41 cents, which would make the gas over forty-fold dearer than the Sawyer-Man light. Mr. Sawyer does not stand on this estimate, however, holding that even if the electric light should prove in practice on a large scale to be ten times as costly as calculation indicates, it will yet easily compete with gas, the light furnished being so much better and purer.

It is promised that facilities will soon be offered for the photometric test of a large number of lights, in a circuit, with dynamometric tests of the power employed in generating the electric supply. This, as already noted, is all that the system lacks to prove itself an accomplished economical fact.

3945 Defendant's Exhibit Times Article of Oct. 30, 1878.

A New Electric Light.

The Electro-Dynamic Light Company ready to commence operations.

An interesting exhibition of a new electric light was given by the Electro-Dynamic Light Company yesterday afternoon, at the corner of Elm and Walker streets. The new light is the invention of W. E. Sawyer, of this city, and Albon Man, of Brooklyn. It is a very simple affair, consisting of a small pencil of carbon, a little larger than an ordinary pin, connected by wires with an electric machine, and enclosed in a hermetically sealed glass globe which is filled with pure nitrogen gas. The pencil of carbon is heated by the electric current to a temperature of from 30,000° to 50,000° Fahrenheit in an atmosphere with which it cannot chemically combine. The carbon is practically indestructible and the light is therefore produced without any consumption of material. In the experiments made yesterday five lights were placed in different parts of the darkened room and all connected by wires with a small Hochhausen electric machine in an adjoining room. A simple key was placed in one of three ordinary keyholes in one of the walls and turned a little. Two of the burners attached to a hanging chandelier in the centre of the room immediately glowed faintly and as the key was turned still further around, the glow increased, until a brilliant and perfectly steady white light was obtained equal to the light of 12 ordinary gas jets. The key was then turned in another of the keyholes and another of the lamps was "lighted up." In the same way the fourth and fifth burners were ignited and there resulted an exceedingly brilliant white light, yet so soft and steady that it did not pain the eyes. The lights were easily turned to any desired degree of brilliancy from that of a mere spark to a light of six times the intensity of the common gas jet—that being the
3946 maximum power of the lights in use yesterday. The company asserts its ability to easily fit up lights equal to 30 gas-burners. By a very simple "switch" in the wall the current of electricity is divided and subdivided to supply any number of burners

desired, the electricity reaching the switch from the generator through a single wire. The light is turned on or off, or regulated to any degree merely by turning a key which operates the switch. Messrs. Sawyer and Man have recently taken out a number of patents covering all the points of their new invention which are now the property of a stock company which has been formed to introduce the light to the public.

The plan is similar to that proposed by Edison—the establishing of central stations in various parts of the city from which powerful electric generators will supply the necessary electricity. The company claims to be able to supply the electric light at one-fortieth the cost of ordinary gas. Whether this will prove true or not remains to be seen. The difficulty of a meter has been overcome by the invention of a meter which will record the number of burners used in any given house, and the number of hours each burner is lighted. The measurement of the electricity used would involve so complicated and delicate instruments that the time plan has been adopted. Mr. Sawyer asserted yesterday that Mr. Edison was behind time with his much trumpeted light, as the Electro-Dynamic Company have their light nearly ready for the public and every necessary point is covered by patents of recent date."

3947 U. S. Circuit Court, Western District of Pennsylvania.

THE CONSOLIDATED ELECTRIC LIGHT CO.
vs.
THE MCKEESPORT LIGHT CO.
In Equity.

I, William T. Farnham, special examiner, herein duly appointed, do hereby certify that the foregoing are the proofs for final hearing taken before me in behalf of defendants under the 67th rule of the U. S. Supreme Court in equity as amended under the orders for that purpose herein duly entered.

I further certify that on the dates in said record set forth, the witnesses named therein, to wit, John M. D. Keating, William Hochhausen, William Sharp, Walter K. Griffin, Thomas A. Edison, Cyrus F. Brackett, George F. Barker, William P. Wilson, Amos Broadnax, Henry E. Vineing, Charles Batchelor, William Holzer, Grosvenor P. Lowrey, Calvin Goddard, Robert M. Gallaway, James Hood Wright, Richard N. Dyer and John C. Tomlinson appeared before me and having been by me first duly sworn, they gave their depositions, which were reduced to writing partly by myself and partly by stenographers and typewriters, by consent of counsel for the respective parties, and that said witnesses thereupon signed their several depositions.

I further certify that I am not of counsel or attorney for either of the parties nor in anywise interested in the event of said cause.

I further certify that R. N. Dyer, Grosvenor P. Lowrey, Walter K. Griffin and H. D. Donnelly, Esquires, appeared on behalf of de-

3948 fendants and Thomas B. Kerr, Amos Broadnax, Samuel A. Duncan and Leonard E. Curtis, Esquires, appeared on behalf of complainants at the times and places stated in said record.

Dated New York, May 17th, 1889.

WILLIAM T. FARNHAM,
[SEAL.] *Special Examiner and Notary Public.*

3949 EDISON'S EXHIBIT NO. 10. W. H. M., Notary Public, N. Y. C.

DEF'T'S EXHIBIT NO. 10. W. T. F., S. E.

CONSOLIDATED E. L. CO.
vs.
MCKEESPORT CO.

Edison's Electric Light.

By Francis R. Upton (Mr. Edison's mathematician).

Editor Scribner's Monthly.

DEAR SIR: I have read the paper by Mr. Francis Upton, and it is the first correct and authoritative account of my invention of the electric light.

Yours truly, THOMAS A. EDISON.

Menlo Park, N. J.

The crowning discovery of Mr. Edison—the electric light for domestic use—is at last a scientific and practical success. A mistaken idea has been afloat that this new light was intended to be a rival of the sun, rather than what it really is,—a rival of gas. The contrivances of the new lamp are so absurdly simple as to seem almost an anticlimax to the laborious process of investigation by which they were reached. A small glass globe from which the air has been exhausted, two platinum wires, a bit of charred paper—and we have the lamp. The generator of the electricity is simpler than a gas-generator, and the wires for its distribution are more manageable than are gas mains and pipes. The light is equal to gas in brightness and whiter in color; it is inclosed and, consequently, perfectly steady; it gives off no appreciable heat; it consumes no oxygen; it yields up no noxious gases, and, finally, it costs less than gas. The difficulty of subdivision Mr. Edison has also overcome; in his method of illumination a number of separate lights can now be supplied from the same wire, and each one, being independent, can be lighted or extinguished without affecting those near it.

In order to a clear comprehension of the electric light, a few words upon the general subject are necessary. All illuminants are produced by the incandescence or white heat of matter. This matter may either be in a finely divided state—the particles widely separated—as in the flame of candles, lamps and gas jets, or an aggregation of particles, as in the calcium light. Both of these methods

have been used in the various systems of electric lighting. Electricity flowing through a conductor generates a quantity of heat proportioned 1, to the amount passing through, and 2, to the friction, or resistance, of the medium. Ordinarily, the amount is hardly appreciable in a good conductor. When, however, a poor conductor forms part of the electric circuit, a heat is generated that, under certain conditions, rises steadily to whiteness, causing the substance forming the imperfect conductor to become luminous. If the wire of an electric circuit be cut and the two ends, after being touched, are drawn slightly apart, the current leaps the chasm and a spark appears which vaporizes a small portion of the metal, and this forms a sufficient conductor to enable a constant electrical current to flow from end to end of the wire. When the two ends of the severed wire are properly tipped, a continuous and brilliant light may be produced. Carbon is found to be the best material for these tips, and so long as the current flows and the distance between the points is properly regulated, a storm of white-hot carbon particles is carried across the space, giving a brilliant illumination. This is the voltaic arc, a light produced by the incandescence of finely
3950 divided matter. The broken circuit may be completed by the interposition of some solid matter capable of sustaining a white heat without melting. Platinum and carbon were long thought to be the forms of matter which would best answer the purpose.

These methods of utilizing electricity presented so many difficulties that it was thought impossible to use either for domestic purposes. The objections to the voltaic arc were that the carbon did not offer sufficient resistance to the passage of the current, and that it wasted, the light therefore requiring either continual attention, or else some complicated mechanism, both troublesome and expensive, to keep the distance between the carbon points constant. (See Fig. 3.) The objections to platinum lay in its great cost and rarity, and the fact that its point of fusion is too low to ensure its successful use as the source of light. And finally the objection to all known methods was that the conductors necessary to the supply of any lamp then known would have been of such enormous cost and size as to be impracticable for general use.

In order to understand the difficulties of the problem presented to Mr. Edison, and the simple perfection of his lamp, a short summary of the history of the electric light will be necessary. The first method of illuminating by electricity was by the voltaic arc. About twenty years after the discovery of galvanism, or the modes of generating electricity by chemical decomposition, the voltaic arc was discovered by Sir Humphrey Davy. The battery of a single cell was succeeded by those of multiplied power. In 1812, by the use of a battery of 2,000 cells, Davy succeeded in producing an intensely brilliant arc measuring five inches. The experiment was, however, a very costly one, and had apparently no practical outcome; yet the effects produced by it were so brilliant that Professor Dumas, who repeated it in Paris, in 1834, predicted its final success as an illuminant, in spite of the enormous cost—six dollars a minute. For a number of years no improvement was made, the batteries then in existence being incapable of supplying a constant and steady flow of electricity. Daniell's invention in 1836 of a constant battery, used still in telegraphy, and Grove's improvement in 1839, of electrical generators, gave a new impulse to inventors. A constant and powerful current being supplied by these two inventions, the practical use of it was shortly afterward made in Morse's telegraph. In 1845, about the same time, we find that the first mechanisms for regulating the distance between the carbon points were independently invented by Staite and Foucault, who thus in another direction utilized the electrical power supplied by the batteries. Staite's patents show great inventive genius; in one of them there is a well-defined suggestion of the widely known Jablochkoff candles. In this field of research, as in so many others, the earlier investigators possessed a clearness of vision which enabled them to see further and more accurately than those who came after. Staite, before 1850, produced an electric light, which was exhibited in England, and was so favorably received that a company was organized and gas stock suffered a panic. Many other inventions were made, with a vast expenditure of time, ingenuity and patience, which, like those of Staite and Foucault, failed because of their great cost. It is not enough to invent a good light, nor even to perfect its mechanism; the cost of production must be small enough to enable it to compete with all existing methods of illuminating.

Electric lighting had now passed through three stages. It had been a brilliant laboratory experiment, it had been the subject of practical investigation, and it had been advanced to the precarious dignity of occasional use in the theaters and on great festal occasions. At the coronation of Alexander of Russia, the city of Moscow was lighted by numbers of electric lamps suspended in the old bell tower of the Kremlin, a thousand gilded domes glittering in the unearthly radiance, in happy contrast with the quaint arches of the old cathedral close at hand, while the River Moskva was transmuted into a stream of liquid silver.

The year 1860 saw improvements in generators. The force of steam was found to be convertible into electricity. In 1862 Faraday introduced the electric lamp into a British light-house. France and Brazil tried the same experiment, but even this failed to arouse public interest. The invention of the Gramme generator (though an instrument fully anticipating it had been lying for years in the cabinet of an Italian university) at last gave the impetus needed to set the inventors at work. This was soon followed by the Jablochkoff candles, the contrivance by which some streets in Paris are illuminated. So much for the history of illumination by the voltaic arc.

In 1845, to go back to the second method,—that of illuminating
by an incandescent solid,—an American named Starr, backed
3951 by George Peabody, went to England, and took out a patent
for the use of platinum, which had been already employed
in laboratory experiments, although it had never been used for

practical purposes. In the same year Grove speaks of reading by an incandescent platinum spiral.

In 1847, Dr. Draper, of New York, made a number of experiments to test the qualities of highly heated platinum. He used a lever suspended by a straight wire, very much resembling a door latch held by a string. So marked was the illumination from, and the expansion of, the heated wire at the temperature required for the experiment that he wrote: "An ingenious artist would have very little difficulty, by taking advantage of the movement of the lever, in making a self-acting apparatus in which the platinum wire should be maintained at uniform temperature, notwithstanding any change taking place in the voltaic current." This suggestion, though so clear and practical, lay for twenty years unheeded, and would probably have done so much longer, but that Mr. Edison, with no knowledge of it, entirely independently made use of a similar device and proved himself to be the "ingenious artist," in his first electric light invention.

Fig. 1 shows the plan of the apparatus.* The current enters through the curled wire at the left, and flows from one post, P, to the other, P′, through a spiral and out at the right. It is carried to the top of the glass case, G, then through the straight wire, W, to the lever at A, then to the hinge, H, so that it escapes at the right. In passing through the straight piece of platinum wire, W, enclosed in the spiral the heat generated by the current causes the wire to expand. This expansion allows the lever, L, to fall until it touches the point, B. When this is done the electricity takes the short route through the lever and does not pass through the lamp. The wire, W, contracts and the process is repeated.

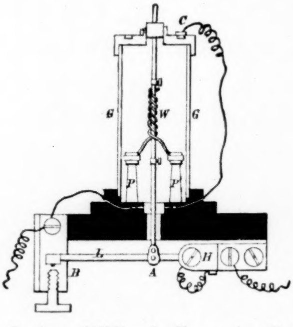


Fig. 1.—*Section of Edison's Expansion Regulator.*

Another method of accomplishing the same purpose is shown in Fig. 2. The current passes, in this case, through the wire, W. In so doing it heats the air in G. The air in expanding forces downward the small metal bellows which is connected with the chamber, until the lever attached below closes the break, B, and short circuits the lamp, allowing the air to cool. These two inventions really belong to the infancy of electric lighting, though invented by Mr. Edison only a short time ago.

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* The portions marked black in the cuts are insulated.

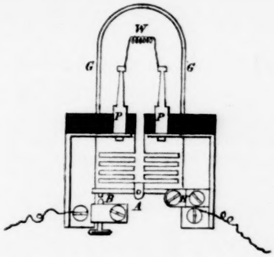

FIG. 2.—*Edison's Pneumatic Regulator.*

In 1849 Despretz describes a series of experiments on sticks of incandescent carbon which were sealed in a glass globe, the air being exhausted, or nitrogen substituted for it. He used several ingenious methods for holding the carbon—patented within the last few years.

So completely had the mode of lighting by an incandescent solid been forgotten, that in 1873 a medal was bestowed by the St. Petersburg Academy on Lodyguine for its supposed discovery, and letters patent were granted to Sawyer and Mann for a stick of carbon rendered incandescent in nitrogen. No successful light by incandescence had, however, been produced when Mr. Edison began his experiments.

In 1878 the lighting of Paris by the Jablochkoff candles was creating a great stir. It had been proved that electricity was really a rival of gas, and that, especially where great concentration was needed, it could take its place. The question now was whether light could be produced in such small amounts as to make it of general domestic use. The money value of an invention which could
compete with gas may be judged from the following items:
3952 The United States has $400,000,000 invested in gas, New
York and the vicinity owning about $35,000,000 of this; England has $500,000,000, $60,000,000 of which is in London. Paris has $40,000,000; Germany $50,000,000, etc. Capitalists, with these figures before them, and the further fact that notwithstanding the great depreciation in plant, the larger portion of this enormous capital was drawing ten per cent., were quick to see an opening for their money and enterprise. Several New York gentlemen, Mr. Grosvenor P. Lowrey and members of the eminent banking-house of Drexel, Morgan & Co. being the most prominent, placed $100,000 in cash at Mr. Edison's disposal, as the requisite means to make the research.

Mr. Edison came to the investigation unhampered by the blunders of his predecessors. He had never seen an electric light. He took hold of the subject in his usual clear-headed, practical way. Next to solving a problem, its intelligent statement is to an investigator the most important thing. Mr. Edison saw that permanence in the lamp and a subdivision of the light were the main things to be sought after. Of the two methods already described, he soon discarded the carbon arc. He perceived that from its nature this arc was inconstant, as its very existence depended upon the destruction of the carbon, and also that it presented greater difficulties in the way of subdivision. Even if he succeeded in conquering the latter

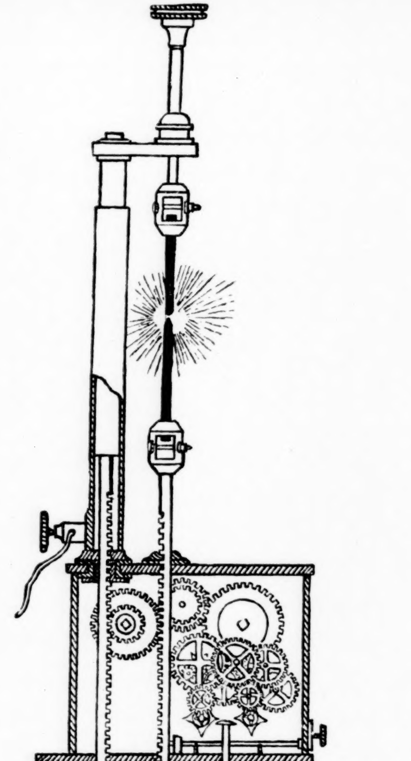

FIG. 3.—*Foucault's Regulator.*

difficulty, and was enabled to produce small lights, the carbon rods waste so rapidly that a system of such lamps would require an expert for every four or five houses to keep it in working order. The most effective apparatus then devised was Foucault's regulator, Fig. 3, which it will be seen is a very complicated piece of mechanism. The Jablochkoff candles, simple as they appear to be, require mechanical contrivances to light them and keep them burning, each candle lasting only a few hours, which makes the constant expense for new burners more than that of the electricity which they can utilize. Mr. Edison, therefore, concentrated his attention wholly upon the light from an incandescent solid.

The advantages of subdivision are twofold and may be explained in a few words. To show that a good gas jet or German student's lamp gives, near the source of light, all the illumination necessary for ordinary domestic purposes, a simple experiment may be tried. A printed page directly under the light, will be seen to be brightly illuminated. After carefully noting this, let another equally strong light be kindled. The room will be brighter, but the page will appear to be scarcely brighter. This is because beyond a certain limit the eye becomes insensible to light. One therefore gains nothing for ordinary use from a single intensely brilliant light. The object of such an illumination being of course to bring, by means of several moderate lights, all parts of the room up to that point where the eye, before it begins to be numb, can utilize the
light. This explains the first advantage of subdivision;
3953 the second is of another kind. Every one familiar with the
electric light, as it has been exhibited, knows that the intense brilliancy of the light and the sharp definition of the shadows as well as their depth, makes it most trying to the eyes. The same amount of light distributed among a number of burners would not give more illumination, but it would be of more practical value, the light would be more diffused, the contrast between light and shadow less sharp and startling. Fig. 4 shows the effect of a shadow from a single brilliant carbon light, and Fig. 5 the effect from sev-

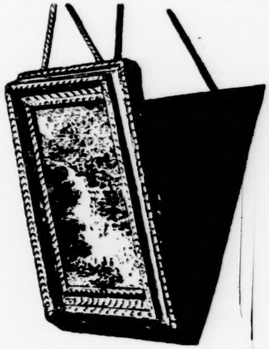

FIG. 4.—*Effect of Carbon Arc Illumination.*

eral shaded lights; the advantage of the latter for practical and domestic use will be readily seen. This is equally true with other illuminators; though gas may be made to give out a brighter illumination per cubic foot when burned in a concentrated form, it is yet more grateful to the eye and less trying when burned as a number of small lights, so that sharp contrast shall be avoided. It is also found that the shape and size of flame, apart from the quantity of light emitted, makes a great difference in this respect—a large light softening the edges of the shadows. The shading of a light, although it obstructs illumination, is useful in diffusing it.

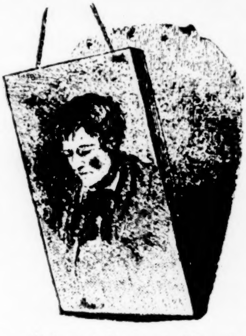
FIG. 5.—*Effect of General Illumination.*

As has been said, Mr. Edison came to the subject unhampered. He saw that subdivision was his goal, and toward that he steadily worked. With a steadfast faith in the fullness of nature, a profound conviction that, if a new substance were demanded for the carrying out of some beneficial project, that substance need only be sought for, he set to work. Two examples of the reward of his faith may be mentioned. One of the great difficulties in the way of illuminating by an incandescent solid—a difficulty constantly urged as insuperable—was that platinum, though the most infusible material which could be drawn out into a wire, still melted at a temperature too low to insure its successful use. Mr. Edison, by experimenting, found that by slowly raising a piece of platinum to a white heat in a vacuum, he could make a practically new metal, the fusing point was so greatly raised. Again, Mr. Preece, chief government electrician in England, declared, and was sustained by many others, that subdivision of the electric light was impossible, because of the enormous size of the conductors and the number of Faradic generators necessary. Edison simply introduced into his lamp an increase of friction or resistance to the electric flow, and the problem was solved.

Mr. Edison's idea in regard to the electric light was that, in all respects, it should take the place of gas. Following the analogy of water, the inventor conceived of a system which should resemble the Holly water works. As the water is pumped directly into pipes which convey it under pressure to the point where it is to be used, so the electricity is to be forced into the wires and delivered under pressure at its destination. In the case of water, after being used, it flows away by means of a sewer pipe, and is lost. But it is easy to imagine that the water used in working machinery, for instance, instead of being lost, might be returned to the pumps and used over and over again. With such a system as this, we should have a perfect analogy to the Edison electric lighting system. The electricity, after being distributed under pressure and used, is returned to the central station. As the light results from no consumption of a material, but is mere transmutation of the energy exerted in the pumping process, it is therefore seen that all which is essential to an electric lighting system is the generator (or pump), 3954 the two lines of wire, one distributing the electricity, the other bringing it back, and a lamp which transmutes into light the energy carried by the electricity when it passes from one wire to the other, and in which the energy of the pressure expresses itself as the light. In Edison's invention the amount of electricity delivered in the lamp is determined by the size and resistance in the carbon, just as in water the amount of flow is determined by the size of the openings. As a great many small jets of water can be supplied from one pipe, so a great many lamps or small escapes for electricity can be furnished from one wire.

As in the case of water, the amount of work done by electricity—either as illuminant or motor—is dependent quite as much upon the pressure from which it escapes as upon the quantity passing through the wires. We might have a system of lamps which would give a certain amount of light from large quantities of electricity escaping under low pressure, or another system which could give an equal amount of light from a small quantity of electricity escaping under high pressure. As in either case the amount of electricity flowing through a wire is in proportion to the size of the wire, it will be readily seen that the application of pressure made by Mr. Edison obviates the main difficulty in the way of subdivision (*i. e.*, in the way of the domestic use of the electric light), namely, the enormous size and cost of conductors. The well-known principle of the effect of pressure upon the dynamic power of electricity had never been utilized because the proper lamp was still unknown. This lamp is Mr. Edison's main discovery. In order to utilize this, one of the plans devised by him was to make the flow of electricity intermittent. Enough was allowed to escape in a short time, say one-third, to keep the lamp all the time supplied. It of course would require a large wire to furnish the quantity of electricity needed, yet two-thirds of the time the wire would be inactive, during which period it could be used to supply two other lamps constructed on the same principle. According to the doctrine of probabilities, one-third of a large number of lamps would be in use all the time. Such being the case, the cost of a conductor would be divided among three lamps. The lamps were so constructed as to burn steadily all the while, although the electricity was passing through them only one-third of the time.

One form of apparatus for accomplishing this distribution among several lamps on the same electrical circuit is shown in Fig. 6. The current conducted by a single wire enters the wire, O, from the lower left-hand corner and flows through the spring, S, by way of B and B; upward through O′, around the magnets, M, M, and out through the lamp, B, B, are two points where the circuit can be broken if the spring, S, is depressed. Two points are made in order that the spark caused by the breaking of the circuit may be made less by division. The spring S is depressed by the arms, C, C, which are attached to the armature, A, by the rod, R. The action is as follows: The current renders the magnet active, it attracts the armature, A, and presses the spring, S, under, stopping the flow of electricity by breaking the circuit at B B. The magnet thus losing its power, the armature is drawn back by the spring to which it is attached and the apparatus is ready to work again. The period of this vibration may be regulated by means of a screw underneath, which can make the excursion of the armature more or less before it breaks the circuit, or can even act to break the circuit itself.

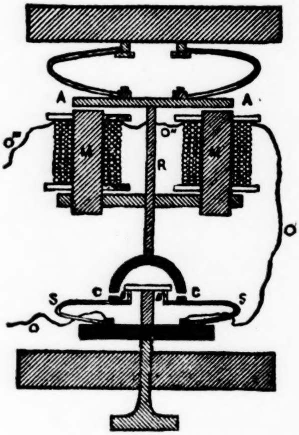

FIG. 6.—*Edison's Vibrating Regulator.*

In making an electric lamp which would be efficient without a regulator (as is Mr. Edison's later invention), two things are essential, great resistance in the wire, and a small radiating surface. Mr. Edison sought to combine these two essential conditions by using a considerable quantity of insulated platinum wire wound like
3955 thread on a spool. This arrangement is shown in Fig. 7.

The spool was made of zircon, pressed extremely hard, and was to be suspended in an exhausted glass bulb by two leading wires. The platinum, as has been incidentally mentioned, was hardened by alternate heating and cooling *in vacuo*, which is done by passing electricity through it till white heat is reached and then cutting it suddenly off. A theory is that the sudden cooling contracts the metal and squeezes out the air contained in it.

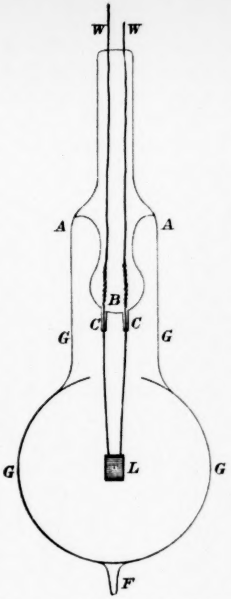
W
W
A
A
B
C
C
G
G
G
L
G
F

FIG. 7.—*Edison's Platinum Lamp. Half size.*

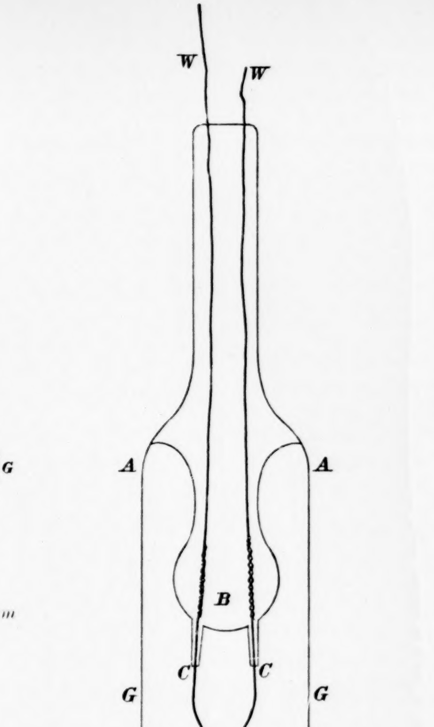
W
W
A
A
B
C
C
G
G
D
D
G
G
L
F

FIG. 8.—*Edison's Electric Lamp. Exact size.*

One of Mr. Edison's greatest difficulties was to get a substance with which to insulate his wires that would not melt, and also become a conductor in the intense heat generated by the current,—in which case the electrical flow instead of traversing the whole length of the wire would flow across from layer to layer, or sidewise from wire to wire. This difficulty diverted his attention from platinum to carbon, which is infusible. He did not suspect, at first, that it could be made to offer sufficient resistance to the passage of the electric current, and that through it he was to reach a happy solution of the entire problem. A long time was spent, with a fair degree of success, in seeking to make a spiral of lamp-black tar in the form of a wire. To hold this together he used a bit of ordinary

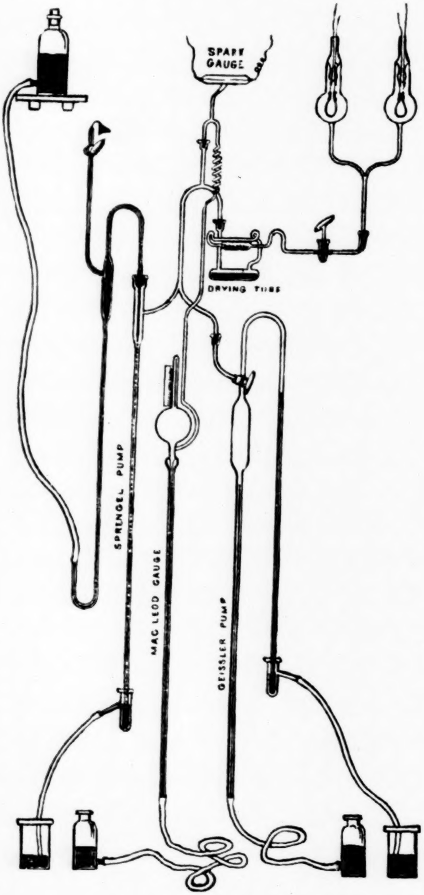

Fig. 9.—*Mercury Pumps for Producing Vacuums.*

sewing cotton which was covered with lamp-black, and succeeded in producing from an inch and a half of this simple thread, bent into an arch, a light equal to an ordinary gas jet. The lamp-black, however, contained air, which greatly interfered with the success of the method. He then used a simple thread, which he found to answer the purpose, though it presented the objection of being fragile, uneven in texture, and unmanageable. This difficulty suggested the use of charred paper, cut into a thread-like form. The difficulties apparently so insuperable melted away. The electric lamp was completed. A piece of charred paper cut into horseshoe shape, 3956 so delicate that it looked like a fine wire, firmly clamped to the two ends of the conducting and discharging wires, so as to form part of the electric circuit, proved to be the long-sought combination. From this a light, equal in power to twelve gas jets, may be obtained. Fig. 8.

The process by which the paper is rendered serviceable is also extremely simple and inexpensive. The horseshoe loops are cut from card-board and placed in layers, within an iron box, with tissue paper between; the box is hermetically sealed, and then raised to a red heat. Nothing remains but the carbon loops and the carbonized tissue paper. All other forms of carbon previously used had presented the difficulty of containing air or gas. The carbonized paper, however, is found to be perfectly homogeneous in structure, elastic, tough, and of an almost vitreous cleavage. It is strong enough to stand far more strain than will be put upon it in any ordinary use. If this paper were burned in air, or in a vacuum prepared by a common air pump, it would of course be almost instantly destroyed. In a high vacuum it burns, but is never consumed. The small glass globe which holds the simple apparatus is exhausted of air by means of nearly the same combination of the Sprengel and Geissler mercury pumps used by Crookes in making his radiometer, or "light mill," and in his wonderful discovery of the phenomena of radiant matter in high vacuums, recently brought before the Royal Society of England. Much attention has been bestowed of late on the question of securing good vacuums. An absolutely perfect one is unattainable. It is, however, found that, by the use of the mercury pumps and chemical appliances, where a nearly perfect vacuum is formed, the minute portion of air remaining shows some remarkable properties. When electricity under strong pressure passes through an Edison lamp, the whole bulb shines with a delicate blue light. So remarkable is the behavior of various substances in a vacuum prepared by means of mercury pumps, that physicists consider that a gas thus rarefied constitutes another state of matter, differing as much from that of an ordinary gas (either under atmospheric pressure or with the pressure removed by means of a common air pump) as a gas differs from a liquid, or a liquid from a solid. Mr. Edison's use of carbon in such a vacuum is entirely new.

The pumps are shown in Fig. 9; the Geissler pump is to the right and below. By raising a bottle which is connected with it, the air is forced out of a large glass bulb, and allowed to escape through

the tube A. On lowering the bottle, the mercury flows back into it, leaving a vacuum in the bulb. The opening of a stop-cock allows some of the air which is left in the pump to flow into this bulb, when the air is again forced out as described; this is continued until the air is exhausted. The working principle of the Sprengel pump is the continuous dropping of mercury through a tube, each drop acting as a piston, carrying before it a small quantity of air. As there is no return stroke, even by the aid of a small tube, the
3957 work of exhaustion goes on quite rapidly. The MacLeod gauge in the center is so constructed that it will measure with exactness when less than one-millionth of the original air is left in the pump.

Another purpose besides that of preventing the destruction of the carbon is served by burning it in a vacuum. Almost all the electricity is converted into light, very little being dissipated by convection or conduction as heat. The little glass globe only an inch from this brilliant light remains cool enough to be handled, and does not scorch tissue paper wrapped closely around it.

Fig. 8 shows the lamp of its actual size. The current enters it by one of the wires, W. At B this copper wire is twisted and soldered to a platinum wire, which passes through the glass at C, and by means of a small platinum clamp into the horseshoe, L, from which, by as simple a route as it entered, it returns. L, the source of light, was made in the form of a horseshoe, in order to approximate to the shape of a gas jet, and is large enough to cause the edges of the shadows to be softened down, and so obviates the common objection to familiar forms of electric lighting. The carbon is sealed in a glass bulb, G G G G, the knob of glass, F, is the melted extremity of the tube by means of which the bulb was connected with the pumps. At the points, C, C, where the platinum wires are sealed into the bulb, some trouble was occasioned by the cracking of the glass, which allowed air to leak into the bulb. It will be noticed that the glass is now drawn up around the wire in a thin tube. This is found to heat and cool so rapidly that it is practically homogeneous with the wire, and even if the wire be heated red hot it will not break. Mr. Edison has tried putting a lamp alternately on and off the circuit for several hours by means of a telegraph key, without loosening the wire. This experiment was equivalent to using the lamp several thousand times.

Mr. Edison has thus succeeded in making a lamp of the simplest imaginable construction, and of materials whose expense is extremely small. The paper costs next to nothing, the glass globes very little, and the platinum tips of the wires are so small that, though the metal used is expensive, their cost is trifling. The test of the value of every invention is its simplicity, and this is the crowning characteristic of Mr. Edison's lamp, for it is really nothing more than a piece of wire looped into a glass globe.

The lamp being complete, let us consider the generator (Fig. 10), for which Mr. Edison has proposed the name Faradic, in honor of the great physicist.

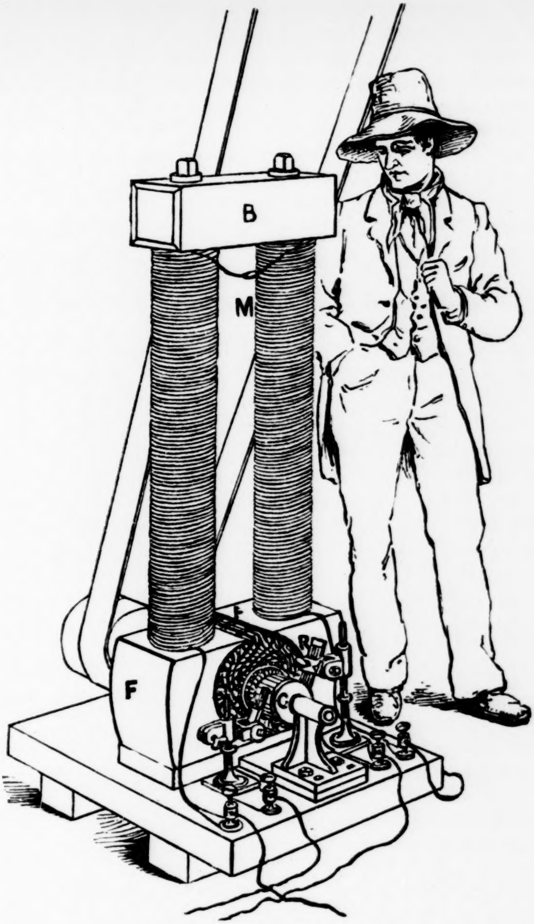

FIG. 10.—*Faradic Generator.*

3958 The cylinder which is placed below, between the blocks of iron, F, on which the magnets, M, rest, is called the armature, and is so arranged that it can be made to revolve rapidly by means of a belt. This armature consists of a small cylinder of wood, which is wound around with iron wire as thread is wound on a spool, the ends being made as in a spool, to hold the wire in place. Around the whole spool are a number of loops of copper wire, covered with cotton thread, running lengthwise of the armature. The ends of these loops may be seen as they are taken from the armature to the cylinder, C, which is an extension of the armature, by which the currents generated in the copper wire may be taken away from the machine. This cylinder, called the commutator, consists of blocks of copper that really represent the ends of the wire, which are placed side by side around the axis of the cylinder in such a manner that no current can pass from one to the other. Touching these as they revolve are brushes, R, made of copper wire, by means of which the electricity flows from the machine.

That the wire about the armature may be able to pump electricity into the line, it is needful that it be revolved immediately in front of magnets. The magnets are made of such large dimensions that the electricity, which is pumped through the machine, may meet with as little friction as possible in passing through the wire of the armature, since by means of the great strength of the magnets, very little wire can be made extremely powerful in forcing the electricity to a higher level or in putting it under pressure. It is exactly as in pumping water, if we have a poor pump (analogous to a machine with a poor magnet) the water may meet with an enormous friction in the pump itself, or require two or more, perhaps, to give it the required pressure, while in a good pump all the parts are so made that while great pressure is given to the water, it passes through it with the utmost freedom. The machine has such strength that it is intended to use only a small fraction of the power, which it could convert into electricity, and deliver outside.

It is proposed to mass a large number of such machines, as in Fig. 11, and have them all pump electricity up from one wire into

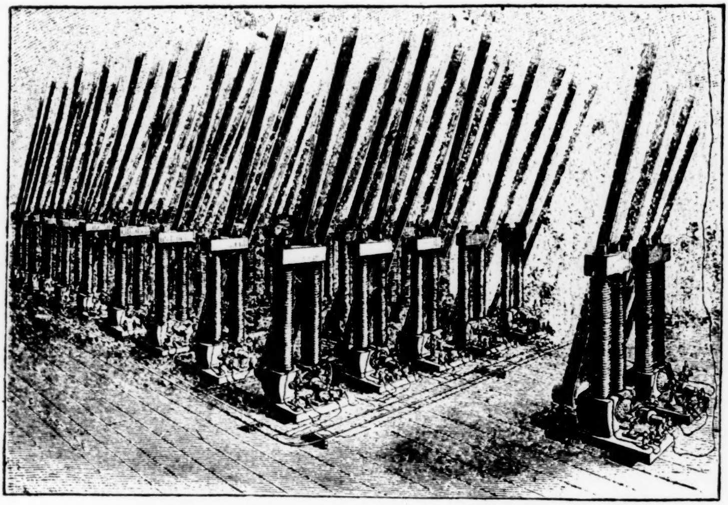

Fig. 11.—*Proposed Central Station.*

a second. The two large wires, held on supports above the floor, are intended, the one to carry the electricity away, and the other bring it back after it has been used. Two machines are placed at one side; these are for the purpose of rendering active the magnets of all the others.

3959 It is proposed to establish such stations in the course of a few months in the heart of several of our large cities. These will supply houses for quite a distance around them. 1,000 horse power is thought to be a sufficient amount for a unit, and the stations will be at such distances from one another that each district will require about this amount. The engines will be divided into four groups of 250 horse power each, with a spare one in each station of the same power.

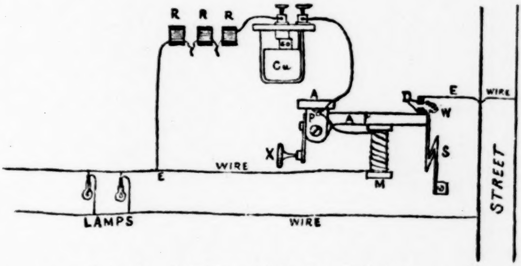

Fig. 12.—*Diagram of Meter and System.*

The wires will be laid in fascines or bundles under the edge of the sidewalk in a tight box. The object of this is to make them easy of access and easy to place in position. Nor is there need of putting them out of the reach of the frost, for they are continuous and not liable to leak from change in position. Even more important is the fact that the colder the wires are the less is the waste of electricity, thus giving a decided advantage over gas in winter, when most light is needed.

The main wires may be either of iron or copper according to the market price of these metals; as quotations are to-day the preference is slightly in favor of copper wire. These lines of wire will start from the central station and send out branches in the same manner that gas or water pipes diverge, growing smaller the farther they are removed from the central station. Fig. 12 also shows the branch wires as they enter the house. It is proposed to color the distributing wires red and the waste wires green. These two distinct wires will be carried all through the house, and every lamp will be so placed that the electricity will flow through it from one wire to the other.

Before passing into the house, the electricity is carried through a sort of meter containing a safety-valve, by means of which it can be measured. The contrivances for doing this are shown in diagram, in Fig. 12, and in perspective in Fig. 13. The lettering is the same in both for identical parts. The current enters at E, passes through the two platinum points, D, then through the armature, A, to the dividing points, P P. The larger portion of the current then flows around the magnet, M. The armature above the magnet is held from it by means of the spring, X. The object of the device is to furnish a means of cutting out a house if too large a flow of electricity by any accident should occur. The magnet would then be capable of drawing down the armature which would separate the platinum points, D, and break the circuit.

The small wire, W, serves a double purpose and is a remarkably clever solution of a double problem. First: If the circuit were partly opened it would weaken the magnet, and the armature would recede, closing the circuit. It would thus form a vibrator resembling Fig. 6. The wire, W, allows enough electricity to pass to close the snap, S, so that the armature is firmly held in place, after which the wire, W, will melt off and completely break the flow of electricity.
3960 Secondly, the wire serves another purpose: If the points were drawn apart an arc would spring between them. The wire, W, conducts the electricity by a shorter route than that offered by an arc and so keeps the space between the two points free from the intensely heated vapors of the metal.

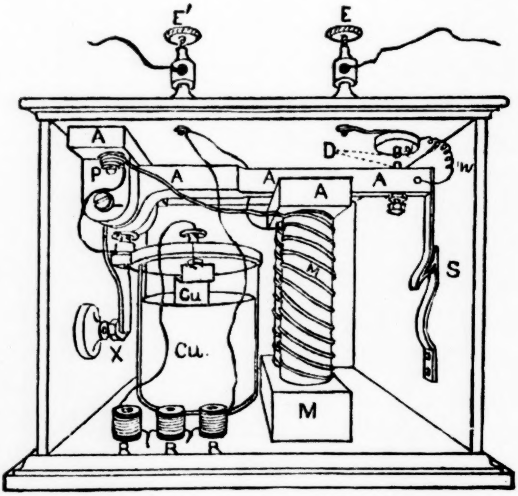

FIG. 13.—*Edison's Electric Light Meter.*

A small fraction of the current passes by another route to the lamps, from the point P. It first traverses a length of wire wound on small spools marked R. The amount placed here will regulate the flow through this line. The current next passes through from one copper plate marked C*u* to another, through a solution of copper salt. In thus flowing, for every unit of current a certain amount of copper is deposited on a thin sheet, the amount for a lamp being once determined by burning one for a number of hours. It must be remembered that only a small amount passes through the meter, but that which passes is proportionate to the whole. It is proposed to make a standard lamp, which shall give a light equal to that from a gas flame consuming five cubic feet each hour. From this it will be calculated how much copper will be deposited, and the amount will be said to represent five cubic feet. The bills for electricity will be made out in 1,000 feet, as in the case of gas. The inspector will take the strip on which the copper is deposited to the central station, in order to determine the amount of electricity used.

Besides giving light, the electricity supplies a convenient form of motor for domestic purposes. A small electrical engine placed beside a sewing machine for example, and connected with the distributing wire, may save all the fatigue of treading the machine, at an expense exactly equal to that of one jet burning for the same time. Elevators may be lifted, lathes turned, and instruments operated up to several horse power, by this same means. Fig. 14 shows the form adopted by Mr. Edison. It is substantially a small model of the large Faradic machine, the only change being in the fact that the armature, C, is placed lengthwise of the magnets, M M, instead of across them. At S is a switch by means of which the motor can be started or stopped. It is expected that the amount of power used in the daytime will largely pay for the expenses of generating—an additional advantage over gas.

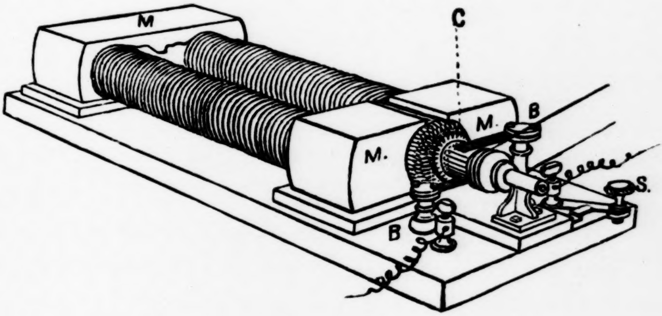

FIG. 14.—*Edison's Electric Motor.*

In order to use the lamp, it is brought into the circuit by turning a handle in a certain direction, or thrown out by reversing the motion, or by means of plugs, which are inserted in a socket. This may be done either in the chandelier or in any other convenient place in the house. Very simple arrangements may be made so that by touching a knob by the bedside the whole house may be brilliantly lighted for the reception or discovery of a suspected burglar. Of course, no matches have to be used; the light kindles itself by the turning of a handle, and so one fruitful source of destructive fires is avoided.

In order that the philosophical relations of the processes may be understood it is needful to trace the history of the energy as it is taken from the coal and conveyed over the wire to the lamp. A large portion of the heat produced by the combustion of the coal under the boiler is found in the steam as it flows to the engine. By means of the latter a small fraction, about ten per cent. of the original energy, is transformed into the motion of the wheels attached to the engine. It may be traced as it flows through the belt to the shaft, and again as it is carried from the shaft to any machine which it may drive. A belt exactly resembles, in carrying power, a man pulling a shaft around by means of a rope. The amount he is pulling can be measured by the strain on the belt, and the work he is doing by determining the speed with which he carries

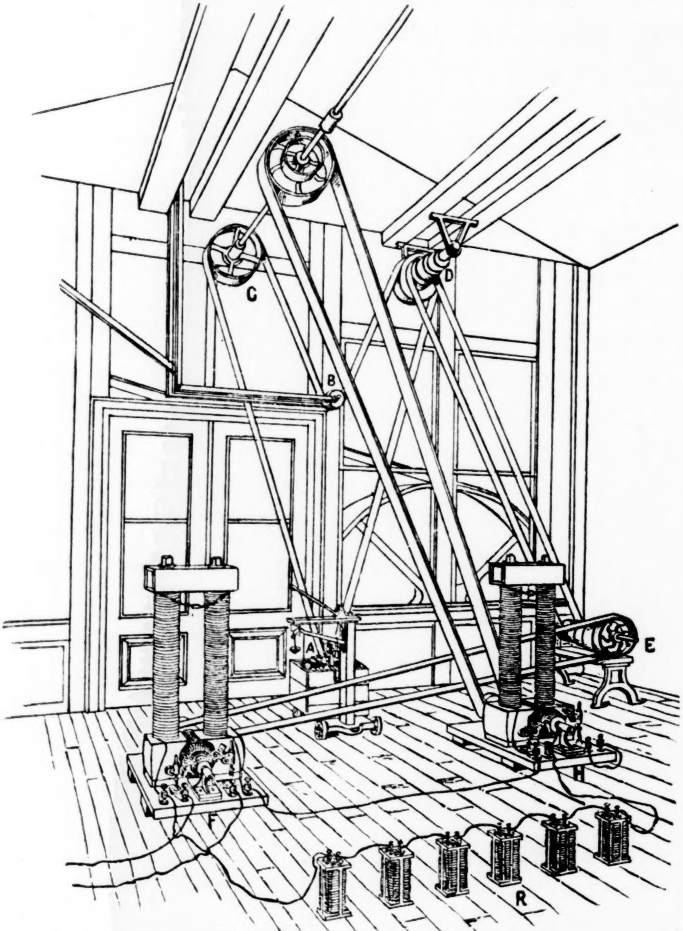

Fig. 15.—*Edison's Dynamometer, for Measuring the Force of an Electric Current.*

the end of the rope. Mr. Edison has made a device, repre-
3961 sented by Fig. 15, to measure this strain. The belt starting
from the pulley over the main shaft, C, is carried under a pulley, A, which is attached to a large box containing heavy weights. This box is placed upon a platform scale. The belt then runs over pulley, D, which it has to drive, and under a wheel, B, which rests heavily upon what would otherwise be the slack part of the belt, for the purpose of tightening it. The pulley, A, attached to the weight, will have a tendency to be drawn upward by any strain that may be put on the belt, just as the block of a tackle is drawn up when the rope is tightened which runs through it. The weight lifted may be measured by the diminution of weight on the scale, one-half of which gives the strain on the belt. Fig. 15 also shows the arrangement of machines as they were placed in order to be tested. The cones D and E were for the purpose of changing the speeds at which the machines were run. The machine, H, at the right, renders active the field of the other machine, F; the current may be regulated by passing through more or less of the resistance boxes, R. By means of this apparatus the exact amount of power carried by the belt can be reckoned when its speed is known. This latter measurement is made from the main shaft.

The energy which the belt carries is seemingly lost, as material motion, when it has turned the armature of the Faradic machine. Since this seems to be a point where the majority lose the track of the energy, in order to explain clearly allusion must be made to some fundamental experiments. Arago many years ago tried this experiment: a sheet of copper, which is not attracted by the magnet under ordinary conditions, was passed between the two poles of a powerful magnet, and it was found to be retarded in its motion. If the magnets are extremely strong, though the copper sheet to the
eye passes through nothing but air, yet to the hand it seems
3962 as if it were cutting cheese, so strong is the drag put upon
the copper. This phenomenon Tyndall calls the apparent viscosity of the magnetic field. Faraday, a few years after this discovery, clearly explained the reason for seeming friction between the plate of copper and the invisible lines of magnetic force which he imagined to reach out from every magnet. He used wires and passed them in front of the magnet, and found that whenever they were made to cut these lines electricity was thrown into the wire. This grand discovery is at the basis of all that is now done in making strong currents, for it furnishes the method by which motion of mass may be transformed into the molecular motion called electricity.

As the energy appears in the wire, it is measured again by an electrical dynamometer, the main idea of which was that of Professor Trowbridge, of Harvard university.

By means of the two instruments, one is enabled to trace out the amount of energy absorbed and given back by the machine, and in many cases ninety per cent. of the original power applied is found converted into electricity. A system of electric lighting is nothing more than a gas system, where energy takes the place of vapors.

It is one of the laws of progress, that no sooner is a method for producing a certain result perfected than a practical use of it follows. This is attested by the history of many great inventions. Following out the laws of discovery, it has been for some time a speculation of the writer that the wonderful perfection to which vacuums had been brought, pointed historically toward some direct connection between them and the electric lamp. For the past few years no more striking result of scientific work has been effected than the startling phenomena shown in high vacuums; parallel with this, a growing want has been felt for a cheaper and more efficient mode of illuminating. Is this a mere coincidence? or may we believe that the demand and means of supply have been developing independently, but side by side; and that now in the electric light we find a practical application of what had been reached by purely theoretical research?

Besides the enormous practical value of the electric light, as domestic illuminant and motor, it furnishes a most striking and beautiful illustration of the convertibility of force. Mr. Edison's system of lighting gives a completed cycle of change. The sunlight poured upon the rank vegetation of the carboniferous forests, was gathered and stored up, and has been waiting through the ages to be converted again into light. The latent force accumulated during the primeval days, and garnered up in the coal beds, is converted, after passing in the steam engine through the phases of chemical, molecular and mechanical force, into electricity, which only waits the touch of the inventor's genius to flash out into a million domestic suns to illuminate a myriad homes.

3963 **DEFENDANT'S EXHIBIT FONTAINE'S BOOK. H. C. M., SPE. EX.**

Consolidated Electric Light Co.
vs.
The McKeesport Light Co.

ECLAIRAGE

A L'ÉLECTRICITÉ

RENSEIGNEMENTS PRATIQUES

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HIPPOLYTE FONTAINE

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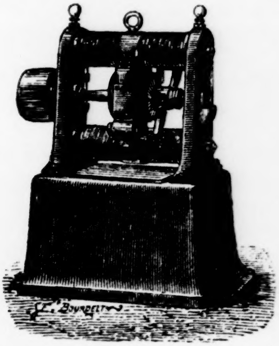

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CHAPITRE III.

Charbons Électriques.

Baguettes en charbon de bois.—Charbon de cornue.—Ses inconvénients.—Charbon Staite et Edwards.—Charbon Le Molt.—Charbon Lacassagne et Thiers.—Charbon Curmer.—Charbon Jacquelain.—Charbon Peyret. — Charbon Archereau. — Expériences de M. Carré.—Ses procédés de fabrication. Expériences de M. Gaudoin.—Ses procédés de fabrication.—Essais comparatifs de diverses sortes de charbons.

Dans ses expériences sur l'arc voltaïque, Davy se servait de baguettes de charbon de bois éteint dans l'eau ou dans le mercure. Ces baguettes brûlaient avec un bel éclat et d'une manière très-régulière, mais elles s'usaient si rapidement, que leur usage était forcément réservé-aux expériences de laboratoire. En remplaçant le charbon de bois par les dépôts recueillis sur les parois des cornues à gaz, Foucault ouvrit réellement à l'arc voltaïque l'ère des applications utiles. Le charbon de cornue est, en effet, beaucoup plus dense et rèsiste bien plus longtemps à l'action destructive du foyer électrique.

Mais, comme l'fait observer avec raison M. Le Roux, le dernier mot n'est pas dit sur cette question, et le charbon de cornue offre encore de graves inconvénients: sa compasité n'est pas uniforme, tant s'en faut; il éclate quelquefois, s'use souvent irrégulièrement et produit des variations d'éclat assez considérables. Ces variations tiennent surtout à la présence de matières étrangères, telles que des sels alcalins ou terreux, et aussi de quantités notables de silice. Ces matières sont beaucoup moins fixes que le charbon, elles
3965 entrent en vapeur et forment pour une grande partie la flamme
qui entoure l'arc. Cette flamme est plus conductrice que l'arc voltaïque proprement dit; en outre, comme elle a une plus grande section, elle s'échauffe moins que lui, et comme, de plus, c'est un corps gazeaux, son pouvoir d'irradiation est moindre que celui des particules charbon-neuses qui constituent l'arc.

Hâtons-nous de dire que, tel qu'il est, en choisissant convenablement les deux baguettes qui doivent garnir un régulateur, le charbon de cornue donne des résultats satisfaisants dans la plupart des applications.

Lorsqu'on renferme l'arc voltaïque dans un globe de verre dépoli, les scintillements, les intermittences et les oscillations dans l'intensité du foyer se font beaucoup moins sentir: les ombres sont moins vives, la lumière est plus douce, plus homogène, plus agréable. Mais le globe est la cause d'une perte de lumière assez considérable et toutes les fois que les petites irrégularités dues à l'imperfection du charbon sont supportables, on laisse brûler les charbons sans globe. On s'habitue d'ailleurs très-facilement à la lumière électrique et les ouvriers, loin de s'en plaindre, recherchent aujourd'hui les usines éclairées par ce procédé.

Plusieurs inventeurs ont cherché à substituer au charbon taillé directement dans les dépôts recueillis sur les parois des cornues, des agglomérés analogues, mais plus purs; d'autres ont simplement purifié les charbons des cornues; quelques-uns ont obtenu des produits très-remarquables au point de vue de l'éclat lumineux, mais irréalisables en pratique à cause de l'exagération du prix de revient.

Parmi tous les procédés proposés et appliqués pour l'amélioration des charbons électriques, nous citerons ceux de MM. Staite et Edwards, Le Molt, Lacassagne et Thiers, Curmer, Jacquelain, Peyret, Archereau, Carré et Gaudoin.

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Charbon Staite et Edwards.

En 1846, MM. Staite et Edwards firent breveter un procédé de fabrication de charbon pour lumière électrique qui avait pour base un mélange de coke pulvérisé et de sucre.

Le coke était d'abord réduit en une poudre presque impalpable et additionné d'une petite quantité de sirop, puis le mélange était malaxé, moulé et fortement comprimé. Le charbon subissait ensuite une première cuisson et était plongé dans une dissolution très-concentrée de sucre et soumis de nouveau à la chaleur blanche.

Charbon Le Molt.

M. Le Molt a fait breveter, en 1849, une composition pour crayons électriques, formée de 2 parties de charbon de cornue, 2 parties de charbon de bois ou de coke et 1 partie de goudron liquide. Ces substances étaient préalablement pulvérisées, tamisées, mélangées et amenées par une forte trituration à l'etat de pâte dure très-consistants, puis, à l'aide d'un puissant moyen mécanique, soumises à une forte compression.

Les pièces moulées étaient recouvertes d'un enduit de sirop de sucre et placées les unes contre les autres, dans un vase en charbon de cornue. Elles étaient alors soumises à une haute température pendant 20 à 30 heures et purifiées, si nécessaire, par des immersions dans des acides.

Charbon Lacassagne et Thiers.

MM. Lacassagne et Thiers, en 1857, s'occupèrent de la purification des baguettes de charbons de cornue.

Ces messieurs faisaient fondre, par voie ignée, une cer-
3967 taine quantité de potasse ou de soude caustique. Lorsque
leur bain était à l'état rouge, ils y faisaient digérer, pendant un quart d'heure environ, les baguettes de carbone provenant des parois intérieures des cornues (ces baguettes étaient préalablement taillées).

Cette opération avait pour but de changer en silicate de potasse ou de soude soluble la silice contenue dans lesdits charbons, et si pernicieuse à la constance de la lumière. Les baguettes de charbon étaient en suitelavées à l'eau bouillante, puis soumises (dans un tube de porcelaine ou de terre réfractaire chauffée au rouge), pendant plusieurs heures, à l'action d'un courant de chlore, dont la propriété était de faire passer les différentes terres que la potasse ou la soude n'avaient pas attaquées, à l'état de chlorures volatils, de silicum, de calcium, de potassium, de fer, etc.

Ainsi épurés, ces charbons donnaient une lumière un plus régulière.

Charbon Curmer.

Le procédé Curmer consiste surtout dans la calcination de noir de fumée, de benzine et d'essense de térébenthine, le tout melangé et moulé sous forme de cylindres; la décomposition de ces matières laisse un charbon poreux qu'on imbibe avec des résines ou des matières sucrées et qu'on calcine de nouveau. C'est en répétant ces opérations que M. Curmer réussissait à produire des charbons peu denses et peu conducteurs, il est vrai, mais extrêment réguliers et exempts de toutes impuretés.

Charbon Jacquelain.

M. Jacquelain, ancien chimiste à l'Ecole centrale, a cherché
3968 à imiter les circonstances qui, pendant la fabrication du gaz,
donnent naissance au charbon de cornue. Ces circonstances sont l'arrivée au contact des parois incandescentes des cornues de matières hydrocarburées trés-denses dont une partie se volatilise, et dont le reste se décompose en laissant pour résidu une couche de charbon. Dans les cornues des usines à gaz, ces matières hydrocarburées entraînent avec elles un grand nombre d'impuretés que contient la houille. En prenant des goudrons provenant d'une véritable distillation, débarrassés, par conséquent, de toutes les impuretés non volatiles, et réalisant dans des appareils spéciaux ces conditions de décomposition au contact de parois fortement échauffées, on devait reproduire les charbons des cornues, mais jouissant d'une pureté parfaite. C'est ce qu'a fait M. Jacquelain en opérant avec un tube de terre réfractaire de 0^m, 15 de diamètre dans un fourneau improvisé; et il a obtenu des plaques qui, débitées en baguettes à la scie, ont donné une lumière parfaitement tranquille, plus blanche et d'environ 25 pour 100 plus intense, à courant électrique égal que celle donnée par les charbons ordinaires.

Les expériences faites avec ces crayons, à l'Administration des phares de Paris, avient été si concluantes, que nous eûmes, vers le commencement de 1876, l'idée de mettre le procédé en pratique. Mais M. Jacquelain, consulté, nous expliqua qu'il lui était impossible de calculer: 1e les dépenses à faire pour l'installation d'une fabrication continue; 2e le prix de revient approximatif du charbon obtenu. Comme d'autre part le procédé de M. Gaudoin commençait à donner de bons résultats, nous ne donnâmes pas de suite à notre idée. Nous savons depuis longtemps ce qu'il en coûte pour convertir un procédé de laboratoire, même très-exact, en opération industrielle, et nous ne vouilions pas nous lancer dans une affaire de cette nature sans quelques données numériques.

3969 Les charbons de M. Jacquelain, une fois formés, ont d'ailleurs l'inconvénient d'exiger un travail considérable de main-d'œuvre pour être utilisés (car la matière est si dure, qu'on ne la scie que difficilement) et de produire des déchets relativement considérables.

Charbon Peyret.

M. Peyret, docteur à Lourdes, a préparé des charbons en imbibant des morceaux do moelle de sureau ou tout autre corps poreux avec du sucre fondu et en décomposant ensuite le sucre par la chaleur. En répétant l'operation un nombre de fois suffisant, il obtenait des crayons très-denses qu'il-soumettait ensuite à un courant de sulfure de carbone.

Nous n'avons eu en mains que de très-petits fragments de ces crayons, et il nous a été impossible de nous rendre bien compte de leur valeur; leur prix élevé est en tout cas un obstacle très-sérieux au développement d'une fabrication industrielle.

Charbon Archereau.

M. Archereau, dont le nom revient souvent à la plume lorsqu'on s'occupe de questions d'agglomérés de charbons ou d'électricité, vient de présenter à l'Académie des sciences des nouvelles baguettes pour régulateurs électriques, composées de carbone aggloméré et comprimé, mêlé à de la magnésie, qui ont, d'après l'auteur, l'avantage de rendre la lumière plus stable et d'augmenter son pouvoir éclairant.

Nous avons essayé divers échantillons de ces crayons; les uns étaient de bonne qualité, les autres inférieurs aux charbons de cornue. Plusieurs crayons ont fourni une lumière de 150 becs avec une mesure totale de $0^{m},03$ à l'heure. C'est une fabrication qui peut devenir bonne, mais qu'il faut absolument régulariser.

3970 *Charbon Carré.*

M. Carré a fait un grand nombre d'expériences de lumière électrique sur les charbons de cornue imprégnés de divers sels et a combiné un nouveau produit pour le même usage. Quelques détails sur ses travaux sont nécessaires pour en faire comprendre l'importance et le mérite.

En imprégnant des charbons assez poreux, et par une ébullition prolongée dans des dissolutions concentrées, M. Carre constata :

1° Que la potasse et la soude doublent au moins la longueur de l'arc voltaïque, le rendent muet, se combinent à la silice et l'éliminent des charbons en la faisant fluer à 6 ou 7 millimètres des pointes, à l'état de globules vitreux, limpides et souvent incolores ; qu'elles augmentent la lumiere dans le rapport de 1,25 à 1 ;

2° Que la chaux, la magnésie et la strontiane augmentent la lumière dans la proportion de 1,40 à 1, en la colorant diversement;

3° Que le fer et l'antimoine portent l'augmentation à 1,60 ou 1,70;

4° Que l'acide borique augmente la durée des charbons en les envelloppant d'un enduit vitreux qui les isole de l'oxygène, mais sans augmenter la lumière;

5° Que enfin l'imprégnation des charbons purs et régulièrement poreux avec des dissolutions de divers corps est un moyen commode et économique de produire leurs spectres, mais qu'il est préférable de mélanger les corps simples aux charbons composés.

Pour la fabrication des crayons factices, M. Carré préconise une composition de coke en poudre, de noir de fumée calciné et d'un sirop spécial formé de 30 parties de sucre de canne et de 12 parties de gomme.

3971 La formule suivante est indiquée au brevet du 15 janvier 1876 :

Coke très-pur en poudre fine presque impalpable....	15	parties
Noir de fumée calciné........................	5	—
Sirop spécial..................................	7 à 8	—

Le tout est fortement trituré et additionné de 1 à 3 parties d'eau pour compenser les pertes par évaporation et selon le degre de dureté à donner à la pâte.

Le coke doit être fait avec les meilleurs charbons pulvérisés et purifiés par lavages. (Les poudres charbonneuses peuvent être aussi purifiées par des lavages avec décantation, macération à chaud dans des bains acides.) Le coke des crasses de cornues à gaz est généralement assez pur.

La pâte est alors comprimée et passée par une filière, puis les charbons sont étagés dans des creusets et soumis pendant un temps déterminé à une haute température.

La cuisson comprend uni série d'opérations.

Pour la première, les charbons sont placés horizontalement dans le creuset en fonte sur une couche de poissière de coke, chaque lit est séparé par une feuille de papier pour éviter toute adhérence. Entre la dernière couche et le couvercle, on met 1 centimetre de sable de coke et 1 centimètre de sable siliceux sur le joint du couvercle.

Après la première opération, qui doit durer de quatre à cinq heures au moins et atteindre le rouge-cerise, les charbons doivent rester deux ou trois heures dans un sirop très-concentré et bouillant de sucre de canne ou de caramel, avec deux ou trois intervalles de refroidissement notable, afin que la pression atmosphéric le fasse pénétrer dans tous les pores. On laisse ensuite les charbons égoutter en ouvrant un robinet placé au bas du vase, puis on les agite quelques instants dans l'eau bouillante pour dissoudre le sucre resté à la surface.

3972 Après dessiccation, on soumet les charbons à une seconde cuisson à l'étage qui suit; on peut alors les mettre debout dans le creuset en remplissant leurs interstices avec du sable.

On les traite de même en les descendant d'un étage à chaque cuisson jusqu'à ce qu'ils aient acquis la densité et la solidité requises et en se servant d'un four ayant autant d'étages qu'on désire de cuissons.

Les charbons sont séchés lentement. On termine leur dessiccation dans une étuve dont la température atteint graduellement 80 degrés en douze ou quinze heures. Peur les empêcher de se déformer, en séchant, les baguettes sont placées dans des tôles ayant la forme de V.

Les charbons Carré sont plus tenaces et plus rigides que ceux de cornue. Ils sont surtout remarquablement droits et réguliers. Des baguettes de $0^{m},01$ de diamètre peuvent être employées à $0^{m},50$ de longeuer, sans crainte de rupture. Leur forme cylindrique, jointe à leur homogénéité, fait que leurs cônes se maintiennent aussi parfaitement taillés que s'ils étaient usés au tour. Ils sont aussi plus conducteurs que les charbons de cornue. Les seuls inconvénients que nous ayons remarqués dans l'emploi consistent en une désagrégation assez rapide, la production de petites flammèches et l'irrégularité dans l'éclat lumineux.

Crayons Gaudoin.

M. Gaudoin a également fait de nombreuses expériences sur les charbons contenant des substances étrangères.

Les corps suivants ont été introduits dans les crayons : 1° phosphate de chaux des os ; 2° chlorure de calcium ; 3° borate de chaux ; 4° silicate de chaux ; 5° silice précipitée pure ; 6° magnésie ; 7° borate de magnésie ; 8° phosphate de magnésie ; 9° alumine ; 10° silicate d'alumine.

3973 Les proportions étaient calculées de manière à obtenir 5 pour 100 d'oxyde après la cuisson des crayons. Ceux-ci étaient soumis à l'action d'un courant électrique toujours de même sens, fourni par une machine Gramme assez puissante pour entretenir un arc voltaïque de 10 à 15 millimétres de longueur.

Le crayon négatif étant placé en bas, M. Gaudoin a observé les résultats suivants :

1° La décomposition complète du phosphate de chaux ; sous la triple influence de l'action électrolytique, de l'action calorifique, et de l'action réductrice du carbone. Le calcium réduit se rend sur le charbon négatif et brûle au contact de l'air avec une flamme rougeâtre. La chaux et l'acide phosphorique se répandent dans l'air, en produisant une fumée assez abondante. La lumière, mesurée au photomètre, est double de celle qui est produite par des crayons de même section taillés dans les résidus des cornues à gaz.

2° Le chlorure de calcium, le borate et le silicate de chaux sont également décomposés, mais les acides borique et silicique paraissent échapper par la volatilisation à l'action de l'électricité. Ces corps donnent moins de lumière que le phosphate de chaux.

3° La silice introduite dans les crayons les moins conducteurs diminue la lumière, fond et se volatilise sans être décomposée.

4° La magnésie, le borate et le phosphate de magnésie sont décomposés ; le magnésium en vapeur se rend sur le charbon négatif et brûle au contact de l'air avec une flamme blanche. La magnésie, les acides borique et phosphorique se répandent dans l'air à l'état de fumée. L'augmentation de lumière est moins considérable qu'avec les sels de chaux.

5° L'alumine et le silicate d'alumine ne sont décomposés qu'avec un courant très-fort et un arc voltaïque très-considérable; 3974 mais, dans ces circonstances, la décomposition de l'alumine est bien manifeste, et l'on voit l'aluminium en vapeur sortir du négatif comme un jet de gaz et brûler avec une flamme bleuâtre peu éclairante.

La flamme et la fumée qui accompagnent constamment ces lumières électro-chimiques lui ayant paru un grand obstacle à leur utilisation pour l'éclairage, M. Gaudoin n'a pas poussé plus loin ces expériences. Il a préféré poursuivre ses études sur les agglomérés en carbone.

Les produits fabriqués par M. Gaudoin[1] étant supérieurs à tous les autres, nous allons nous étendre un peu sur leur mode de fabrication.

Le brevet est daté du 12 juillet 1876.

Ainsi que nous l'avons dit plus haut, les crayons destinés à la production de l'arc voltaïque doivent être en carbone chimiquement pur. Or, la poussière de charbon de cornue, quoique ne contenant qu'une faible proportion de matières étrangères, n'est pas suffisamment bonne pour cet usage, et son emploi présente des inconvénients. Les lavages aux acides ou aux alcalis qu'on peut faire subir aux matières charbonneuses, dans le but d'enlever les impurétes qu'elles contiennent, sont coûteux et insuffisants. Le noir de fumée est assez pur, mais son prix est élevé et son maniement difficile. M. Gaudoin a dû chercher ailleurs une meilleure source de carbone, et il a trouvé sa solution en décomposant, par la chaleur en vases clos, les brais secs, gras ou liquides, les goudrons, résines, bitumes, essences et huiles naturelles ou artificielles, matières organiques susceptibles de laisser du carbone suffisamment pur, après leur décomposition par la chaleur.

Les appareils employés pour effectuer cette décomposition 3975 sont des cornues ou creusets fermés en plombagine. Ces creusets sont disposés dans un fourneau capable de les chauffer au rouge clair. La partie inférieure des creusets est munie de deux tubes servant, l'un au dégagement des gaz et matières volatiles, l'autre à l'introduction de la matière première.

On peut conduire les produits volatils de la décomposition sous la grill du foyer et les brûler pour chauffer les creusets, mais il est plus advantageux de les diriger dans une chambre de condensation, puis dans un serpentin en cuivre, et de recueillir, après condensation, les goudrons, huiles, essences et carbures d'hydrogène qui prennent naissance dans cette opération.

M. Gaudoin utilise ces différents sous-produits dans la fabrication même de ses charbons; il a grand soin d'éviter, pour les serpentins et les vases de conservation, l'emploi du fer, de la fonte, du zinc et de toutes substances susceptibles d'être attaquées par ces goudrons, car toute leur valeur réside dans leur pureté.

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[1] M. Octave Gaudoin est l'inventeur du procédé de galvanisation directe de la fonte et du fer, appliqué en grand au Val d'Osne, lequel donne des résultats bien supérieurs à tous les autres systèmes de cuivrage en usage aujourd'hui.

Quelle que soit la matière première employée à la fabrication de ce charbon, la décomposition par la chaleur peut être menée lentement ou brusquement, selon la nature des produits secondaires qu'on se propose d'obtenir. Pour opérer lentement, il suffit d'emplir la cornue aux deux tiers et de chauffer graduellement jusqu'au rouge clair, en évitant, autant que possible, le boursouflement de la matière. Pour opérer brusquement, on chauffe d'abord la cornue vide au bon rouge, et on fait arriver la matière première au fond par petite portion, soit en filet, si elle est liquide, soit en petits fragments, si elle est solide.

La distillation lente donne plus de goudron et d'huiles lourdes et peu de gaz. La décomposition brusque donne plus d'essences légères et de gaz.

Lorsque la matiére premiére a été convenablement choisie,
3976 il reste dans la cornue du charbon plus ou moins compacte.
On le pulvérise aussi finement que possible et on l'agglomère soit seul, soit mêlé à une certaine quantité de noir de fumée, au moyen des carbures d'hydrogène obtenus comme produits secondaires.

Ainsi préparées ces carbures sont complétement exempts de fer, et sont bien préférables à ceux qu'on trouve dans le commerce, nonseulement par l'agglomération du carbone, mais encore par l'imprégnation ou l'imbibition des objets fabriqués. (Cette dernière opération, tout en bouchant les pores, y introduit de l'oxyde de fer quand elle est faite avec les produits du commerce.)

Les objets faits en carbone agglomere sont, pour une variété de carbone d'autant plus combustibles qu'ils sont plus poreux, et d'autant plus poreux qu'ils ont été moulés à une moindre pression. L'inventeur se sert, pour sa fabrication, de moules en acier capables de résister aux plus hautes pressions d'une forte presse hydraulique.

Quoique la filière, ou appareil à mouler, usitée depuis longtemps dans la fabrication des crayons ordinairs de plombagine, puisse servir sans aucune modification à la fabrication des crayons pour lumière électrique, M. Gaudoin a apporté à cet appareil certains perfectionnements importants. Ainsi, au lieu de faire sortir les crayons de haut en bas, suivant la verticale, il place l'orifice ou les orifices du maule sur le cêté et de manière à ce que les crayons sortent en formant avec l'horizon un angle descendant de 20 à 78 degrés. Les crayons sont guidés sur toute leur longueur par des tubes ou par des rigoles.

Cette disposition permet de vider toute la matière contenue dans le moule sans interompre le travail, et comme les crayons sont constamment soutenus, ils ne cassent plus sous leur propre poids, ce
qui arrive souvent quand ils sortent de haut en bas.
3977 Nous avons fait, à diverses époques, de nombreux essais
avec toutes sortes de crayons, et ce sont ceux de la fabrication de M. Gaudoin qui nous ont donné les meilleurs résultats. Il a

fallu beaucoup de temps et des dépenses d'argent considérables pour faire entrer cette fabrication du domaine scientifique dans celui de la pratique, mais enfin le succès est venu couronner les efforts de l'inventeur.

Tableau des Expériences Faites le 6 *Novembre* 1876 *sur Divers Crayons Électriques.*

Désignation des crayons.	Dimensions.	Vitesse de la machine.	Usure du négatif.	Usure du positif.	Usure totale.	Usure moyenne des deux expériences.	Régularité.	Observations.
			mm	mm	mm	mm		
Cornue	9^{mm^2}	800	19	36	55	63	Irrégulière.	Scintillement, éclipse de courte durée, un peu de désagrégation.
	9	920	23	48	71		Assez régulière.	
Archerau ..	10^{mm} de diamètre.	800	20	60	80	85	Assez régulière.	Un peu de désagrégation, un peu de flammèches.
	10^{mm} de diamètre.	920	30	60	90		Assez régulière.	Cendres d'oxyde de fer en assez grande quantité. Lumière blanche, Taille bonne.
Carré	10^{mm}, 4 de diamètre.	800	18	60	78	92	Irrégulière.	Un peu de désagrégation, un peu de flammèches; plus de cendres que les précédents; rougissant sur une plus grande longueur.
	10^{mm}, 4 de diamètre.	920	26	80	106		Assez régulière.	
Gaudoin ...	11^{mm}, 3 de diamètre.	800	20	38	58	73	Très-régulière.	Pas de désagrégation, ni de flammèches; moins de cendres que les crayons Carré et Archerau.
	11^{mm}, 3 de diamètre.	920	38	50	88		Très-régulière.	

3978 La lumière produite avec les charbons de cornue était égale à 103 becs, et celle produite par les charbons artificiels variait entre 120 et 180 becs pour les crayons Archereau et Carré, et entre 200 à 210 pour les crayons Gaudoin. La moyenne de 150 becs peut être appliquée, sans erreur appréciable, aux crayons Archereau et Carré, et celle de 205 aux crayons Gaudoin.

Ramenée à une section uniforme de 0^{m^2},0001, l'usure des charbons était respectivement :

Pour les charbons de cornue	51	millimètres.
Pour les agglomérés Archereau	66	—
— Gaudoin	73	—
— Carré	77	—

Par rapport à la lumière produite, cette usure était :

Pour les charbons Gaudoin	35	millimètres	pour 100 becs.
— Archereau	44	—	—
— Carré	51	—	—
— de cornue	49	—	—

Ces expériences ont été faites avec une machine Gramme construite par M. Bréguet et une lampe Carré du même constructeur. Les charbons avaient été pris au hasard dans un lot du plusieurs mètres pour chaque catégorie.

Sur la demande d'un des inventeurs, nous avons fait de nouvelles expériences avec le concours de MM. Gramme et Lemonnier, en opérant avec une machine Gramme plus puissante et une lampe Serrin.

Le tableau suivant contient les moyennes de trois séries d'expériences exécutées avec la plus grande précision. La lampe électrique était placée bien verticalement au même niveau que la lampe à huile et que le photomètre. Toutes les précautions étant prises pour qu'il n'y ait aucune erreur sensible dans les mesures d'intensité lumineuse.

3979 *Résultats des Expériences Faites le 4 Avril 1877, sur Divers Charbons.*

Désignation des charbons.	Forme et dimensions.	Section en millimètres Carrés.	Usure totale a l'heure en millimètres.	Lumière moyenne en becs carcel.	Longueur de l'arc en millimètres.	Nombre de tours par minute de la machine.	Régularité.	Observations.
Charbon de cornue, bonne qualité.	Carré. 9^{mm} de côté.	81	60	120	2½	820	Passable.....	Eclats nombreux. Projection d'un petit morceau. Scintillement. Charbons se taillant très-irrégulièrement.
Charbon de M. Archerau. Nouvel échantillon.	Rond. 10^{mm} de diamètre.	78	68	173	3	820	Nulle........	Désagrégation, flammèches, lumière très-variable d'intensité par période. Taille en petites facettes.
Charbon de M. Carré. Nouvel échantillon.	Rond. 9^{mm} de diamètre.	64	69	175	3	820	Médiocre	Petites flammèches. Lumière tournante. Très-variable d'intensité. Bonne taille des charbons.
Charbon de M. Gaudoin. Type nº 1.	Rond. 11^{mm}, 2 de diamètre.	98	80	203	3	820	Bonne.......	Pas de flammèches, ni éclat. Lumière un peu rougeâtre, mais bien constante.
Charbon de M. Gaudoin. (Aggloméré de charbon de bois.)	Rond. 11^{mm}, 5 de diamètre.	78	78	240	3	820	Assez bonne..	Lumière très - blanche. Moins fixe qu'avec les charbons Gaudoin nº 1. Pas de flammèches. Petites variations.

3980 L'usure des charbons, ramenés à une section uniforme de 0^{m2},0001, était respectivement, dans ces nouvelles expériences :

Pour les charbons	Carré	44	millimètres.
—	de cornue	49	—
—	Archereau	53	—
—	Gaudoin (charb. de bois)	61	—
—	Gaudoin n° 1	78	—

Par rapport à la lumière produite cette usure était :

Pour les charbons	Gaudoin (charb. de bois)	32	mill. pour	100 becs.
—	Archereau	39	—	—
—	Carré	40	—	—
—	Gaudoin, n° 1	40	—	—
—	de cornue	50	—	—

La lumière donnée par les charbons Gaudoin n° 1 était un peu moins régulière que celle observée le 6 novembre 1876. Celle donnée par les charbons Carré variait en moins d'une minute de 100 à 250 becs ; elle tournait positivement autour des pointes, comme cela a lieu avec des courants alternatifs. Les crayons Archereau nous ont paru moins bons qu'aux premiers essais ; ils s'usaient lentement, mais ils produisaient des éclats lumineux si variables, qu'il était difficile de prendre des mesures photométriques. Seuls les charbons de cornue avaient conservé leur durée, leur intensité lumineuse, et, malheureusement, leur irrégularité.

Nous signalerons, pour terminer ce chapitre, les perfectionnements que M. Gaudoin vient d'apporter à son procédé et qu'il a fait breveter le 7 avril 1877.

Au lieu de carboniser du bois, de le réduire en poudre et de l'agglomérer ensuite, l'inventeur prend du bois sec, convenablement choisi, auquel il donne la forme du crayon définitif,
3981 puis il le convertit en charbon dur et l'imbibe finalement
comme dans la fabrication que nous avons décrite. La distillation du bois se fait lentement de manière à chasser les corps volatils, et le séchage final est obtenu dans une atmosphère réductrice d'une température très-élevée. Un lavage préalable dans des acides et des alcalis enlève au bois les impuretés qu'il possède.

M. Gaudoin indique également le moyen de boucher les pores du bois en le faisant chauffer au rouge et en le soumettant à l'action du chlorure de carbone et de divers carbures d'hydrogène. Il espère ainsi produire des charbons électriques s'usant peu et donnant une lumière absolument fixe.

3982 Def't's Exhibit Fontaine's Book. } This Chapter.
H. C. M., Sp'l Ex'r. }

Chapitre XI.

Éclairage par Incandescence.

Emploi des tubes de Geissler.—Rapport présenté á l'Académie des sciences par M. Coste, au nom de M. Gervais.—Invention de M. King.—Lampe Lodyguine.—Rapport de M. Wild à l'Académie de Saint-Pétersbourg.—Lampe Konn.—Lampe Bouliguine.—Expériences faites par l'auteur sur l'éclairage par incandescence. Lampe Chérémeteff et Fontaine.

Ainsi que nous l'avons dit, l'arc voltaïque convient éminemment pour l'éclairage des grands espaces à découvert ou des vastes salles sans cloisonnements intérieurs, mais lorsqu'il s'agit d'éclairer de petits emplacements ou de grands locaux très-subdivisés, il est beaucoup plus avantageux d'employer le gaz, le pétrole et même l'huile, ordinaire.

Il a été fait de nombreux travaux sur la creation de petits foyers électriques, mais jusqu'à ce jour aucun des moyens préconisés n'a donné des résultats pratiques. On a notamment cherché à éclairer avec des tubes Geissler et avec des petits charbons incandescents, et, si ces deux moyens n'ont pas réussi, ils offrent néanmoins assez d'intérèt pour que nous leur consacrions quelques pages.

Chacun sait que Geissler, artiste à Bonn, a construit le premier des tubes à ampoules de formes variées, fermés hermétiquement et ne contenant que des traces de vapeurs deverses. Ces tubes, mis en communication avec un courant au moyen de fils de platine scellés dans le verre et d'une bobine Ruhmkorff, produisent une lumière stratifiée, c'est-à-dire composée de couches minces transversales séparées par des couches sombres continuellement agitées.
3983 En même temps les parois des tubes présentent un éclat particulier qu'on désigne sous le nom de fluorescence.

Le 27 mars 1865, M. Coste a présenté à l'Académie des sciences, au nom de M. Gervais, le rapport suivant:

"L'appareil a été construit par M. Ruhmkorff, qui s'est acquitté de ce soin avec son habileté et sa complaisance habituelles. C'est une caisse ou marmite en bronze, montée sur quatre pieds, et son couvercle est hermétiquement appliqué au moyen de vis de pression serrant, entre les deux surfaces ainsi mises au contact, une rondelle annulaire en caoutchouc. Au couvercle est attaché un anneau servant à la suspension de l'appareil optique. La caisse étanche renferme 2 éléments au bichromate de potasse, fermés à leur tour par des plaques que maintiennent des lames de cuivre solidement vissées. Les pôles du courant fourni par les 2 éléments peuvent être, à volonté, mis en communication avec la bobine, et le courant induit, fourni par celle-ci, est porté au dehors à travers la paroi inférieure du récipient, et transmis au tube de Geissler par des fils enveloppés de caoutchouc. Ce tube, d'une forme appropriée et rempli

d'acide carbonique, est enfermé dans un cylindre en verre, à parois épaisses, muni d'armatures en cuivre et dans lequel l'eau ne peut pénétrer. C'est la partie éclairante de l'appareil. On obtient avec cet instrument une lumière douce, mais très-sensible et en tout semblable à celle que le génie militaire et les mineurs emploient maintenant. Elle ressemble sous certains rapport à celle que donnent les animaux phosphorescents, quoique plus intense. Elle peut être aperçue d'assez loin, même lorsque l'appareil fonctionne à plusieurs mètres sous l'eau. Il n'est pas douteux qu'elle ne doive attirer le poisson, comme le fait aussi la phosphorescence de certaines espèces, et l'on pourrait également s'en servir pour éclairer des espaces
3984 restreints, situés au-dessous de la surface de l'eau, ou pour instituer des signaux flottants. M. le capitaine de vaisseau Devoulx, commandant les côtes sud de la France, a vu fonctionner cet appareil dans le port de Cette, au mois de septembre dernier. Il est resté pendant neuf heures immergé, et il a éclairé pendant six heures dans ces conditions, bien que je l'eusse apporté tout chargé de Montpellier. La phosphorescence peut être de plus longue durée. Un second essai, fait à Port-Vendres, à bord du Favori (capitaine Trotabas), m'a également réussi."

La lumière obtenue par les tubes Geissler est tellement faible, qu'on n'a jamais pu l'utiliser pratiquement et que de nombreux essais faits dans les mines et les poudreries sont restés infructueux.

L'éclairage par incandescence a été étudié depuis fort longtemps; mais son application usuelle a rencontré de si grandes difficultés, qu'aujourd'hui on peut encore le considérer comme du domaine purement scientifique, bien qu'il existe déjà un certain nombre d'appareils d'un assez bon fonctionnement.

Le premier document que nous ayons trouvé sur la question est une patente anglaise délivrée le 4 novembre 1845.

M. King, l'inventeur, entre dans des détails précis sur son idée et présente des considérations qui tendraient à prouver que des machines magnéto-électriques, assez puissantes pour produire de la lumière, existaient déjà en 1845.

Voici la traduction des passages principaux de cette patente:

L'invention a pour base l'emploi de conducteurs métalliques ou de charbons continus, chauffés à blanc, par le passage d'un courant électrique. Le meilleur métal pour cet usage est le platine, le meilleur charbon est celui de cornue.

Quand on emploie le charbon, il est utile, à cause de son
3985 affinité pour l'oxygène à haute température, de le mettre à l'abri de l'air et de l'humidité, comme il est indiqué figure 45. Le conducteur C repose sur un bain de mercure; la tige B est en porcelaine, elle sert à soutenir le conducteur C, le conducteur D est fixé sur la cloche par un joint bien hermétique. La baguette en charbon de cornue A repose, en haut et en bas, sur des blocs conducteurs et devient incandescenté par le passage d'un courant électrique. Le vide est préalablement fait dans la cloche, et le mieux est d'employer un véritable baromètre en mettant un des pôles de la pile en communication avec la colonne de mercure et l'autre avec le conducteur D.

Pour obtenir une lumière intermittente, on rompt périodiquement le circuit par un mouvement d'horlogerie.

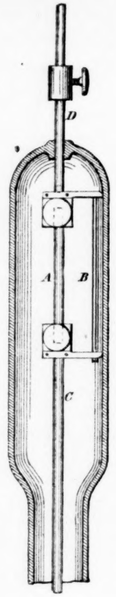

FIG. 45.—*Lampe King.*

3986 L'appareil, convenablement fermé, peut être appliqué à l'éclairage sous-marin ainsi q'à l'illumination des poudreries, des mines, partout où l'on redoute les dangers d'explosion ou l'inflammation rapide de corps très-combustibles.

Lorsque le courant est d'une intensité suffisante, deux ou un plus grand nombre de lumières peuvent être placées dans le même circuit, en ayant soin de régler la puissance des machines magnéto-électriques ou des éléments de la pile, produisant le courant.

En 1846, Greener et Staite se firent breveter pour une lampe analogue à celle de King, en indiquant qu'il serait bon de débarrasser, avant son emploi, le charbon de ses impuretés en le traitant par l'acide nitro-muriatique.

En 1849, Pétrie termine la description d'un brevet de lampe par l'indication suivante : " Une lumière peut être produite en faisant passer un courant électrique à travers un conducteur court et mince qui s'échauffe et devient luminex ; mais la plus grande partie des substances fondent et brûlent rapidement ; cependant j'obtiens une bonne lumière en me servant de l'iridium ou de quelques-uns de ses alliages. L'iridium peut être fondu jusqu' à produire un lingot lorsqu'il est soumis à la chaleur de l'arc voltaïque ; on le décarbonise ensuite et on le rend plus malléable. Puis on le coupe par petits morceaux de 0^m,001 de diamètre et de 0^m,010 à 0^m,020 de longueur que l'on fixe entre deux supports métalliques isolés, lesquels sont en connexion avec les deux fils d'une batterie galvanique convenable. On obtient alors une belle lumière."

Plusieurs autres brevets ont étéé pris en Amerique, en France et en Angleterre dans le même ordre d'idées; mais aucun d'eux ne nous parait plus complet, plus explicite et plus réalisable que celui de King; il est donc inutile de continuer notre nomenclature.

3987 L'éclairage par incandescence et le principe de sa production étaient depuis longtemps tombés dans l'oubli, lorsqu'en 1873, un physicien russe, M. Lodyguine, ressuscita l'un et l'autre et créa une petite lampe, qui fut depuis perfectionnée par MM. Konn et Bouliguine.

En 1874, l'Académie des sciences de Saint-Pétersbourg décerna un grand prix à M. Lodyguine. Voici quelques extraits du rapport présenté à cette occasion par M. Wild, directeur de l'Observatoire impérial russe; ce rapport, comme on le verra, renferme plusieurs erreurs capitales:

"On savait aussi depuis longtemps que l'on peut employer la faculté réchauffante du courant électrique, même sans l'aide d'un gaz comme dans l'arc galvanique lumineux, pour chauffer au blanc un corps solide. Se basant sur ce principe, on a souvent chauffé ainsi des fils de platine minces, donc mauvais conducteurs, en les faisant traverser par un fort courant électrique. La lumière obtenue par ce procédé est beaucoup plus faible et plus constante que la lumière électrique au charbon; elle a aussi plus de force d'extension, et peut être augmentée ou diminuée à volonté; néanmoins, elle n'a jamais trouvé un emploi pratique, parce qu'elle est trop faible en comparaison de son prix de revient, et parce qu'en voulant lui donner plus d'intensité on aboutit facilement à faire fondre le fil de platine, qui, en général, n'est pas tout à fait homogène.

"C'est M. Lodyguine qui, le premier, a eu l'idée de remplacer, dans ces expériences de combustion, le fil de platine par de minces tiges d'un charbon (coke) analogue au graphite, c'est-à-dire bon conducteur, et par là il a résolu le problème de l'éclairage électrique.

"Les avantages de cette substitution du charbon au platine sautent tellement aux yeux aussi au point de vue théorique, que l'on est tout étonné—comme cela est d'ailleurs le cas pour
3988 beaucoup d'importantes inventions—de ce qu'on n'en ait pas
eu l'idée plus tôt. Le charbon posséde, à température égale, un pouvoir beaucoup plus grand de rayonnement que le platine; la capacité calorique du platine est supérieure (presque du double) à celle du charbon en question, bon conducteur, de sorte que la même quantité de calorique élève la température d'une petite tige de ce charbon à un degré presque deux fois plus élevé n'elle ne le fait pour un fil de platine du même volume. En outre, la résistance du charbon en question, comme conducteur d'électricité, est environ 250 fois plus grande que celle du platine; il en résulte que la petite tige de charbon peut être 15 fois plus épaisse qu'une tige de platine de la même longeur et que le courant qui la traverse engendrera la même quantité de chaleur. Enfin, le charbon peut être chauffé au blanc jusqu'au degré le plus extrême sans qu'on ait à en redoubter

la fusion, comme c'est le cas pour le platine. C'est à ces importants avantages théoriques que l'on doit évidemment le grand succès du mode d'èclairage électrique de M. Lodyguine.

"Le seul inconvénient de l'emploi du charbon au lieu du platine consiste en ce que, dans la combustion, le charbon se combine avec l'oxygéne de l'air et se consume ainsi-peu à peu. Mais M. Lodyguine a déjà paré à cet inconvénient en enfermant le charbon chauffé ou blanc par le courant électrique dans un récipient en verre hermétiquement clos et de l'intérieur duquel l'oxygéne est expulsé par un procédé des plus simples.

"Il n'appartient d'ailleurs pas à l'Académie des sciences de donner son jugement ni, d'un côte, sur ces difficultés techniques et d'autres encore qui se présenteront dans l'application en grand de l'invention de M. Lodyguine, ni, d'un autre côté, sur les nombreux avantages pratiques de ce mode d'éclairage comparativement à tous les autres; il suffira à l'Académie d'avoir constaté que, grâce à 3989 cette invention, se trouve résolu, de la manière la plus simple possible, le grand probléme de diviser la lumiére électrique et de la rendre constante[1], pour reconnaître M. Lodyguine, en considération des nombreuses applications utiles de son invention, digne d'obtenia le prix Lomonossow."

Dans sa lampe, M. Lodyguine employait des crayons d'une seule piéce en diminuànt leur section à l'endroit du foyer lumineux, et il plaçait deux charbons dans un même appareil avec un petit commutateur extérieur, pour faire passer le courant dans le deuxième charbon quand le premier était usé. Rien de moins pratique et de moins étudié que les appareils de cet inventeur.

M. Kosloff, de Saint-Pétersbourg, qui vint en France dans l'espoir d'exploiter le brevet Lodyguine, perfectionna un peu sa lampe, sans cependant aboutir à quelque chose de passable.

En 1875, M. Konn, également de Saint-Pétersbourg, fit breveter une lampe plus pratique que nous représentons figure 46, et qui a été construite pour la première fois, en France, par M. Duboscq.

(Here follows diagram marked p. 3990.)

Cette lampe se compose d'un socle A en cuivre sur lequel sont fixées deux bornes X pour attacher les conducteurs, deux tiges C, D en cuivre et une petite soupape K, ne s'ouvrant que de dedans en dehors. Un globe B, évasé à sa partie supérieure, est retenu sur le socle au moyen d'un écrou en bronze L pressant sur une bague en caoutchouc, exactement comme cela a lieu dans les niveau d'eau de chaudiéres à vapeur.

Une des tiges verticales D est isolée électriquement du bàti et communique avec une borne également isolée. L'autre tige 3991 C est formêe de deux parties: 1° d'un tube fixé directement sur le socle sans isolation, et 2° d'une baguette de cuivre, fendue dans une partie de sa longeur. Cette fente lui donne de l'élasticité et lui permet de coulisser dans le tube tout en restant fixe, si l'on n'exerce pas sur elle un certain effort.

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[1] On verra dans la suite combien le probélme a été peu résolu par M. Lodyguine.

No. 286.
C.E. Light Co
v.
McK. Light Co
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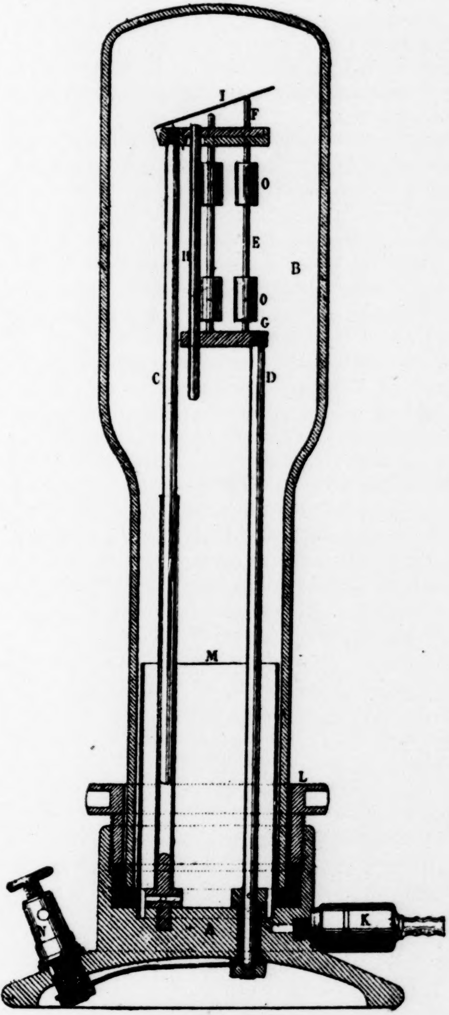
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Fig. 46. Lampe Konn.

Les charbons de cornue E, au nombre de 5, sont placés entre les deux petits plateaux qui couronnent les tiges.

Chaque charbon est introduit dans deux petits blocs, également en charbon, lesquels reçoivent des baguettes de cuivre à leurs extrémités. Les baguettes sont égales entre elles à la partie inférieure et de longueurs inégales à la partie supérieure. Une charnère I est articulée sur la tige C et repose sur la baguette d'un seul charbon à la fois.

Si l'on place cette lamp dans un circuit en attachent les deux conducteurs d'une pile aux bornes NN′ (la borne N′ est cachée par la borne N; mais elle est identique et n'est pas isolée du socle), la tige de carbone E est traversée par le courant qui passe par l'intermédiaire de la charnière I, de la baguette de quivre F, des deux blocs de charbon O, O, de la baguette de cuivre G et du plateau couronnant la tige D.

Le vide a été préalablement effectué en plaçant sur l'ajutage de K le conduit d'une pompe à air ou d'une machine pneumatique quelconque.

La tige E rougit, blanchit et devient lumineuse. Sa lumière est d'abord blanche, fixe, constante; puis petit à petit la section diminue, la tige se rompt et la lumière disparaît. La charnière I tombe alors sur une autre tige, et, presque instantanément, l'éclairage est rétabli.

Quand tous les charbons sont usés, la charnière s'arrête sur une tige en cuivre H et le courant n'est pas rompu. De cette manière, s'il y a plusieurs lampes alimentées par un même générateur d'êlectricité, l'extinction de l'une n'entraîne pas celle des autres.

3992 Pour éviter la projection des petits charbons rompus et de leurs blocs contre le verre, M. Konn a placé à la partie inférieure de sa lampe un tube mince en cuivre M, qui reçoit les débris jusqu'à ce qu'on garnisse de nouveau les plateaux.

Trois de ces lampes ont été installées depuis deux ans chez M. Florent, négociant à Saint Pétersbourg, et mises en action avec une machine de l'Alliance. Chaque charbon dure environ deux heures, à l'exception du premier, qui se consume presque immédiatement; la lumière est très-agréable, mais son prix de revient dépasse notablement celui du gaz. M. Florent, que nous avons eu occasion de voir plusieurs fois, nous a dit que le grand avantage qu'il avait trouvé dans l'emploi de l'éclairage électrique était dans sa propreté. Ses magasins renferment beaucoup de linge blanc, que le gaz altérait rapidement et sur lequel l'électricité n'exerce aucune fâcheuse influence. Le blanchissage économisé compense largement les frais supplémentaires nécessités par une installation importante, eu égard au peu de lumière obtenue.

Aucume expérience photométrique n'a été faite chez M. Florent; mais, en comparant avec le gaz, on évalue que chaque lampe Konn donne environ 20 becs Carcel.

La cause principale de la dépense exagérée qu'entraine l'emploi de la lumière par incandescence, réside dans la difficulté de préparer les petits charbons, qui reviennent, en place, à plus de 5 francs le mètre.

Un officier russe, M. Bouliguine, a combiné une lampe (Fig. 47) qui atteint àpeu prés le même but que celle de M. Konn avec un seul charbon. Elle se compose, comme la précédente, d'un socle en cuivre, de deux tiges verticales, de deux barres de prise de courants et d'une soupape d'évacuation.

(Here follows diagram marked p. 3995.)

3993 & 3994 Une des tiges est percée d'un petit trou du haut en bas et possède, sur presque toute sa longueur, une fente permettant le passage de deux petites oreilles latérales.

Le charbon est introduit dans cette tige comme la mine d'un porte-crayon ordinaire, et il est sollicité à monter par dos contre-poids reliés au moyen de deux câbles microscopiques, aux orielles du support en croix sur lequel repose le charbon.

La partie du charbon que doit entrer en incandescence est retenue entre les levres de deux blocs coniques en charbon de cornue.

Une vis, placée sous le socle, permet d'augmenter ou de diminuer la longuer de la tige qui porte le bloc conique supérieur, et, par suite, de donner à la partie lumineuse une plus ou moins grande longuer.

La fermeture du globe est obtenue par la pression latérale de plusieurs rondelles en caoutchouc.

Lorsque la lampe est placée dans un circuit, la baguette de charbon rougit et s'illumine jusqu'à ce qu'elle vienne à se rompre. A ce moment un petit mécanisme[1] commandé par un électro-aimant ouvre les lèvres des porte-charbons, le contre-poid du haut chasse les fragments qui pourraient rester dans l'entaille, les contre-poids du bas relèvent la tige en charbon, laquelle pénètre dans le bloc supérieur et rétablit le courant. Le mécanisme commandé par l'électro-aimant agit de nouveau, mais en sens inverse de sa première manœuvre, les porte-crayons se resserrent et la lumière renaît.

Nous avons, à plusieurs reprises, expérimenté cette lampe et nous
n'avons jamais obtenu de très-bons résultats. Elle renferme
3996 trop d'organes en mouvement, et le moindre obstacle empêche le mécanisme de jouer. Cependant nous avons observé que lorsque par hazard elle fonctionnait régulièrement, les contacts étant meilleurs et moins nombreux que ceux de la lampe Konn, il falliat moins d'intensité de courant pour la production d'un éclat lumineux déterminé. Avec une machine Gramme de 100 becs, nous avons obtenu avec une seule lampe jusqu'à 80 becs, tandis qu'avec une lampe Konn nous ne pouvions jamais dépasser 60 becs.

Pour bien nous rendre compte de la valeur réelle du système d'éclairage par incandescence, nous avons fait faire, sous nos yeux, une série d'expériences avec plusiers lampes Konn et une pile Bunsen de 48 éléments de $0^{m},20$ de hauteur.

La première opération a consisté dans la mesure des résistances du charbon de cornue à section carrée. Les échantillons essayés avaient $0^{m},002$ de côté. Voici les résultats de huit expériences :

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[1] Le mécanisme en question, que l'exiguïté de notre dessin ne nous a pas permis de figurer, se compose en substance d'une armature en fer placée dans l'intérieur de la lampe et de deux tringles métalliques agissant sur deux leviers croisés et articulés sur la bague enveloppant les porte-charbons.

No. 286.
C. R. Light Co. } p. 3995
v.
McK. Light Co.

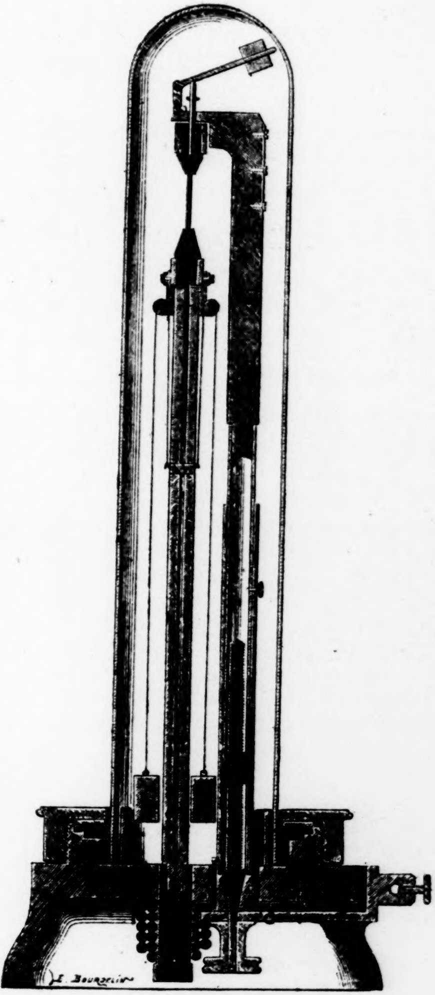
E. Bourgeois

FIG. 47. Lampe Bouliguine.

Numéros des expériences.	Longueur des échantillons.	Résistance en mètres de fil télégraphique.
1	$0^{m},100$	16^{m}
2	0 ,100	14
3	0 ,100	15
4	0 ,100	14 ,50
5	0 ,100	19
6	0 ,050	7
7	0 ,050	9
8	0 ,050	7
Totaux.......	$0^{m},650$	$101^{m},50$

D'où il résulte que la résistance linéaire moyenne du charbon de cornue de $0^{m},002$ est d'environ 172, celle d'un fil télégraphique de $0^{m},004$ étant prise pour unité.

3997 On a ensuite arrondi les charbons jusqu'à réduire leur diamètre à $0^{m},0016$ et réglé leur longueur de manière à obtenir $0^{m},018$ de partie incandescente. Le vide était obtenu à environ $0^{m},70$ de mercure.

Les résultats ci-dessous représéntent les monennes de plus de 20 séries d'expériences.

État de circuit.	Modes de couplage de la pile.							
	2 séries parallèles de 24 éléments.		3 séries parallèles de 16 éléments.		4 séries parallèles de 12 éléments.		1 seule série de 48 éléments en tension.	
	Indication du galvanomètre.	Intensité lumineuse de chaque lampe.	Indication du galvanomètre.	Intensité lumineuse de chaque lampe.	Indication du galvanomètre.	Intensité lumineuse de chaque lampe.	Indication du galvanomètre.	Intensité lumineuse de chaque lampe.
Circuit fermé sur luimème .	47	"	70	"	70	"	50	"
5 lampes	28	Rouge blanc.	17	Rouge cerise.	10 ou 11	Rouge sombre.	35	½ bec.
4 lampes.......	29	½ bec.	22	Rouge blanc.	16	Rouge orangé.	38	2 becs ½.
3 lampes.......	38	1 à 2 becs.	28	⅓ de bec.	26	¼ de bec.	41	3 becs ½.
2 lampès.......	40	3 becs.	41 à 42	2 becs. ½ à 3 becs.	40 à 45	3 à 5 becs.	44	5 becs.
1 lampe	43	4 à 5 becs.	49	11 à 12 becs.	60	40 becs.	45 à 46	6 becs ½ à 7 becs.

Les lampes étaient groupées comme les éléments d'une pile en tension, elles formaient donc une série unique.

Dans le tableau suivant sont consignés les résultats obtenus avec des lampes assemblées en batteries, c'est-à-dire sur des courants distincts dérivés de la pile. A cause des différences notables reconnues dans les intensités des lumières de chaque lampe, pend-
3998 ant la même expérience, nous donnons la lumière totale au
lieu de celle produite par chaque lampe.

État du circuit.	Modes de couplage de la pile.							
	2 séries parallèles de 24 éléments.		3 series parallèles de 16 éléments.		4 séries parallèles de 12 éléments.		8 séries parallèles de 6 éléments.	
	Indication du galvanomètre.	Totalité de la lumière émise par l'ensemble des lampes.	Indication du galvanomètre.	Totalité de la lumière émise par l'ensemble des lampes.	Indication du galvanomètre.	Totalité de la lumière émise par l'ensemble des lampes.	Indication du galvanomètre.	Totalité de la lumière émise par l'ensemble des lampes.
Circuit fermé sur lui-même......	$58\frac{1}{2}$	"	68	"	69	"	70	"
5 lampes.........	57	"	$64\frac{1}{2}$	$\frac{1}{4}$ de bec.	$63\frac{1}{2}$	2 becs $\frac{1}{2}$	60	"
4 lampes.........	$56\frac{1}{2}$	"	63	$\frac{3}{4}$ de bec.	63	3 becs.	59	"
3 lampes.........	56	1 bec.	$61\frac{1}{2}$	2 becs.	62	4 becs.	58	$\frac{3}{4}$ de bec.
2 lampes.........	55	5 becs.	60	6 becs $\frac{1}{2}$	59	15 becs $\frac{1}{2}$	55	1 bec $\frac{1}{2}$.
1 lampe.........	$52\frac{1}{2}$	9 becs.	$57\frac{1}{2}$	54 becs.	55	63 becs.	46	8 becs.

Plusieurs observations importantes ont été faites pendant les expériences.

Quand les récipients sont étanches et les contacts soiguneusement mis d'aplomb, les charbons ont une durée satisfaisante. Le premier charbon d'une lampe ne dure jamais moins d'un quart d'heure, quelquefois il ne se brise qu'au bout de 30 à 35 minutes, mais cela est très-rare, sa durée moyenne est de 21 minutes. Les charbons qui succèdent, durent en moyenne 2 heures, à moins cependant que l'intensité lumineuse n'atteigne 40 becs, auquel cas ils ne durent en moyenne qu'une demi-heure. Dans l'expérience des 4 séries parallèles de 12 éléments, les 5 lampes étant assemblées en batteries et une seule allumée, le charbon, qui donnait 65 becs, n'a duré que 23 minutes en moyenne.

L'examen attentif des charbons incandescents, à travers
3999 un verre fortement coloré, a montré qu'ils ne sont pas uniformément brillants. Ils présentent des taches obscures, indices de non-homogénété et siéges de gerçures qui désagrégent rapidement le charbon.

Le vide n'étant jamais parfait dans les récipients, le premier charbon est brûlé en grande partie. Il semble qu'ensuite, le peu d'oxygène contenu dans la lampe étante transformé en acede carbonique et oxyde de carbone, le charbon doive se conserver indéfiniment. Mais il se produit alors une sorte d'évaporation qui continue à ruiner lentement les baguettes incandescentes. Cette évaporation est d'ailleurs nettement prouvée par un dépôt pulvérulent de charbon sublimé qu'on trouve sur la surface intérieure des cloches, sur les diverses pièces intérieures : tiges, contacts, charnières, etc.

Aucune cloche n'a été cassée par chaleur ou refroidissement pendant toutes les expériences qui ont duré plusieurs mois, mais plusieures ont eu leur col brise par le serrage trop énergique du joint.

La partie délicate de la lampe est dans la série des contacts qui précèdent la baguette incandescente. On n'obtient l'aplomb des charbons, indispensable à leur durée, qu'avec des précautions minutieuses et longues. Après rupture, le contact ne se reforme pas toujours automatiquement, et une fois sur trois on est obligé de secouer la lampe pour provoquer l'allumage du charbon suivant.

Les rendements maxima ont constamment été ceux obtenus avec une seule lampe et avec 4 étéments de quantité ; dès qu'on employait deux lampes ou qu'on descendait à 2 éléments de quantité, les résultats étaient considérablement diminués.

Nous avons fait tout récemment les mêmes expériences avec des charbons artificiels Gaudoin de même section que les premiers et les résultats ont été plus satisfaisants Ainsi la lumière totale pro-
4000 duite avec 48 éléments en 4 séries et une seule lampe a atteint 80 becs et celle produite avec la même pile et 3 lampes a atteint 30 becs.

La même pile, couplée en tension et agissant sur une lampe Serrin, donnait un arc voltaïque de 105 becs ; mais la lumière obtenue par incandescence était beaucoup plus fixe et plus agréable aux yeux.

De ce qui précède il paraî résulter que le procédé King et Lodyguine est beaucoup plus favorable aux grands foyers qu'à la divisibilité de la lumière électrique ; cependant il convient de remarquer que lorsqu'on ne dépasse pas 10 becs par lampe, les charbons ont une assez longue durée, tandis qu'ils s'usent très-vite pour une intensité de 60 et 80 becs.

Les charbons de $0^m,0016$ de diamètre et $0^m,018$ de longeur lumineuse étaient jusqu'alors les seuls que nous ayons essayés ; ils se comportaient assez bien avec un fort courant, mais ne donnaient aucune lumière avec 12 éléments. Il était intéressant de chercher quelle lumière on peut obtenir avec 12 éléments en diminuant la longueur des charbons. Ce fut le but d'une nouvelle série d'expériences.

Cinq combinaisons diverses one été tentées, en faisant varier tour à tour le couplage de la pile, le diamètre du charbon et sa longueur.

Les meilleurs résultats ont été obtenus avec une lampe unique garnie de charbons Gaudoin de $0^m,0016$ de diamètre et de $0^m,015$ de partie incandescente.

La lumière constatée a varié entre 2 et 8 becs, elle a été le plus souvent de 5 becs. Chaque charbon a duré 15 minutes en moyenne.

Nous devions reprendre toutes ces expériences, en substituent à la pile une machine Gramme combinée pour donner le meilleur

4002 effet utile possible; mais les imperfections des lampes la difficulté d'obtenir de bons contacts, les soins trop minutieux à prendre au commencement de chaque opération, nous ont décide à étudier préalablement une lampe un peu plus commode et un peu plus pratique que celle de M. Konn.

(Here follows diagram marked p. 4001.)

Cette lampe, que nous représentons figure 48, est actuellement en construction chez M. Bréguet. Elle est caractérisée par les deux points suivants: 1° les charbons sont encastrés par chacune de leurs extrémités dans des contacts rigides et maintenus fixes, ce qui permet de faire fonctionner la lampe dans toutes les positions; 2° le courant électrique passe automatiquement d'un charbon à l'autre par l'action d'un électro-aimant intercalé dans le circuit.

Une description, même sommaire, n'aurait pas un grand intérêt, puisque la lampe n'est pas encore exécutée; le desin indique d'ailleurs suffisamment le dispositif que nous avons adopté pour réaliser notre projet.

(Here follows diagrams marked pp. 4003 to 4012, incl.)

(Here follow lithographs and drawings marked pp. 4013 to 4022, incl.)

4023

CONSOLIDATED
vs.
McKEESPORT.

DEFENDANT'S CROSS-EXAMINATION EXHIBIT MORTON'S PAPER ON ELECTRIC LIGHT. W. T. F., S. E.

(From the "American Gas Light Journal," Feb. 17, 1879.)

Lecture Upon the Electric Light.

Delivered Oct. 17, 1878, before the American Gas Light Association,

By Prof. Henry Morton, Ph. D.,

Pres. Stevens Inst., Hoboken, N. J.

(Concluded from page 54.)

In addition to the other forms or modifications of magneto-electric machines—by which name I intend to designate all that I have already described, as I do not think that the term dynamo-electric machines, to designate those in which electro-magnets, excited by the machine itself, are used as producers of the "field of force" or magnetic field in which the revolving magnets move, as distinguished from the earlier sort, using permanent magnets or the like, is at all necessary—there are some others which should not be passed over without notice.

No. 286.
C.E. Light Co
v.
McK. Light Co. } p. 4001

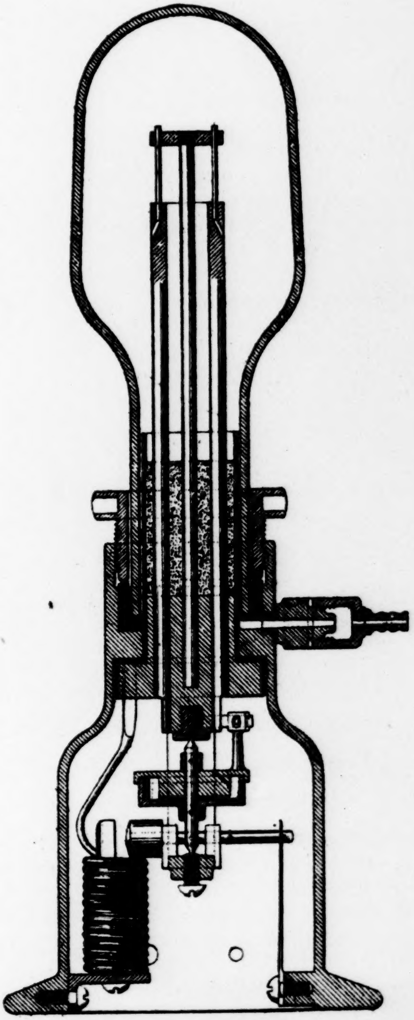

Fig. 48. Lampe H. Fontaine.

No. 286
C.E. Right Co.
v.
McK Right Co
} p. 4003

III.

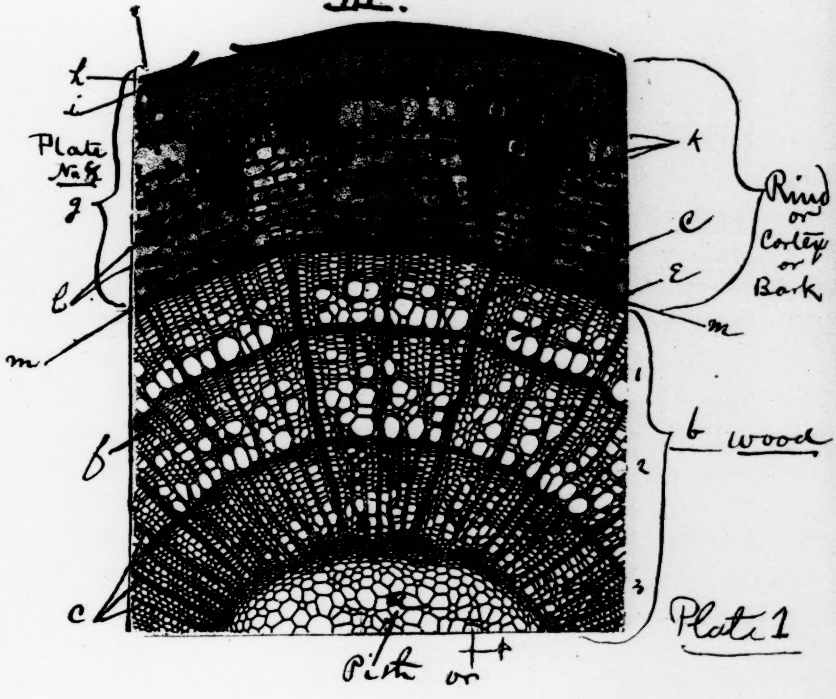

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Plate
No. 8
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or
Cortex
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Bark
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Plate 1

II.

Define Exogenous Woods.

— Anatomy —

In the Exogenous plant the rind Contains the the Bast.

Plate 9

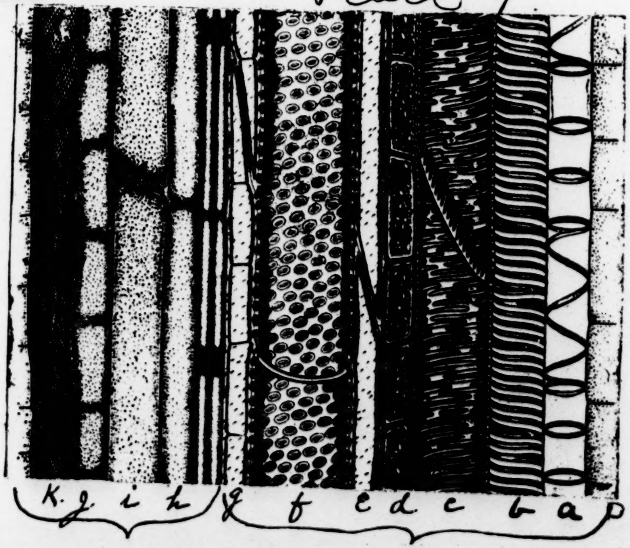
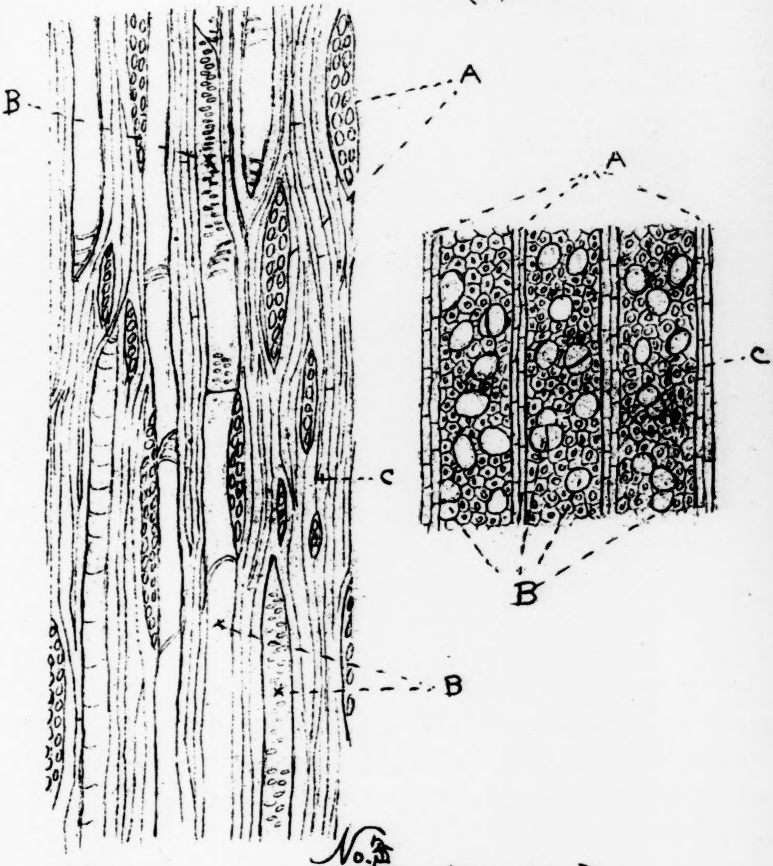


Plate
~~No 9.~~
No 2

No. 286.
C. E. Light Co
v.
McK Light Co. } p. 4004

No. 286
E. Light Co.
v.
McK. Light Co. } p. 4006

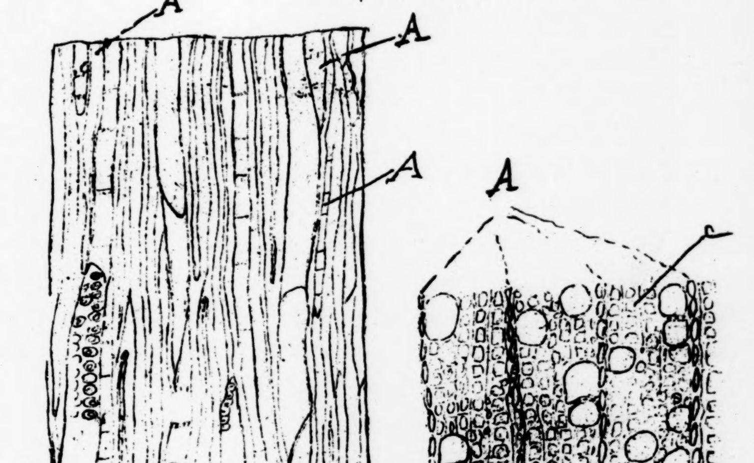


No. 35

Liriodendron tulipifera.

White Wood

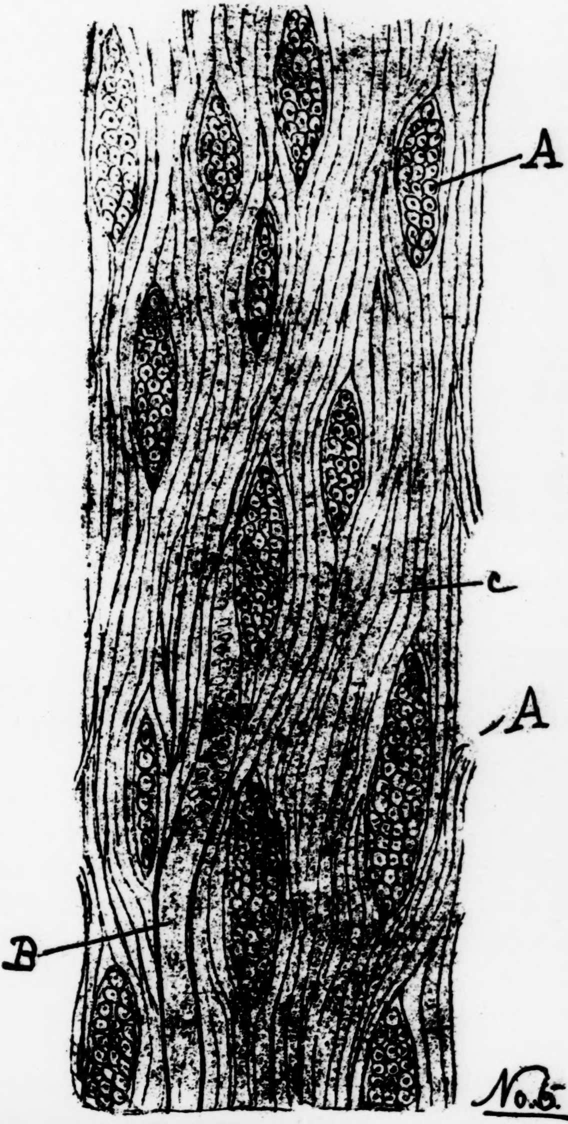
No. 286.
CE Light Co.
v.
McK Light Co } p. 4006


A
A
A
B
A
B
A
c
c
B

No. 4

Willow

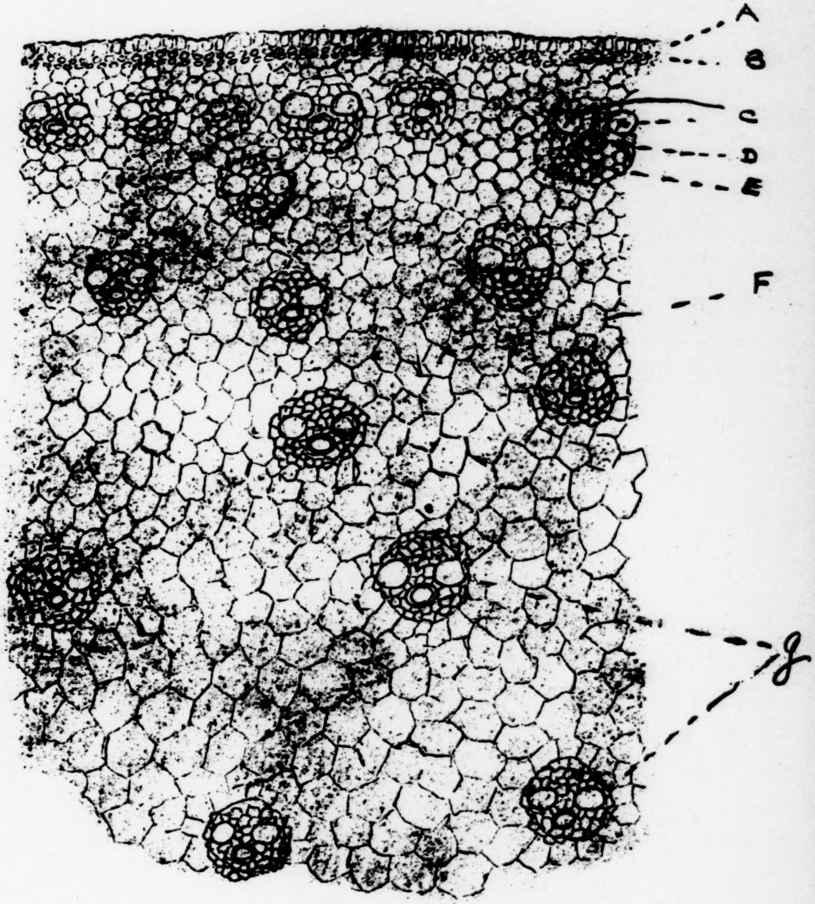
No. 286.
C.E. Light Co.
v.
M.W.K. Light Co. } p. 4007



No. 5.

Rock Elm.

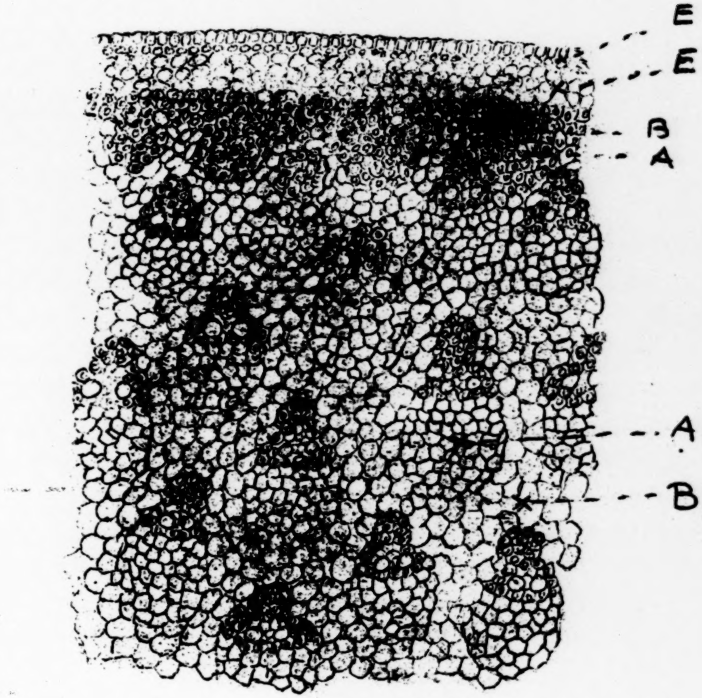
No. 286.
C.E.Light Co
v.
McK.Light Co.
p. 4008



No. 6

Corn.

No. 286
C.E. Light Co
v.
McK. Light Co. } p. 4009

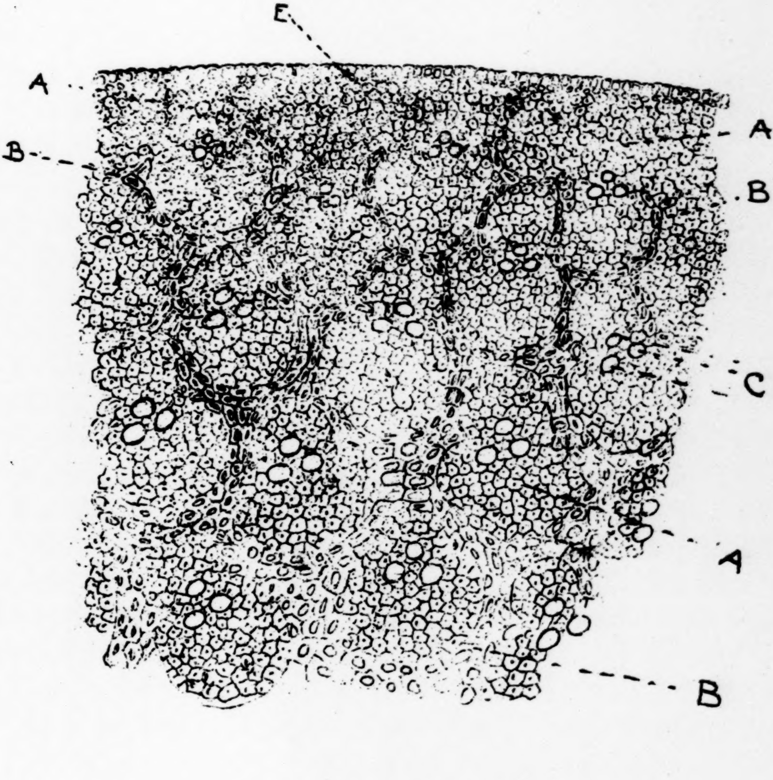


No. 7.

(Young Stem) Bamboo.

[illegible]

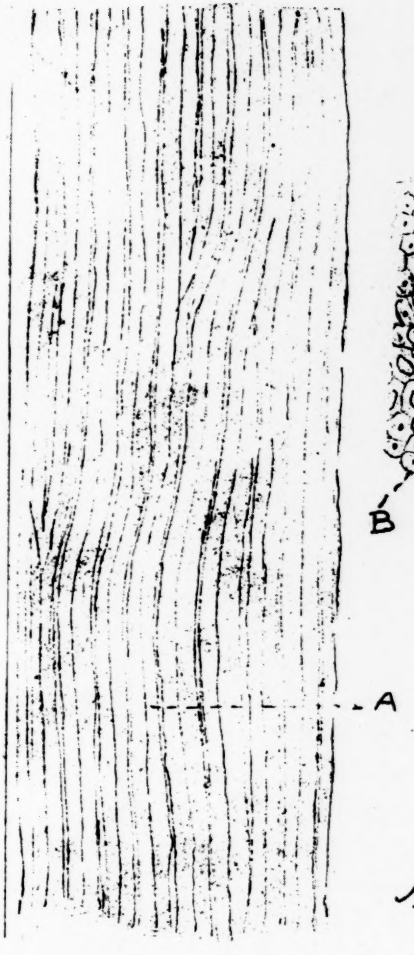
No. 286.
C. E. Light Co.
v.
McK. Light Co
} p. 4010

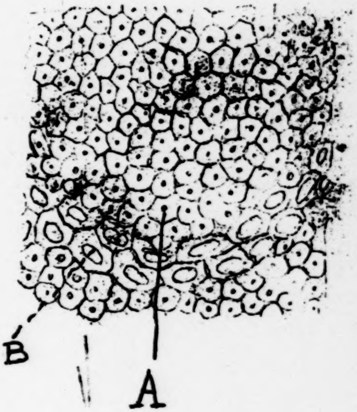


No. 8

(Old stem) Bamboo.

No. 286.
C.E. Light Co.
v.
McK. Light Co. } p. 4011





No. 9.

Bamboo.

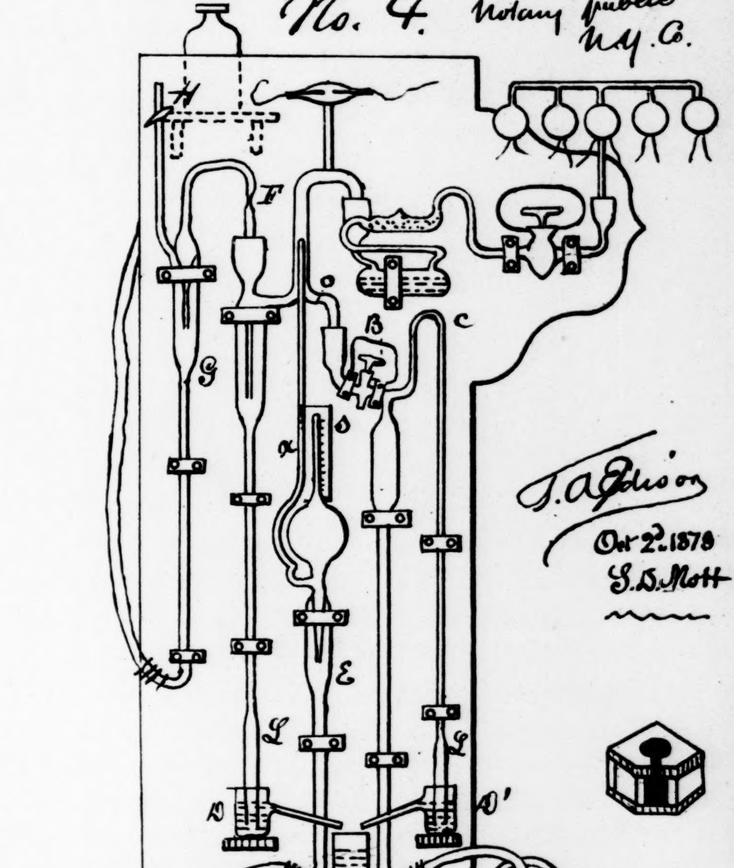
No. 286.
C. E. Light Co.
vs
McK Light Co. } p. 4016

Cons E L Co
vs
McKeesport Co } Dfts Exhibit No 6
W. J. J.
S. E.

Edison's Exhibit No. 6.

W. H. M.
Notary public
N. Y. Co.

No. 4.



T. A. Edison

Oct 2d 1879
S. D. Mott

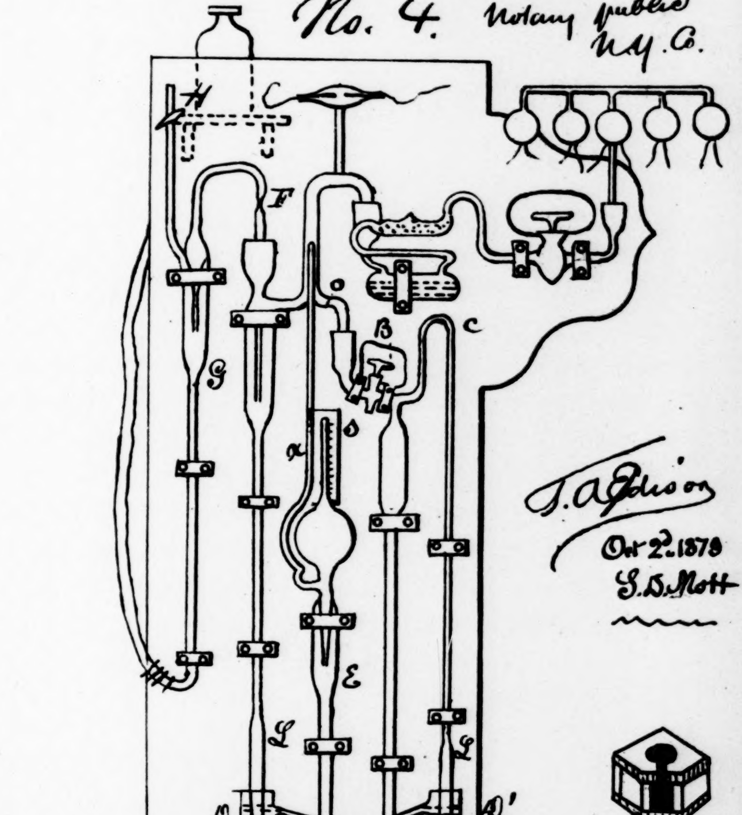
No. 286.
C.E. Light Co.
vs
MCK Light Co.
} p. 4016

Cons E L Co
vs
McKeesport Co
} Defts Exhibit No 6
W.J.J. S.E.

Edison's Exhibit No. 6.

W.H.M

No. 4. Notary public N.Y. Co.



T. A. Edison
Oct 2d 1879
S.D. Mott

351 1 July 20 1877

1 – Hammered Aluminium
2 – Platina
3 – Silver
4 – Phosphor bronze
5 – Zinc
6 – Lead
7 – French Steel
8 – Wrought Iron
9 – Nickel
10 – Russian leather
11 – White spruce shellaced
12 – Light Mahogany
13 – Box wood
14 – Brass
15 – Walnut wood
16 – paper of all kinds
17 – Celluloid
18 – Hard Rubber
19 – Vulcanized fibre
20 – Cardboard
21 – Carbon paper
22 – Copper foil
23 – Mica
24 – Bastie Glass
25 – Papier-Maché
26 – Veneering of different wood
27 – Plaster of Paris
28 – Crocodile skin
29 – Fish skin near tail (Mackerel)
30 – Paper barrel stock
31 – Iridium foil
32 – Collodionised paper
33 – Gelatin
34 – Oil board such as used for Copy press
35 – Soft rubber thick
36 – Gold foil
37 – thin slate –
38 – Oil cloth –

Chas Batchelor
James Adams

(Edison's Exhibit No. 14) W. H. M.
notary public, N.Y. Co.

Consolidated E L Co
vs
McKeesport Co
~~offered in evidence~~
~~on behalf of Defendants~~
Exhibit No 14 W J H. D.C.

No. 286.
C. E. Light Co
v
McK. Light Co
p. 4019

No. 285.
C. E. Light Co.
v.
McK. Light Co. } p. 4022

Dear Stillman Please fill this bag with pure gas, expelling all the air you can first.

When can I have it?
Will you come round after the gas is made & show me how to fix the solutions? Also bring some phosphoric anhydride

Yours truly
(Edison's Exhibit No. 24) W. E. Sawyer
W.H.M.
notary public
N. Y. Co.

Cons E L Co vs. McKeesport L Co Defts Exhibit W J S. S.E.

In the first place, Mr. Edward Weston, of Newark, is manufacturing a machine resembling exactly in appearance, and, as far as I can see, in all essentials of construction, that which I have already described and shown as Siemens' later form (see Fig. 27). With several of these machines I have made numerous trials lately, and ~~find them~~ to run well for as much as ten hours at a time, and to give a higher efficiency in light per horse power than any of the other machines with which I have experimented. This re-
4024 sult seems to agree with the general result of experiments made in Europe with the machines of Siemens, and with a

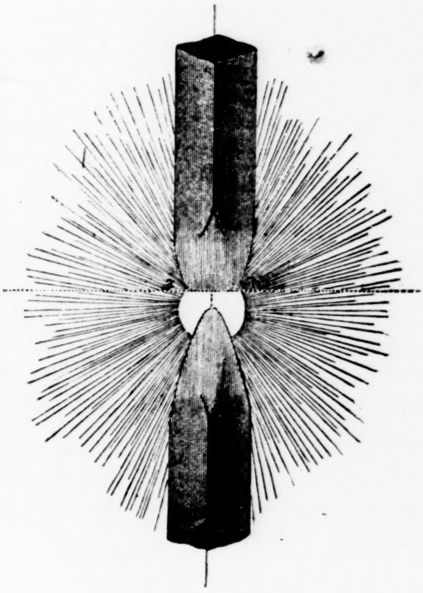


FIG. 40.

general verbal statement which was made to me as to the result of experiments at the U. S. torpedo station at Newport, R. I., where they have one of these Siemens machines.

There is also a very efficient machine manufactured by Messrs. Arnoux & Hochhausen, of New York. Some of these were used very successfully last summer for lighting the bathing beach at Coney Island and for lighting several points in New York during the holiday season this winter and the new state-house at Albany during its inauguration.

One of these was kindly loaned to me on the evening of the address here reported, but as it was soon afterward required for use by its manufacturers I have not had an opportunity to make any examination of or experiments with it. It much resembles the second form of Wilde, or the Farmer machine in general arrangement.

4025 In describing the various forms and modifications of these machines I have not attempted in all cases to follow the chronological order of each step, as this would sometimes have involved the skipping about from one type of machine to another. I will now, therefore, give an abstract of the chronology of the subject, following Dr. Schellen's book as an authority for a part of the list:

1831. Faraday discovered magneto-electric induction.
1832. Pixii made first magneto-electric machine
1833. Saxton made magneto-electric machine.
1836. Clarke made magneto-electric machine.
1849. Nollet-Van Malderen—Alliance machine.
1852. Holmes introduced electro-magnets.
1857. Siemens introduced peculiar armature.
1864. Pacinotti, the first continuous current machine.
1866. Wilde made his first form of machine.
1866. Siemens & Halke, same principle as Ladd.
1867. Ladd, self-exciting principle.
1867. Wheatstone developed same principle.
1871. Gramme first described his continuous current machine.
1873. Wilde described his second form.
1875. Siemens describes his machine. (Fig. 27.)
1873. Farmer patented machine like Wilde's second.
1874. Lontin machine, for many circuits.
1878. Gramme's alternating machine.

In considering the practical application of the electric arc as a source of light, it becomes very important to notice with accuracy just what is the chief location of light in the ignited poles, and how this may be affected by various conditions.

Thus, in the first place, if we are using a machine with a current of uniform direction, we will find that the upper or positive pole, as they are generally arranged, soon acquire a cup-shaped form, as shown in Fig. 40, and that the most intensely luminous portion of the carbon is the interior of this positive cup. The edges of this cup will evidently cut off this light from spreading upward for a
very considerable angle, while on the other hand all the
4026 light from this interior luminous area will pass freely down-
ward. From this it will of course follow that very different results would be obtained if, with such machine and arrangement of the carbons, the lights were measured from below, or on a level, or from above.

If the two carbon points are not placed truly in line with each other, then we have such a state of affairs as is shown in Fig. 41.

Here, evidently, while the light from the hollow positive pole would radiate freely in front, it would be largely cut off behind, and escape only with a medium degree of facility at either side; in fact, measurements made with such arrangements show the following figures:

itted, in a horizontal position, when for the various directions, when they are displaced as shown in Fig. 41: in front, 287; latterly, 116; backward, 38.

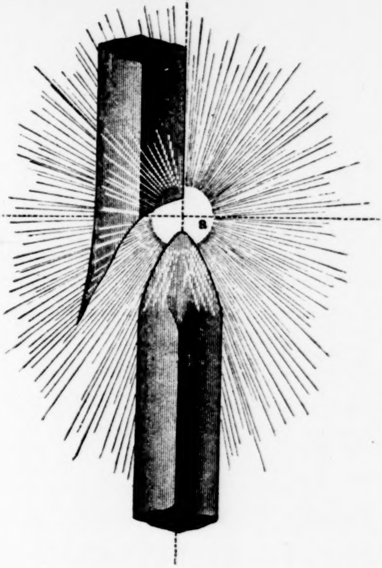


Fig. 41.

4027 In the report of experiments made by a committee of the Franklin institute (see Journal of that society, vol. 75, p. 301) I find the record of a similar set of measurements, as follows:

Front	2,218	candles.
Side	578	"
"	578	"
Back	111	"
	3,485÷4=871	

"The light produced by the machine, under the same conditions, except the carbons being adjusted in one vertical line, was 525 candles. This would seem to indicate that nearly 66 per cent. more light than was produced by this adjustment of the carbons; but a close study of the conditions satisfied us that such is not the case, and there is no advantage to be derived from such adjustment, except when the light is intended to be used in one direction only."

This shows us, among other things, how very great a difference of result in candle power may be obtained with the same apparatus, if a difference occurs in the arrangement of the points; and it also

explains why an arc which giv[illegible]rmer machine in general arrange-
measured, may quite fail to exh[illegible] degree of actual illuminating power when put to some practical use.

Thus, in the case just cited, while the candle power, measured from the front, would be 287, the average for all directions would be only 139, or about one-half as great.

In this connection a certain advantage is found in the use of machines with alternating currents. Here the carbons both burn away alike to the pointed ends, and the light is thus much more equally distributed on all sides. (See Fig. 42.)

In most of the machines now in use the current which produces the light is the same which passes around the coils of the stationary magnets, by which the field of force is developed; hence there is the most intimate relations between the machine and the
4028 lamp, and any fluctuation in the resistance offered at the latter is at once felt at the machine. To eliminate this source of uncertainty and irregularity, in some experiments which I have lately conducted with various machines I have employed a simple, substantial holder for the carbons, with means of adjustment from time to time by hand. This requires, of course, the frequent attention of an assistant during the experiments, but by this means I have obtained more constant and favorable results, from all the machines tried, than with any of the automatic lamps.

Next to this I have found the Brush lamp to be most satisfactory, when used with its own machine.

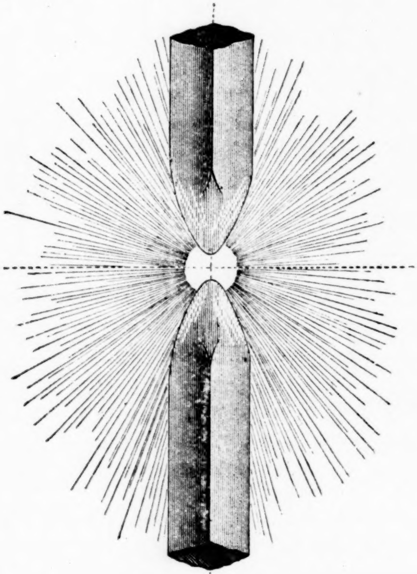


Fig. 42.

As the structure of this lamp is very simple, I will give a description of it here.

This lamp is shown in Figs. 43 and 44, in which *a* is a helix of insulated copper wire, resting upon an insulated plate, *b*, up-
4029 held by the metallic post, *c*. Loosely fitted with the helix
is the core *d*, partly supported by the adjustable springs *e*. The rod, *f*, passes freely through the center of the core, *d*, and has at its lower end a clamp for holding the carbon pencil. A washer, *h*, of brass, surrounds the rod *f*, just below the core. *d*, and has one edge resting on the lifting finger attached to the latter, while the other edge is overhung by the head of an adjustable screw stop, *x*.

The metal post, *c*, is supported and guided by a tubular post, *i*, secured to a suitable base plate. Attached to the lower end of the post, *c*, and passing out through a slot in *i*, is the arm, *y*, supporting an insulated holder for the lower carbon.

If now one conducting wire from the machine be connected to the base plate, and the other to the lower carbon-holder, the current of electricity will pass up through the posts, *i* and *c*, through the helix *a*, rod *f*, and the carbons, *k k*, thus completing the circuit.

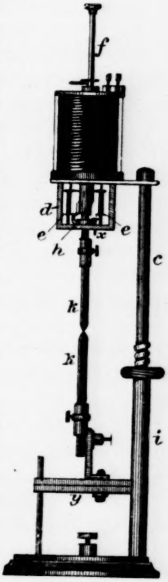


Fig. 43.

The axial magnetism produced in the helix will draw up the core, *d*, and it, by means of the lifting finger, will raise one edge of the washer *h*, which, by its angular impingement against the rod, *f*, clamps and lifts it to a distance controlled by the adjustable stop, *x*, but separating the carbon points far enough to produce the light.

As the carbons burn away, the increased length of the electric arc increases its resistance, and weakens the magnetism of the helix, and therefore the coil, rod, and carbon move downward by the force of gravity, until, by the shortening of the arc, the magnetism of the helix is strengthened, and downward movement arrested. When, however, the downward movement is sufficient to bring the clutch-washer, *h*, to the support, *g*, it will be released from the clamping effect of the lifting finger,
and the rod, *f*, will slip through until ar-
4030 rested by the upward movement of the core,
due to the increased magnetism of the helix.

The normal position of the clamp-washer is with the edge under the adjustable stop, just touching the support, *g*, the office of the core being to regulate the slipping of the rod through it. If, however, the rod, from any cause, falls too far, it will instantly and automatically be raised again, as at first, and the carbon points thus continued at the proper distance from each other.

In the lamps used in these experiments, the helix was composed of two separated insulated wires wound together, so that, by means of suitable pin contracts, shown at the top of Fig. 10, they could be connected either couples or end to end, thus varying the intensity of the magnetism of the helix. Thus, in connection with varying the weight to be lifted by the magnetism of the helix, either by loading the core or increasing the upward thrust of the springs, enabled us to adjust the lamp to suit the varying qualities of the currents dealt with.

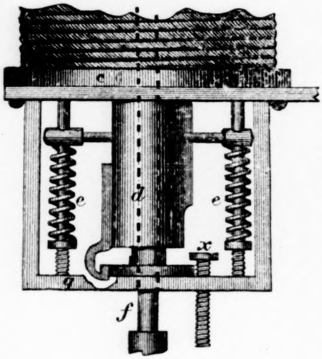


FIG. 14.

Several new methods of arranging the carbons, and rendering them more or less adjustable automatically, have been recently suggested or put in practice.

Thus, in “Nature” for December 19th, 1878, I find a plan
4031 described by Wilde, which consists in placing two carbon
rods beside each other, as in the Jablochkoff candle, but without any insulating material between them. Under these circumstances the author states that the arc will keep to the extremities of the rods, or will run to them if established elsewhere.

To provide against extinction, and secure automatic relighting, one of the holders is hinged so as to allow its carbon to fall against the other unless pulled away by an electro-magnet in circuit. This arrangement is certainly very simple, and free from many of the objections offered in connection with the Jablochkoff candle. It will be seen here, however, that the maximum light will be developed between the two rods, or, in other words, on their respective inner surfaces where it will have the least facility for producing useful effect.

A very curious modification of this candle has been made by Mr. Edward Weston, in which he places a strip of some relatively volatile matter on the backs or outer sides of the parallel carbon rods. The arc then forms across from these parts, and the incandescent vapor assumes much the appearance of a gas flame.

Among the recent forms of lamp described in Dr. Schellen's recent work, “Die Magnet-und Dynamo-Elektrischen Maschinen,” are several announcements by the Siemens-Halske firm.

In one of these two carbons inclined towards each other are allowed to descend, and thus bring their upper ends together by the withdrawal downwards of a non-conducting interposed rod, whose motion is controlled by an electro-magnet in the circuit.

In another, which, however, looks like a suggestion rather than a practicable machine, the carbons are arranged so that the lower one is constantly vibrating up and down, and the upper one simply rests upon it, except in so far as it is being constantly knocked away by the motion of the lower one, which motion is effected by an electro-magnet in the circuit.

A much more complete apparatus, on the same principle we will describe presently.

Among the latest developments in electric lamps may be
4032 reckoned the plan of Mr. Werdermann, which may be described as follows:

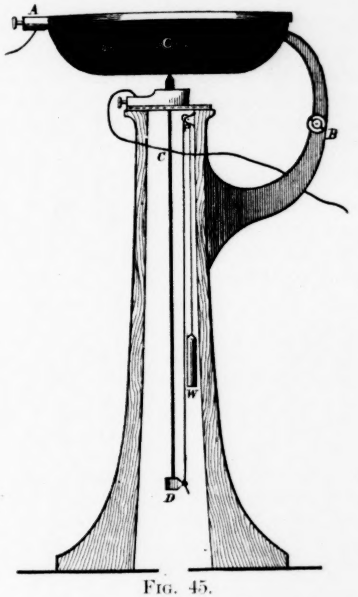


Fig. 45.

Mr. Werdermann makes one electrode to consist of a disc of carbon tapering in thickness from the center to the circumference on one side and flat on the other. The other electrode is a very fine and thin rod of carbon, with one end pointed. The disc is placed horizontally with the rounded side downwards, and the thin rod vertically, and in contact with the disc the current being supplied via the metal collar by which the rod is surrounded near the top. On passing the electricity the fine point of the carbon rod above the collar becomes incandescent, and a very small electric arc is produced between the two carbons. Referring to the diagram (Fig. 45), the upper carbon is shown at C, and the rod carbon at *c*. The former is supported by means of an adjustable jointed bracket
B, attached to the wood stand. The rod carbon is guided by
4033 the spring collar on the top of the stand, and to which the
connection is made, and is supported by the fine cord, run-

ning over the pulley P. This cord is attached to the clasp D at the bottom of the rod and to the balance weight W, by which the rod is maintained in constant, practical, though not absolute contact with the disc. Round the upper part of the disc is a metal band A, to which the circuit wire is attached, and the current thus passed on to the next lamps.

"This lamp" (says the Ironmonger of Nov. 9) "was tried on October 28, and again on November 6, on the works of the British Telegraph Manufactory (Limited), Euston road, London, the current being derived from a small Gramme machine of two-horse power. At the commencement two lights were maintained equal to 640 candles, and the light was perfectly steady. Subsequently the current was sent through a row of 20 lamps the light of each being equal to 40 candles; still the light was steady. Mr. Werdermann asserted his ability to distribute the current from the small machine then at work so as to divide it among 60 lights. In that case the light would inevitably be small; but enough is apparent to prove that, so far as a current will bear division, Mr. Werdermann will be able to utilize it."

It will be noticed that here, as with all other lamps working by incandescence, there is great loss, which increases with the subdivision. A Gramme machine utilizing two-horse power should give, with an ordinary lamp, a light of from 1,000 to 1,500 candles, in place of the 640 here claimed from two lamps, or the 400 candles claimed for ten lamps.

A yet more recent system is that developed or, we might rather say, now in course of development, by Profs. Elihu Thomson and Edward Houston, of Philadelphia, which they have themselves described as follows:

4034 "As is well known, when an electrical current, which flows through a conductor of considerable length, is suddenly broken, a bright flash, called the extra spark, appears at the point of separation. The extra spark will appear, although the current is not sufficient to sustain an arc of any appreciable length at the point of separation.

"In our system, one or both of the electrodes, which may be the ordinary carbon electrodes, are caused to vibrate to and from each other. The electrodes are placed at such a distance apart that in their motion toward each other they touch, and afterward recede a distance apart, which can be regulated. These motions or vibrations are made to follow one another at such a rate that the effect of the light produced is continuous; for, as is well known, when flashes of light follow one another at a rate greater than 25 to 30 per second, the effect produced is that of continuous light. The vibratory motions may be communicated to the electrodes by any suitable device, such, for example, as mechanism operated by a coiled spring, a weight, compressed air, etc.; but it is evident that the current itself furnishes the most direct method of obtaining such motion, as by the use of an automatic vibrator, or an electric engine.

"In practice, instead of vibrating both electrodes, we have found it necessary to give motion to but one, and since the negative electrode may be made of such size as to waste very slowly, motion is imparted to it, in preference to the positive. The carbon electrodes may be replaced by those of various substances of sufficient conducting power. In this system, when desired, an independent battery circuit is employed to control the extinction and lighting of each lamp.

"The following is a description of one of the forms of electric lamp which we have devised, to be used in connection with our system of electric lighting:

"A flexible bar, *b*, of metal is firmly attached at one of its ends to a pillar, *p*, and bears at its other end an iron armature, *a*, placed opposite the adjustable pole piece of the electro-magnet *m*. A metal collar, *c*, supports the negative electrode, the positive electrode being

4035

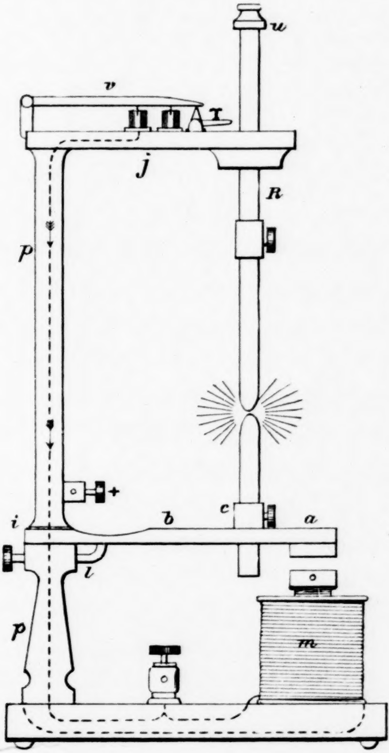


FIG. 46.

supported by an arm, *j*, attached to the pillar, *p*. The pillar, *p*, is divided by insulation at *i* into two sections, the upper one of which conveys the current from the binding post, marked +, to the arm, *j*, and the rod, *r*, supporting the positive electrode.

"The magnet, *m*, is placed as shown by the dotted line the circuit which produces the light. The pillar, *p*, is hollow, and has an insulated conducting wire inclosed, which connects the circuit-closer, *v*, to the binding post, marked —. The current is conveyed to the negative electrode through *b* and the coils of the magnet, *m*. When the electrodes are in contact, the current circulating

4036 through *m* renders it magnetic and attracts the armature, *a*, thus separating the electrodes, when, on the weakening of the current, the elasticity of the rod, *b*, again restores the contact. During the movement of the negative electrode, since it is caused to occur many times per second, the positive electrode, though partially free to fall, cannot follow the rapid motions of the negative electrode, and therefore does not rest in permanent contact with it. The slow fall of the positive electrode may be insured either by properly proportioning its weight, or by partly counterpo-sing it. The positive electrode thus becomes self-feeding.

"The rapidity of movement of the negative carbon may be controlled by means of the rigid bar, *l*, which acts practically, to shorten and lengthen the part vibrating. In order to obtain an excellent but free contact of the arm, *j*, with the positive electrode, the rod, *r*, made of iron or other suitable metal, passes through a cavity filled with mercury, placed in electrical contact with the arm, *j*. Since the mercury does not wet the metal rod, *r*, or the sides of the opening through which it passes, free movement of the rod is allowed without any escape of the mercury. We believe that this feature could be introduced advantageously into other forms of electric lamps.

"In order to prevent a break from occurring in the circuit when the electrodes are consumed, a button, *v*, is attached to the upper extremity of the rod, *R*, at such a distance that when the carbons are consumed as much as is deemed desirable, it comes into contact with a tripping lever, *t*, which then allows two conducting plugs, attached to the bar, *v*, to fall into their respective mercury cups, attached, respectively, to the positive and negative binding posts by a direct wire. This action practically cuts the lamp out of the circuit."

"Philadelphia, Sept. 19, 1878."

In a later publication (Journal of the Franklin Institute for January, 1879), the same inventors describe a further modification and extension of their system as follows:

4037 "The following apparatus was devised by the authors for the purpose of obtaining induced reversed currents for use in electric illumination. These currents we use with a vibrating

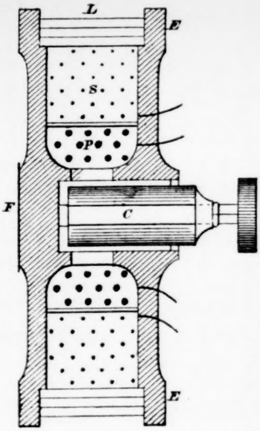


FIG. 47.

lamp, a description of which has already been published.

"Our method of operation is as follows: A reversed primary current is caused to induce reversed secondary currents in secondary coils provided therefor. These secondary currents are caused to give vibrations to carbon electrodes, and thereby at the same time produce a partial arc between them. With sufficient strength of primary current, a considerable number of secondary currents are obtained, each of which is able to operate one of our vibrating lamps.

"The use of a vibrating lamp admits of a wide range in the size of the carbons employed. When a light of very moderate intensity is desired, the carbons are made very small size, and are placed in a closed glass vessel for protection from the atmosphere. To moderate the brilliancy opalescent glass is used. To obtain the highest efficiency of inductive action from a set of primary coils, the following form of induction of coil was devised:—the primary coil, *P*, surrounding the core, *C*, is provided with a secondary coil, *S*, adjacent to it. The ends *E* and *F* of the bobbin are made of disks of iron concentric with the core, *C*, and slit from centre to circumference. The outer extremities of these disks are connected by wires or sheets of iron, *L*, to one another, forming in this manner an induction coil encased in iron, or one whose core has its north and south extremities magnetically connected. The strength of the current developed in the secondary coil is greatest when the core, *C*, which is movable, is inserted so that both of its extremities are in contact with *E* and *F*. By withdrawing this core, the
4038 currents in the secondary coil may be weakened to almost any desired extent. This coil is best adapted to the use of primary currents whose direction is constantly changing. All the wire being completely surrounded by iron, whose direction of magnetic polarization *if* rapidly changed, the highest inductive effect is thereby produced in the secondary coil.

"The variations in the intensity of the induced currents will, of course, be followed by variations in the intensity of the light emitted by the lamp. The movement of the core may therefore be made to increase or decrease the intensity of the light."

With this notice of the newest, or, as we may say, youngest system of electric lighting, which has its birthday with the new year, I may well conclude this hastily prepared and imperfect notice of this very interesting subject, and if what I have here thrown together may supply at least material for a fuller treatment, or a skeleton on which a completely organized structure may be constructed, I shall have accomplished all that I could hope.

Before concluding this address I should draw attention, in a more direct manner, to something which has been developed indirectly in the course of my remarks; and that is that the loss of efficiency in the electric force as a means of producing light, when it is divided, is not a unique phenomenon, but is exactly parallel in the case of ordinary combustion.

If gas is burned in very small flames we may get almost no light from it, and, on the other hand, if we burn it in very large flames, the amount of light developed will increase in a much higher ratio than will the amount of gas consumed.

Thus I have here a new burner made by Sugg, of London, with three concentric argand rings which burns 30 feet of gas, and yields a light equal to 196.4 candles. The same amount of the same gas burned in six standard five-foot burners yielded a light of 114 candles. Here is a gain of over 70 per cent. in the total light produced by simply concentrating the combustion in one large flame in place of dividing it into six small ones.

4039 In the case of the ordiary lime light we have another instance of yet further concentration.

Here, with a consumption of about 7½ feet of gas an hour, in a burner with three jets heating a cylinder of lime from all sides, we obtain a light equal to 260 candles in every direction.

This shows very clearly the illogical character of the comparisons so often made between the concentrated light of the electric arc and the divided light of the ordinary gas-burner.

Heretofore electric lights have only been practically developed in their concentrated form, and it certainly has not yet been shown that, when divided, there will be an enormous loss of efficiency. Gas, on the contrary, has heretofore only been practically used in its divided form, and there can be no doubt that its efficiency is capable of much increase when it is burned in a concentrated manner.

It is here where the actual contest will come in, and the relative success of the two sources of light in each field will depend upon what it will accomplish in that field and not in some other. In other words, we must compare the divided electric lights (say Mr. Edison's, when they become visible) with ordinary burners, and the electric-arc light with the lime light, or some such concentrated form of gas-burning.

THE END.

(See comparative table marked p. 4040.)

4041 **DEF'T'S EXHIBIT HIGGS' TRANSLATION OF FONTAINE'S BOOK. H. C. M., SPE. EX.**

Consolidated Electric Light Co.
vs.
The McKeesport Light Co.

ELECTRIC LIGHTING.

A PRACTICAL TREATISE

BY

HIPPOLYTE FONTAINE.

Translated from the French
By PAGET HIGGS, LL.D., Assoc. Inst. C. E.

WITH FORTY-EIGHT ENGRAVINGS IN THE TEXT.

THOS. A. EDISON.

London:
E. & F. N. SPON, 46 CHARING CROSS.
New York:
446 BROOME STREET.
1878.

4042 DEF'T'S EXHIBIT HIGGS' TRANSLATION OF FONTAINE'S BOOK. H. C. M., Sp. Ex. } Third Chapter.

CHAPTER III.

Electric Carbons.

Wood carbon rods.—Retort carbon.—Its inconveniences.—Staite and Edward's carbons.—Le Molt's carbons.—Lacassagne and Thiers' carbons.—Curmer's carbons.—Jacquelain's carbons.—Peyret's carbons.—Archereau's carbons.—Carré's experiments.—His processes of manufacture.—Gaudoin's experiments.—His processes of manufacture.—Comparative trials of several kinds of carbons.

In his experiments on the voltaic arc, Davy made use of rods of wood carbon extinguished in water or mercury. These rods burnt with great brilliancy, and in a very regular manner, but they wore away so rapidly that their use was obliged to be reserved for laboratory experiments. In replacing the wood carbon by the deposits collected from the walls of gas retorts, Foucault really opened up to the voltaic arc the epoch of useful applications. Retort carbon is, in fact, much more dense, and resists for a long time the destructive action of the voltaic focus.

But, as M. Le Roux has observed with reason, the last word has not been said upon this question, and retort carbon will still offer grave inconveniences: its density is far from uniform, it sometimes splits, frequently works irregularly, and produces considerable variations in brilliancy. These variations chiefly depend upon the presence of foreign matters, such as alkaline or earthy salts, and also notable quantities of silica. These matters are much less refractory than the carbon; they pass into vapour, and form for a great part the flame which envelopes the arc. This flame is more conducting than the voltaic arc proper; moreover, as it has a much greater section it is less heated, and besides, as it is a gaseous body, its power of radiation is less than that of the particles of carbon which constitute the arc.

Let us hasten to say that, by suitably choosing the two rods which should furnish a regulator, retort carbon gives satisfactory results in most of its applications.

4043 When the voltaic arc is enclosed in a globe of frosted glass, the scintillations, intermittences, and variations in the intensity of the focus are much less felt; the shadows are much less marked, the light is softer, more homogeneous, more agreeable. But the globe causes a very considerable loss of light, and whenever the small irregularities, due to the imperfection of the carbon, are supportable, the carbons should be burned without a globe. Moreover, one gets readily accustomed to the electric light; and workmen now, instead of complaining, seek factories lighted in this manner.

Several inventors have endeavoured to substitute for carbons cut directly from the deposits on the walls of retorts similar agglomerates, but purer; others have merely purified retort carbons. Some have obtained products very remarkable in respect of luminosity, but practically inapplicable on account of their extreme cost.

Among the processes proposed for the improvement of electric carbons, we will cite those of Messrs. Staite and Edwards, Le Molt, Lacassagne and Thiers, Curmer, Jacquelain, Peyret, Archereau, Carré and Gaudoin.

Staite and Edwards' Carbon.

In 1846, Messrs. Staite and Edwards patented a process for the manufacture of carbons for the electric light, which had for its base a mixture of pulverised coke and sugar.

The coke is first reduced to a nearly impalpable powder, and a small quantity of syrup added, the mixture being pugged, moulded, and strongly compressed. Then the carbon is subjected to a first heating, and plunged into a very concentrated solution of sugar, and again subjected to a white heat.

Le Molt's Carbon.

M. Le Molt, in 1849, patented a composition for electric carbons, consisting of 2 parts of retort carbon, 2 parts of wood charcoal or of coke, and 1 part of tar. The substances were in the first place
4044 pulverised, pounded, mixed, and much trituration brought
to the state of a stiff paste; then, by the aid of powerful mechanical means, subjected to great compression.

The moulded pieces were covered with a coating of syrup, and placed beside each other in a vessel of retort carbon. They were then subjected to a high temperature for a period of from twenty to thirty hours, and purified, if necessary, by immersion in acids.

Lacassagne and Thiers' Carbon.

In 1875, Messrs. Lacassagne and Thiers gave attention to the purification of retort carbons. They fused a certain quantity of caustic potash or soda. When this bath was at a red heat they digested in it, for about a quarter of an hour, the carbon rods which had been previously cut from the walls of retorts.

This operation was intended to change into a soluble silicate of potash or soda the silica contained in the carbons which is so pernicious to the constancy of the light. The carbon rods were then washed in boiling water, and subjected for several hours (in a red-hot tube of porcelain or fire-clay) to the action of a current of chlorine, which had the effect of converting the different earthy matters that the alkali had not attacked into volatile chlorides, as of silica, calcium, potassium, iron, &c. Thus cleansed, these carbons gave a somewhat more regular light.

Curmer's Carbon.

Curmer's process consists principally in the calcination of lampblack, benzine, and oil of turpentine, the whole mixed and moulded in the form of cylinders; the decomposition of these substances leaves a porus carbon, which is soaked with resins or saccharine matters and again calcined. By repeating these operations, M. Curmer succeeded in producing carbons of small density or conducting power certainly, but extremely regular, and free from all impurities.

Jacquelain's Carbon.

M. Jacquelain, late chemist at l'École Centrale, has endeavoured to imitate the circumstances which, during the manufacture of gas, give birth to retort carbon. These circumstances are 4045 the coming into contact with the white-hot walls of the retort of very dense hydrocarburetted matters, of which part is volatilised and the rest decomposed, leaving as residue a layer of carbon. In the retorts used in the manufacture of gas, these hydrocarburetted matters carry away with them a great number of the impurities that the coal contains. By taking the tars resulting from true distillation, cleared consequently of all the non-volatile impurities, and realising, in special apparatus, these conditions of decomposition in contact with highly heated walls, retort carbons ought to be reproduced possessing perfect purity. It is this that M. Jacquelain has done in operating with a tube of refractory earth of 0·15 mètre diameter, in an improvised furnace; and he has obtained some plates which, cut into rods with a saw, have given a light perfectly steady, whiter, and of about 25 per cent. greater intensity, with an equal electric current, than that given by the ordinary carbons.

The experiments made with these carbons, by the Paris administration of light-houses, have been so conclusive that we had, about the commencement of 1876, the idea of putting the process in practice. But M. Jacquelain, being consulted, explained to us that it was impossible to calculate: 1st, the expenditure necessary for the establishment of a continuous manufacture; 2nd, the approximate nett cost price of the carbons obtained. As another process by M. Gaudoin has commenced to give good results, we have not continued our idea. We have long ago learnt what is the cost of converting a very exact laboratory process into an industrial operation, and we do not wish to launch into an affair of this nature without some figures being given.

The carbon of M. Jacquelain, once formed, has always the inconvenience of requiring a considerable amount of manual labour before use can be made of it (because the material is so hard, that it can with difficulty be cut by the saw), and of producing relatively considerable waste.

Peyret's Carbon.

M. Peyret, a physicist of Lourdes, has prepared carbons by
soaking pieces of elder-tree pith or any other porous body
4046 with liquefied sugar, and afterwards decomposing the sugar
by heat. By repeating the operation a sufficient number of
times, he obtained very dense carbons, which he then submitted to
a current of sulphide of carbon.

We have had in our hands only very small fragments of these carbons, and it has been impossible for us to give an estimate of their worth; their high price is in every case a very serious obstacle to the development of an industrial manufacture.

Archereau's Carbon.

M. Archereau, whose name frequently comes under the pen in questions relating to agglomerates of carbon or to electricity, has presented to the Academy of Sciences some new rods for electric regulators, composed of carbon mixed with magnesia, agglomerated and pressed; the magnesia has, according to the author, the advantage of making a light more steady and of augmenting its lighting power.

We have tried several samples of these carbons, some were of good quality, others inferior to retort carbons. Several carbons furnished a light of 150 burners, with a total consumption per hour of 0·03 mètre. It is a manufacture that is capable of giving good results, but needs very careful revision.

Carré's Carbon.

M. Carré has made a great number of experiments for the electric light upon retort carbons impregnated with different salts, and has combined a new product for the same usage. Some details of his labors are necessary to make their importance and merit understood.

By impregnating porous carbons, and by a prolonged ebullition in concentrated solutions, M. Carré proves:

1st. That potash and soda at least double the length of the voltaic arc, render it more silent, combine themselves with the silica and eliminate it from the carbons by making it flow to 6 or 7 millimètres from the points in a state of vitreous globules, limpid, and
often colourless; that these substances augment the light in the
proportion of 1·25 to 1;

4047 2nd. That lime, magnesia, and strontia augment the light
in the proportion of 1·40 to 1, by the colouring in different
ways;

3rd. That iron and antimony carry the augmentation to 1·60 or 1·70;

4th. That boracic acid augments the duration of the carbons by enveloping them with a vitreous layer which isolates the oxygen from them, but without augmenting the light;

5th. That upon the whole the impregnation of pure and regularly porous carbons, with the solutions of different substances, is a convenient and economical means of producing their spectra, but that the mixing of the simple substances with the carbon compound is preferable.

For the manufacture of carbons, M. Carré recommends a composition of powdered coke, calcined lamp-black, and a special syrup formed of 30 parts of cane sugar and 12 parts of gum.

The following formula is recommended in the patent of the 15th January, 1876:

Coke, very pure, in fine, nearly impalpable powder..	15 parts
Calcined lamp-black...........................	5 "
Special syrup....................................	7 to 8 "

The whole is strongly triturated, and has added to it from 1 to 3 parts of water, to compensate for the loss by evaporation, according to the degree of toughness to be given to the paste. The coke ought to be made with the best coals, pulverised and purified by washings. (The coal powder may likewise be purified by washings by decantation and maceration with heat in acid baths.) The coke dust of gas retorts is generally pure enough.

The paste is now pressed and passed through a draw-plate, then the carbons are placed in tiers in crucibles, and are subjected during a given time to high temperature.

The cooking comprehends a series of operations.

For the first, the carbons are placed horizontally in the crucible resting upon a bed of coke dust, every layer is separated by a cover of paper to avoid any adherence. Between the last layer and the cover is put one centimètre of coke sand, and one centimètre of silicious sand upon the joint of the cover.

4048 After the first operation, which ought to last from four to five hours and attain a cherry-red heat, the carbons should remain two or three hours in a very concentrated and boiling syrup of cane sugar or caramel, with two or three intervals of considerable cooling, in order that the atmospheric pressure may force the syrup into all the pores. The carbons are then left to drain by opening a cock placed at the bottom of the vessel, after which they are agitated for some instants in boiling water to dissolve the sugar remaining on the surface.

After desiccation the carbons are submitted to a second cooking to the degree required; they are then stood up in the crucible by filling up their interstices with sand.

They are thus manipulated from stage to stage until they have acquired the density and solidity requisite, and the manipulation is facilitated by the use of an oven having as many stages as there are cookings required.

The carbons are dried slowly. Their desiccation is completed in a stove, the temperature of which attains gradually 80 degrees in twelve or fifteen hours. To prevent their becoming deformed in drying, the rods are placed on pieces of sheet iron having a V-form.

The Carré carbons are more tenacious and are harder than those of retort carbon. They are remarkably accurate and regular. Rods of 0·01 mètre diameter and of 0·5 mètre length can be employed without fear of rupture. Their cylindrical form and their homogeneity make the cones maintain as perfect shape as if they were turned. They are also better conductors than retort carbons. The only inconvenience that we have remarked in their employment is a rapid disaggregation, the production of small sparks, and irregularity of the luminous brilliancy.

Gaudoin's Carbons.

M. Gaudoin also has made numerous experiments upon carbons containing foreign substances.

The following bodies have been introduced into the carbons:

1st, phosphate of lime from bones; 2nd, chloride of calcium; 3rd, borate of lime; 4th, silicate of lime; 5th, pure precipitated silica; 6th, magnesia; 7th, borate of magnesia; 8th, phosphate of magnesia; 9th, alumina; 10th, silicate of alumina.

4049 The proportions were calculated in such a manner as to obtain five per cent. of oxide after the cooking of the carbons. These were submitted to the action of an electric current always of the same direction, furnished by a Gramme machine powerful enough to maintain a voltaic arc of 10 to 15 millimètres in length.

The negative carbon being placed at the bottom, M. Gaudoin has observed the following results:

1st. The complete decomposition of the phosphate of lime under triple influence of electrolytic action, calorific action, and reducing action of the carbon. The reduced calcium goes to the negative carbon and burns in contact with the air with a reddish flame. The lime and phosphoric acid are diffused into the air, producing abundant fumes. The light, measured by a photometer, is double that which is produced by carbons of the same section cut from the residue of gas retorts.

2nd. Chloride of calcium, borate and silicate of lime are also decomposed, but the boracic and silicic acids appear to escape, by volatilisation, from the electric action. These bodies give less light than the phosphate of lime.

3rd. Silica introduced into the less conducting carbons, melts and volatilises without being decomposed.

4th. Magnesia, borate and phosphate of magnesia are decomposed, the magnesium in vapour goes to the negative carbon and burns, in contact with the air, with a white flame. The magnesia, boracic and phosphoric acids diffuse into the air in a state of vapour. The increase of light is less considerable than with the lime salts.

5th. Alumina and silicate of alumina are decomposed only with a very strong current and a very considerable voltaic arc, but under these circumstances the decomposition of the alumina is well manifested, and the alumina, in vapour, is seen to go off from the negative pole like a jet of gas, and burn with a blue flame of little lighting power.

The flame and vapour which constantly accompany these electrochemical lights having appeared to him a great obstacle to their utilisation for illumination, M. Gaudoin has not pushed these experiments farther. He has preferred to follow up his studies upon the agglomeration of carbon.

4050 The products manufactured by M. Gaudoin being superior to all others, we will expatiate a little upon this mode of manufacture.

The patent is dated 12th July, 1876.

As we have said above, the carbons intended for the production of the voltaic arc ought to be chemically pure. Thus, the dust of retort carbon, though containing only a small proportion of foreign matters, is not sufficiently pure for this use, and its employment presents some inconveniences. The washings in acids or alkalies to which the carbonaceous matters may be submitted, with the aim of extracting the impurities they contain, are costly and insufficient. Lamp-black is pure enough, but its price is high and its management difficult. Owing to this, M. Gaudoin had to seek elsewhere a better source of carbon, and he has found a solution of the problem in decomposing, by heat in closed vessels, the dried pitches, fats or liquids, the tars, resins, bitumens, natural or artificial essences or oils, organic matters capable of leaving behind carbon sufficiently pure after their decomposition by heat.

The apparatus employed to effect this decomposition are closed retorts or crucibles of plumbago. These crucibles are placed in a furnace capable of being heated to a bright red. The lower parts of the crucibles are furnished with two tubes, serving, one for the disengagement of gas and volatile matters, the other for the introduction of the primary material. The volatile products of decomposition may be conducted under the hearth of the furnace and there burnt for heating the crucibles, but it is more advantageous to conduct them into a condensing chamber or into a copper still, and to recover, after condensation, the tars, oils, essences, and hydrocarbons that are produced in this operation.

M. Gaudoin utilises these different sub-products also in the manufacture of his carbons; he takes great care to avoid for the worms and receivers the use of iron, zinc, or any substances susceptible of being attacked by these tars, because the whole value rests in purity.

Whatever may be the primary material employed for the manufacture of this carbon, the decomposition by heat should be 4051 able to be conducted either slowly or quickly according to the nature of the sub-products that it is proposed to obtain. For operating slowly it suffices to two-thirds fill the retort and to heat gradually up to a clear red, avoiding as much as possible the boiling over of the substances. For operating quickly, the empty retort is heated to a deep red, and the primary material thrown into the bottom in small quantities, in a thin stream if it is liquid, and in small fragments if it is solid. The slow distillation gives most tars and heavy oils and little gas. The quick decomposition gives more light oils and gas.

When the primary material has been properly chosen, there remains in the retort, carbon more or less compact. It is pulverised as finely as possible, and agglomerated alone or with a certain quantity of lamp-black by means of the carbides of hydrogen obtained as secondary products.

Thus prepared, those carbides are completely free from iron, and are much preferable to those found in commerce, not only in the agglomeration of the carbons, but also in the impregnation or soaking of the manufactured objects. (The last operation, by filling up the pores, introduces oxide of iron when effected with commercial products.)

The objects made in agglomerated carbon are, for one variety of carbon, as much more combustible as they are porous, and as much more porous as they are moulded with less pressure. The inventor himself uses, for his manufacture, steel moulds capable of resisting the highest pressure of a strong hydraulic press.

Although the draw-plate or moulding apparatus, used long since in the manufacture of ordinary graphite carbons, may be used, without any modification, for the manufacture of carbons for the electric light, M. Gaudoin has added to this apparatus certain important improvements. Thus instead of causing the carbons to issue from top to bottom, vertically, he places the orifice or orifices of the mould upon the side, and in such a manner that the issuing carbons form with the horizon a descending angle of 20 to 70 degrees. The carbon is guided for the whole length by tubes or gutters. This arrangement allows of emptying the whole of the matter contained
in the mould without interrupting the work, and as the car-
4052 bon is constantly supported it does not break under its own
weight, which frequently happens when issuing vertically.

We have made, at different times, numerous trials with all kinds of carbons, and those of M Gaudoin's manufacture gave the best results. It has necessitated much time and considerable expense to remove this manufacture from the merely scientific domain to that of the practical, but success has crowned the efforts of the inventor. (Table A.)

The light produced with the retort carbons was equal to 103 burners, and that produced by the artificial carbons varied between 120 and 180 burners for the Archereau and Carré carbons, and between 200 and 210 for the Gaudoin carbons. The mean of 150 burners may be applied, without appreciable error, to the Archereau and Carré carbons, and that of 205 to the Gaudoin carbons.

Brought to a uniform section of 0.0001 square mètre, the consumption of the carbons was respectively:

For retort carbons	51	millimètres.
Archereau	66	"
Gaudoin	73	"
Carré	77	"

In proportion to the light produced this consumption was:

For the Gaudoin	carbons........	35	millimètres	per 100 burners.
" Archereau	"	44	"	"
" Carré	"	51	"	"
" retort	"	49	"	"

These experiments were made with a Gramme machine constructed by M. Bréguet and a Carré lamp by the same maker. The carbons were taken at hazard from a lot of several mètres for each series.

At the request of one of the inventors we made some fresh experiments, with the co-operation of Messrs. Gramme and Lemonnier, with a more powerful Gramme machine and a Serrin lamp.

The following table (B) contains the mean of three series of experiments made with the greatest precision. The electric lamp was placed, quite vertically, at the same level as the oil-

4053 (TABLE A.)

Table of Experiments Made with Several Electric Carbons, 6th November, 1876.

Name of carbon.	Dimensions.	Speed of machine.	Consumption.				Regularity.	Observations.
			Of negative carbon.	Of positive carbon.	Total per hour.	Mean of two experiments.		
			m.m.	m.m.	m.m.	m.m.		
Retort.......	9^{mm} square.....	800	19	36	55	63	Irregular..........	Scintillating, eclipsed for a short time, a slight disaggregation.
"	9^{mm} square....	920	23	48	71		Sufficiently regular.	
Archereau....	10^{mm} diam.-....	800	20	60	80	85	Sufficiently regular.	A slight disaggregation, a few sparks. Cinders of oxide of iron in rather large quantity. White light. Cones good.
"	10^{mm} diam......	920	30	60	90		Sufficiently regular	
Carré........	$10{\cdot}4^{mm}$ diam....	800	18	60	78	92	Irregular..........	A slight disaggregation, a few sparks; more cinders than the preceding, reddened for a greater length.
"	$10{\cdot}4^{mm}$ diam....	920	26	80	106		Regular enough....	
Gaudoin.....	$11{\cdot}3^{mm}$ diam....	800	20	38	58	73	Very regular.......	Neither disaggregation nor sparks; less cinders than the Carré and Archereau carbons.
"	$11{\cdot}3^{mm}$ diam....	920	38	50	88		Very regular.......	

4054 lamp and photometer. Every precaution was taken that there should not be any sensible error in the measurements of the luminous intensity.

(TABLE B.)

Results of Experiments upon Several Carbons, 4th April, 1877.

Name of carbon.	Form and dimensions.	Section in square millimètres.	Total consumption per hour in millimètres.	Mean light in carcel burners.	Length of the arc in millimètres.	Revolutions per minute of the machine.	Regularity.	Observations.
Retort carbon, good quality.	Square, 9^{mm} in the side.	81	60	120	2·5	820	Passable..	Splinters numerous. Separation of a small piece. Scintillation. Carbons were shaped very irregularly.
Archereau's carbon's, new specimens.	Round, 10^{mm} diam.	78	68	173	3	820	Null......	Disaggregation. Sparks. Light very variable in intensity at periods. Shaping into small facets.
Carré's carbons, new specimen.	Round, 9^{mm} diam.	64	69	175	3	820	Middling..	Small sparks. Light running round. Very variable in intensity. Good shaping of the carbons.
Gaudoin's type No. 1.	Round, 11·2^{mm} diam.	98	80	203	3	820	Good.....	Neither sparks nor splinters. Light a little red, but pretty constant.
Gaudoin's (agglomeration of wood carbon).	Round...... ..	..	78	240	3	820	Sufficiently good.	Light very white. Less steady than with Gaudoin's carbons, No. 1. No sparks. Small variations.

4055 Brought to a uniform section of 0.0001 square mètre, the consumption of the carbons was respectively in these new experiments:

For the Carré carbons.....	44 millimètres
" retort..................................	49 "
" Archereau	53 "
" Gaudoin (wood carbon).............	61 "
" Gaudoin, No. 1........................	78 "

In proportion to the light produced, this consumption was:

For the Gaudoin (wood carbon)...	32	millimètres	per 100 burners
" Archereau	39	"	"
" Carré	40	"	"
" Gaudoin, No. 1	40	"	"
" retort	50	"	"

The light given by the Gaudoin carbons was a little less regular than that observed 6th November, 1876. That given by the Carré carbons varied in less than a minute from 100 to 250 burners; the arc rotated positively round the points, the same as if alternating currents were being used. The Archereau carbons appeared to us less effective than at the first trial; they were consumed slowly, but they produced a light so variable that it was difficult to take photometric measurements. Only the retort carbons maintained their duration, luminous intensity, and, unfortunately, their irregularity.

We shall describe, in terminating this chapter, the improvements that M. Gaudoin has made in his process, and patented, 7th April, 1877.

Instead of carbonizing wood, reducing it to powder, and then submitting it to mixture, the inventor takes dried wood, properly chosen, to which he gives the definite form of the carbon, then he converts it into hard carbon, and finally soaks it, as in the manufacture we have described.

The distillation of the wood is effected slowly, in such manner as to drive out the volatile substances, and the final desiccation is made in a reducing atmosphere, at a very high temperature. A previous washing, in acids or alkalies, removes from the wood any impurities that it possessed.

4056 M. Gaudoin points out also the means of filling up the pores of the wood, by heating to redness, and submitting it to the action of chloride of carbon and different carbides of hydrogen. He hopes thus to produce electric carbons of small consumption, and giving an absolutely steady light.

4057 Def't's Exhibit Higgs' Translation of Fontaine's Book. H. C. M., Spe. Ex. } This Chapter.

Chapter XI.

Lighting by Incandescence.

Use of Geissler tubes.—Report presented to the Academy of Sciences by M. Coste, in the name of M. Gervais.—King's invention.—Lodyguine's lamp.—Wild's report to the St. Petersburg academy.—Konn's lamp.—Bouliguine's lamp.—Experiments by the author on lighting by incandescence.—Chérémeteff and Fontaine's lamp.

As we have said, the voltaic arc is eminently convenient for the lighting of large uncovered spaces, or large halls without interior partitions, but when it is required to light small places or very subdivided localities, it is much more advantageous to employ gas, petroleum, or even ordinary oil.

There are numerous works on the construction of small electric foci, but to the present day none of the means devised have given practical results. It has been endeavoured to use Geissler tubes, and small incandescent carbons, and if these two means have not been successful, they offer nevertheless sufficient interest that we should devote some pages to their description.

It is well known that Geissler, an artist at Bonn, constructed the first tubes blown in various forms, closed hermetically and containing only traces of various vapours. These tubes put into communication with a current, by means of platinum wires fused into the glass, from a Ruhmkorff coil, produce a stratified light, that is to say, composed of fine transverse layers separated by dark layers continually agitated. At the same time the sides of the tubes present a brilliant appearance, to which the term fluorescence has been applied.

On March 27, 1865, M. Coste presented to the Academy of Sciences, in the name of M. Gervais, the following report:

"The apparatus was constructed by M. Ruhmkorff, who has acquitted himself of his task with his usual care and ability. It is a case or box in bronze, mounted on four feet, and its cover 4058 or lid is hermetically closed by means of a press-screw, and between the two surfaces thus brought into contact is a caoutchouc washer. To the cover is attached a ring, serving as a suspension to the optical apparatus. The case contains two bichromate of potash elements closed in their turn by plates to which strips of copper are solidly screwed. The poles of the current furnished by these two elements may be put at will into communication with the bobbin, and the induced current is transmitted to a Geissler tube by two wires covered with India rubber. This tube, of proper form and filled with carbonic acid, is enclosed in a glass cylinder with thick sides, furnished with copper armatures, and into which water cannot penetrate. This is the lighting part of the apparatus. With this instrument a soft light is obtained, similar to that now employed by miners. It resembles in certain respects that given by phosphorescent animals, but is more intense. It can be seen even when the apparatus is several mètres under water. It would doubtless serve to attract fish, as does the phosphorescence of certain species, and it would also serve to light limited spaces, situated beneath the surface of the water, or by floating signals. The captain of the 'Devoulx,' commanding the southern coasts of France, employed this apparatus in the port of Cette, in September last. It remained immersed for nine hours, and it gave light for six hours, under these conditions, as well as when charged at Montpellier. The phosphorescence may be of longer duration. A second trial, made at Port Vendres, on board the 'Favori' (Captain Trotabas), was equally successful."

The light obtained by the Geissler tube is so feeble, that it can never be utilised practically, and numerous trials made in mines and powder mills have been without result.

Lighting by incandescence has been studied for a long time; but its application generally presents so great difficulties, that at the present day it may be considered as within a purely scientific domain, although a certain number of apparatus exist working moderately well.

The first document on the question that we have found, is an English patent of the 4th November, 1845.

Mr. King, the inventor, enters into some exact details of his
4059 idea, and presents some considerations which tend to prove
that magneto-electric machines, powerful enough to produce
light, already existed in 1845.

The following are the principal passages from this patent:

The invention has for its basis the use of metallic conductors, or of continuous carbons, heated to whiteness by the passage of an electric current. The best metal for this purpose is platinum, the best carbon is retort carbon.

When carbon is employed, it is useful on account of its affinity for oxygen at high temperatures to cover it from air and moisture, as indicated in Fig. 45. The conductor C rests on a bath of mercury; the bar B is in porcelain, it serves to support the conductor C; the conductor D is fixed on the bell by a hermetically sealed joint. The carbon rod A rests at top and bottom on conducting blocks and becomes incandescent by the passage of an electric current.

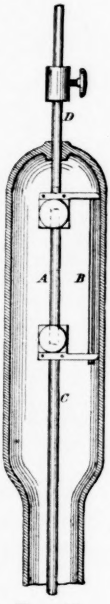


FIG. 45.
King's Lamp.

A vacuum is previously established in the bell, and the apparatus veritably forms a barometer with one of the poles of the battery in communication with the column of mercury, and the other with the conductor D.

In order to obtain an intermittent light, the circuit can be periodically interrupted by a clock-work movement.

The apparatus properly closed may be applied to submarine lighting, as well as to the illumination of powder mills and of mines, especially where the danger of explosion is feared, or the rapid inflammation of very combustible substances.

When the current is of sufficient intensity, two or a larger number of lights may be placed in the same circuit, care being taken to regulate the power of the magneto-electric machines, or the elements of the battery producing the current.

In 1846, Greener and Staite filed a patent for a lamp,
analogous to King's, pointing out that they freed
4060 the carbon, before use, from impurities by treat-
ment with nitro-muriatic acid.

In 1849, Petrie concludes the description of a patent for a lamp with the following remark: "A light may be produced by passing an electric current through a short and thin conductor, which heats and becomes luminous; but the majority of substances fuse and burn rapidly; however, I obtain a good light by using iridium, or one of its alloys. Iridium may be fused so as to produce an ingot whilst it is submitted to the heat of the voltaic arc; afterwards it may be decarbonised and rendered more malleable. It can be cut into small pieces of 0·001 mètre diameter and 0·010 to 0·020 mètre length, that can be fixed upon two insulated metallic supports, which are in connection with the two wires of a proper galvanic battery. There is then obtained a beautiful light."

Several other patents have been taken out in America, France, and England for the same kind of idea; but none of these appear more complete, more explicit, and more practicable than King's; it is then useless to continue our nomenclature.

Lighting by incandescence, and the principle of its production, had for a long time fallen into oblivion, when in 1873 a Russian physicist, M. Lodyguine, resuscitated both, and invented a new lamp, which has since been perfected by Messrs. Konn and Bouliguine.

In 1874, the St. Petersburg Academy of Sciences awarded a high prize to M. Lodyguine. The following includes some extracts from the report presented on the occasion by M. Wild, director of the Imperial observatory; this report, as we shall see, includes several capital errors:

"It has long been known that we can employ the heating faculty of the electric current, even without the aid of gas, as in the luminous galvanic arc, to heat a solid body to whiteness. On this principle there are often thus heated thin platinum wires, which are bad conductors, by causing them to be traversed by a powerful electric current. The light obtained by this process is much more feeble and more constant than the electric light from carbon; it can also be extended further, and may be increased or diminished at
4061 will; nevertheless it has never found practical use, because
it is too feeble compared with its cost, and because when it is desired to give greater intensity, there results fusion of the platinum wire, which in general is not homogeneous throughout.

"M. Lodyguine was the first who had the idea of replacing the platinum wire, in these combustion experiments, by small bars of carbon (coke) analogous to graphite, that is to say, a good conductor, and thus resolved the problem of electric lighting.

"The advantages of this substitution of the carbon for platinum are so obvious from a theoretical point of view, that it is astonishing, as is always the case with important inventions, that no one had the idea sooner. Carbon possesses at equal temperature much greater power of radiation than platinum; the capacity for heat of platinum is superior (nearly double) that of the carbon in question, so that the same quantity of caloric raises the temperature of a small bar of carbon to a degree nearly twice that attained by a platinum wire of the same volume. Besides the resistance of the carbon in question, as a conductor of electricity, is nearly 250 times greater than that of platinum; it results that the small rod of carbon may be fifteen times thicker than a platinum bar of the same length, and that the current traversing it will engender the same quantity of heat. Finally the carbon may by heated to the most extreme white heat without fear of fusion, as is the case with plati-

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No. 286.
C.E. Light Co } p. 4064
v.
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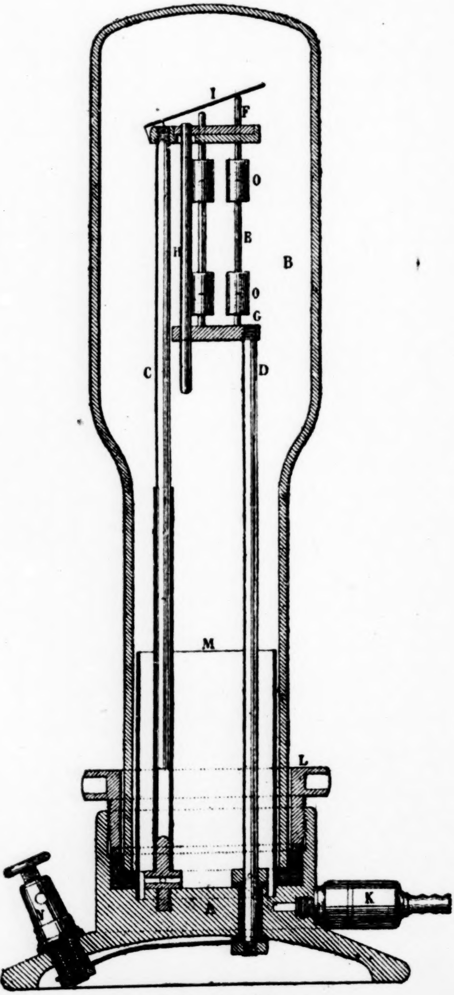
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Fig. 46. Konn's Lamp.

num. It is to these important theoretical advantages that is evidently due the great success of the mode of electric lighting proposed by M. Lodyguine.

"The sole inconvenience of the use of carbon instead of platinum consists in the fact that, in the combustion the carbon combines with the oxygen of the air, and is thus gradually consumed. M. Lodyguine has avoided this inconvenience by enclosing the carbon heated to whiteness by the electric current in a glass receiver hermetically sealed, and from the interior of which the oxygen is expelled by a most simple process.

"It is not within the province of the Academy of Sciences to give its judgment on the technical and other difficulties which will present themselves in the extended application of M. Lodyguine's invention, nor, on the other hand, upon the numer-
4062 ous practical advantages of this mode of lighting above all others; it will suffice to the academy to state that, thanks to this invention, there is resolved in the simplest possible manner the great problem of subdivision of the electric light, and of rendering it constant,* in order to recognize M. Lodyguine as worthy, in consideration of the numerous applications of his invention, to obtain the Lomonossow prize."

In his lamp, M. Lodyguine employs carbon in a single piece by diminishing the section at the point of the luminous focus, and he places two carbons in the same apparatus with a small exterior commutator, in order to pass the current into the second carbon, when the first has been consumed. Nothing is less practical nor less studied than the apparatus of this inventor.

M. Kosloff, of St. Petersburg, who went to France in the hope of working the Lodyguine patent, perfected his lamp slightly, without, however, bordering upon anything passable.

In 1875, M. Konn, also from St. Petersburg, patented a more practicable lamp, represented in Fig. 46, which was constructed for the first time in Paris by M. Duboscq.

(Here follows diagram marked p. 4064.)

This lamp consists of a base A in copper, on which are fixed two terminals N for fastening the conductors, two bars C, D in copper, and a small valve K opening only from within outwards. A globe B, widened at its upper part, is retained on the base by means of a bronze collar L pressing on an India-rubber ring, exactly as occurs with the level gauges of steam boilers.

One of the vertical rods D is insulated electrically from the base, and communicates with a terminal also insulated. The other rod C is constructed in two parts: (1) Of a tube fixed directly upon the base without insulation, and (2) of a copper rod split for a part of its length. This split gives elasticity, and admits of the rod sliding in the tube with only a small effort.

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* We shall see subsequently how the problem has been resolved by M. Lodyguine.

The retort carbons E, to the number of five, are placed between two small plates which crown the rods.

Each carbon is introduced into two small blocks, also of carbon, which receive the copper rods at their extremities. The rods also
are equal in length at their lower ends, and of unequal length
4063 at their upper ends. A hammer I is hinged on the bar C, and
rests only on a single rod of carbon at once. If this lamp is placed in circuit by attaching the two conductors from a battery to the terminals N, N′ (the terminal or binding screw N′ is hidden by the terminal N; but it is identical, and is not insulated from the base), the bar of carbon E is traversed by the current which passes by the aid of the hammer I, from the copper bar F, the two carbon blocks O, O, the copper bar G, and the plate crowning the bar D.

The vacuum has previously been made by putting the cock K in connection with an air pump or other known pneumatic machine.

The rod E reddens, whitens, and becomes luminous. Its light is colourless, steady, and constant; but gradually the section diminishes, the rod breaks, and the light disappears. The hammer I then falls on another rod, and nearly instantaneous*ly* lighting is re-established.

When all the carbons are consumed the hammer rests upon the copper rod H, and the current is not interrupted. In this manner when several lamps are fed by the same electric generator, extinction of one does not cause that of the others.

To avoid the projection of small pieces of carbon and their block against the glass, M. Konn has placed at the lower part of his lamp a small copper tube M, which received the débris until the plates are refurnished.

Three of these lamps were introduced two years ago at the house of M. Florent, a merchant of St. Petersburg, and put in action with an "Alliance" machine. Each carbon lasts about two hours, with the exception of the first, which is consumed nearly immediately; the light is very agreeable, but its cost considerably exceeds that of gas. M. Florent, whom we have had occasion several times to see, has informed us that the great advantage he has found in the employment of electric lighting was its cleanliness. His store-rooms contain much white linen that gas rapidly impairs, and on which electricity exercises no injurious influence. The bleaching economised fully compensates the supplementary cost necessitated by an important introduction, with but little regard to the light obtained.

M. Florent has not made any photometric measurement;
4065 but, by comparison with gas, each Konn lamp has been
valued at about 20 Carcel burners.

The principal cause of the great expense that the use of the light from incandescence entails, rests in the difficulty of preparing small carbons, which cost, as fitted, more than 5 francs per mètre.

A Russian officer, M. Bouliguine, has constructed a lamp (Fig. 47), which attains nearly the same end as that by M. Konn with a single carbon. It consists, like the preceding, of a copper base or

No. 286.
C. E. Light Co.
v.
McK. Light Co.
p. 4066

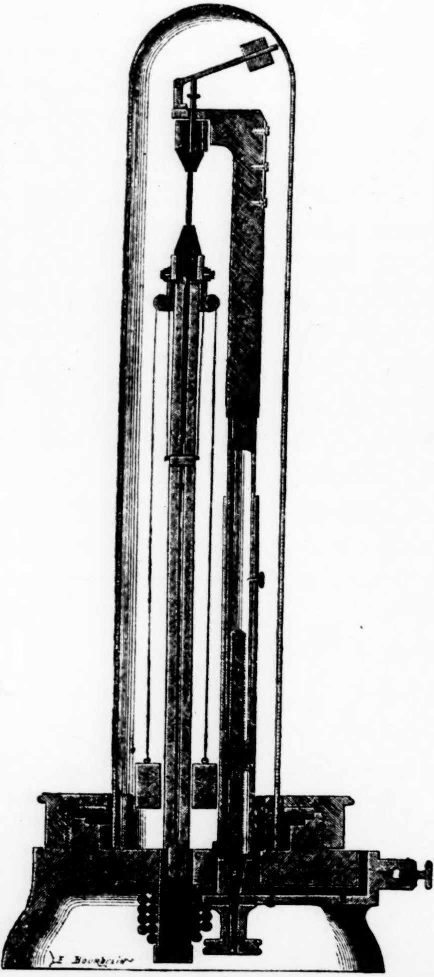

FIG. 47. BOULIGUINE'S LAMP.

socket, two vertical bars, two bars carrying the current, and an exhaust valve.

(Here follows diagram marked p. 4066.)

One of the bars is pierced with a small hole from top to bottom, and has nearly throughout its length a slot admitting the passage of two small lateral lugs.

The carbon is introduced into this bar like the lead of an ordinary pencil case, and it is assisted to rise by a counter-weight connected by two microscopic cables to lugs in the transverse support on which the carbon rests.

The part of the carbon which is to become incandescent is held between the lips of two conical blocks of retort carbon.

A screw placed on the base admits of increasing or diminishing the length of the bar which carries the upper conical block, and consequently of giving to the luminous part greater or less length.

The closing of the globe is effected by the lateral pressure of several India rubber washers.

When the lamp is placed in circuit, the carbon rod reddens and illuminates until it is about to break. At this moment a small mechanism* commanded by an electro-magnet opens the lips of the carbon-holders, the counter-weight above drives out the fragments that would remain in the notch, and the counter-weight below raises the carbon rod which penetrates the upper block, and re-establishes the current. The mechanism again acts, but in contrary direction to its first manœuvre, the carbon-holders contract, and the light is renewed.

4067 We have several times tried this lamp, but we have never obtained good results. It includes too many moving parts, and the least obstacle prevents the play of the mechanism. However, we have observed that when by chance it works regularly, the contacts being better and less numerous than those of Konn's lamp, it needs less intense currents for the production of a given light. With a Gramme machine of 100 burners we have obtained with a single lamp as much as 80 burners, whilst with a Konn lamp we could never exceed 60 burners.

In order to realise the actual value of the system of lighting by incandescence, we have made a series of experiments with several Konn's lamps and a Bunsen battery of 48 elements, of 0·20 mètre height.

The first operation consisted in measuring the resistances of retort carbon of square section. The samples tested were 0·002 mètre in the side. The following results are from eight experiments:

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* The mechanism in question, which the scale of the engraving will not admit of showing, consists substantially of an iron armature placed in the interior of the lamp, and of two metallic rods acting on two cross-levers jointed onto the ring surrounding the carbon-holders.

Number of experiment.	Length of samples.	Resistance in mètres of telegraph wire.
	Mètre.	
1	0·100	16
2	0·100	14
3	0·100	15
4	0·100	14·50
5	0·100	19
6	0·050	7
7	0·050	9
8	0·050	7
Total	0·650	101·50

Whence it results that the mean linear resistance of the retort carbon of 0·002 mètre is about 172, that of a telegraph wire of 0·004 mètre being taken for unity.

We subsequently rounded the carbons, so as to reduce their diameters to 0·0016 mètre, and regulated the length in such a manner as to obtain 0·018 mètre incandescent part. The vacuum was carried to about 0·70 mètre mercurial pressure.

The following results represent the mean of more than twenty series of experiments:

4068

State of the circuit.	Methods of coupling the battery.							
	2 series parallel of 24 elements.		3 series parallel of 16 elements.		4 series parallel of 12 elements.		1 single series of 48 elements in tension.	
	Galvanometer deflection.	Luminous intensity of each lamp.	Galvanometer deflection.	Luminous intensity of each lamp.	Galvanometer deflection.	Luminous intensity of each lamp.	Galvanometer deflection.	Luminous intensity of each lamp.
Circuit closed on itself.	47	....	70	....	70	....	50	
5 lamps...	28	Reddish-white	17	Cherry red.........	10 or 11	Dull red..........	35	½ burner
4 lamps...	29	½ burner.........	22	Reddish-white...	16	Orange-red	38	2½ burners
3 lamps...	38	1 to 2 burners..	28	1/3 burner	26	¼ burner.........	41	3½ burners
2 lamps ..	40	3 burners	41 to 42	2½ to 3 burners...	40 to 45	3 to 5 burners..	44	5 burners
1 lamp.....	43	4 to 5 burners..	49	11 to 12 burners..	60	40 burners.....	45 to 46	6½ to 7 burners

The lamps were grouped like the elements of a battery in tension, then forming a single series.

In the following table are given the results obtained with lamps arranged in batteries, that is to say, on distinct circuits derived from the battery. Because of the considerable differences observed in the intensities of the light of each lamp during the same experiment, we give the total light instead of that produced by each lamp:

State of the circuit	Methods of coupling the battery.							
	2 series parallel of 24 elements.		3 series parallel of 16 elements.		4 series parallel of 12 elements.		8 series parallel of 6 elements.	
	Galvanometer deflection.	Total light emitted by the whole of the lamps.	Galvanometer deflection.	Total light emitted by the whole of the lamps.	Galvanometer deflection.	Total light emitted by the whole of the lamps.	Galvanometer deflection.	Total light emitted by the whole of the lamps.
Circuit closed on itself.	58½	....	68	....	69	....	70	
5 lamps..................	57	....	64½	¼ burner......	63½	2½ burners...	60	
4 lamps..................	56½	....	63	¾ burner.....	63	3 burners.....	59	
3 lamps..................	56	1 burner......	61½	2 burners.....	62	4 burners.....	58	¾ burner
2 lamps..................	55	5 burners.....	60	6½ burners...	59	15½ burners..	55	1½ burner
1 lamp..................	52½	9 burners.....	57½	54 burners...	55	65 burners...	46	8 burners

Several important observations were made during these experiments.

When the receivers are sealed and the contacts carefully put in line, the carbons last for a satisfactory period. The first carbon of a lamp never lasts for less time than a quarter of an hour; 4069 sometimes it breaks at the end of thirty to thirty-five minutes, but that is very rarely; its average duration is twenty-one minutes. The succeeding carbons last upon an average for two hours, so long as the luminous intensity does not reach 40 burners, in which case the average duration is only half an hour. In the experiment of four parallel series of 12 elements, the five lamps being collected in batteries and one only lighted, the carbon, which gave 65 burners, lasted only twenty-three minutes as an average.

Attentive examination of incandescent carbons, through a strongly coloured glass, has shown that they are not uniformly brilliant. They present obscure spots, indicative of non-homogeneity, and the position of cracks which rapidly disintegrate the carbon.

The vacuum never being perfect in the receivers, the first carbon is in greater part consumed. It would appear that consequently upon the little oxygen contained in the lamp being transformed into carbonic acid and carbonic oxide, the carbon should be preserved indefinitely. But there is then produced a kind of evaporation which continues to slowly destroy the incandescent rods. This evaporation is besides clearly proved by a pulverent deposit of sublimed carbon, that we have found on the interior surface of the bells, on the several interior parts: rods, contacts, hammers, &c.

No bell has been cracked by heating or cooling during the whole of the experiments, extending over several months, but several of the necks have been broken by the too energetic closing of the joint.

The delicate part of the lamp is in the series of contacts which precede the incandescent rod. The carbons are got into straight line, which is indispensable to their duration, only with minute and long precautions. After rupture, the contact does not always occur automatically, and two or three times we have been obliged to shake the lamp to cause the lighting of the next carbon.

The maximum efficiency has occurred with a single lamp and with four elements in quantity; by employing two lamps and descending to two elements in quantity, the results were considerably diminished.

4070 We have recently made similar trials with Gaudoin artificial carbons of the same section, and the results have been more satisfactory. Thus the total light produced with 48 elements in four series and a single lamp, reached 80 burners, and that produced with the same battery and three lamps, attained 30 burners.

The same battery coupled in tension and actuating a Serrin lamp gives a voltaic arc of 105 burners; but the light obtained by incandescence is much steadier and more agreeable to the eye.

From what precedes, it appears to result that King and Lodyguine's system is much more favourable to large foci than to the divisibility of the electric light; however it is proper to remark that when 10 burners per lamp are not exceeded, the carbons have a very long duration, whilst they are consumed very quickly for an intensity of 60 to 80 burners.

Only carbons of 0·0016 mètre diameter and 0·018 mètre luminous length were until then those tried; these behave very well with a strong current, but give no light with 12 elements. It became interesting to learn what light could be obtained with 12 elements by diminishing the length of the carbons. This was the object of a new series of experiments.

Five different combinations were attempted, by varying in turn the coupling of the battery, the diameter of the carbon and its length.

The best results were obtained with a single lamp furnished with Gaudoin carbons of 0·0016 mètre diameter, and of 0·015 mètre length, in the incandescent portion.

The light varied between 2 and 8 burners, but it was more often 5 burners. Each carbon lasted on average fifteen minutes.

We were about to repeat all these experiments, substituting for the battery a Gramme machine constructed to give the best useful effect; but the imperfections of the lamps, the difficulty of obtaining good contacts, the too minute care to be taken at the commencement of each operation, led us to decide to previously design a lamp more commodious and slightly more practical than that of M. Konn.

4072 This lamp, which we represent in Fig. 48, is at present under construction by M. Bréguet. It is characterized by the two following points: (1) the carbons are set in a groove at each of their extremities in rigid contacts and kept fixed, which admits of the lamp being placed in all positions; (2) the electric current passes automatically from one carbon to the other by the action of an electro-magnet interposed in the circuit.

(Here follows diagram marked p. 4071.)

A description, even summary, would not be of great interest, since the lamp is not yet finished; the engraving sufficiently indicates the arrangement we have adopted.

No. 286.
C.E. Light Co.
v.
McK. Light Co. } p. 4071

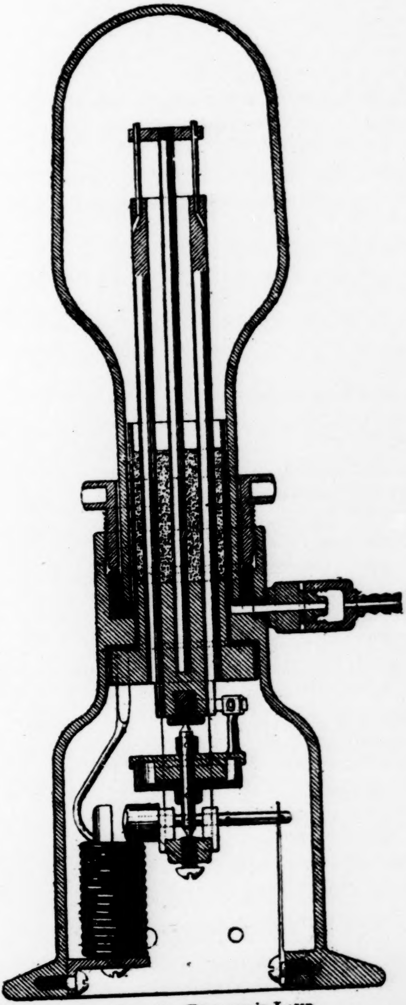


Fig. 48. Fontaine's Lamp.

Complts Exhibit
Sawyers Dynamo Machine Patent

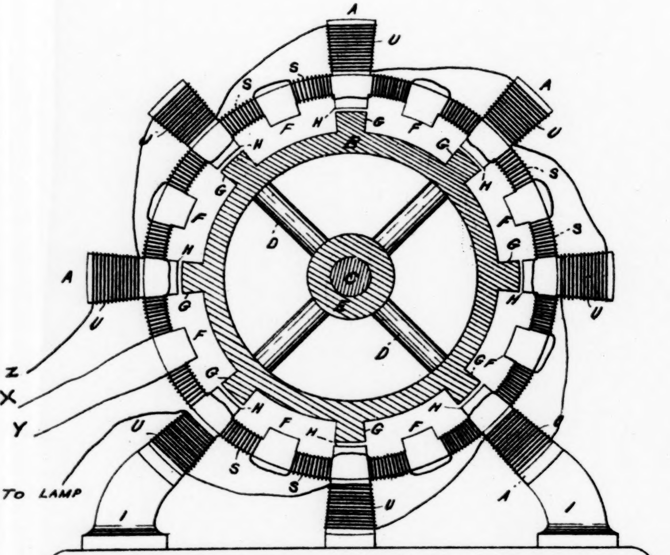
2 Sheets—Sheet 1.

W. E. SAWYER.
Dynamo-Electric Machine.

No. 237,632. **Patented Feb. 8, 1881.**

No. 286.
C.E. Light Co.
vs
McK. Light Co. } p. 4073

FIG. 1.



WITNESSES.
E. R. Knowles, C.E.
William H. Broadnax

INVENTOR.
W. E. Sawyer By
Amos Broadnax

2 Sheets—Sheet 2.

W. E. SAWYER.
Dynamo-Electric Machine.

No. 237,632. **Patented Feb. 8, 1881.**

No. 286.
C.E. Light Co
v.
McK. Light Co } p. 4074

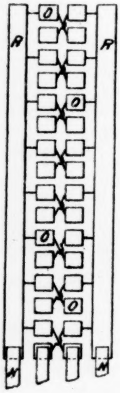


FIG. 3.

FIG. 2.

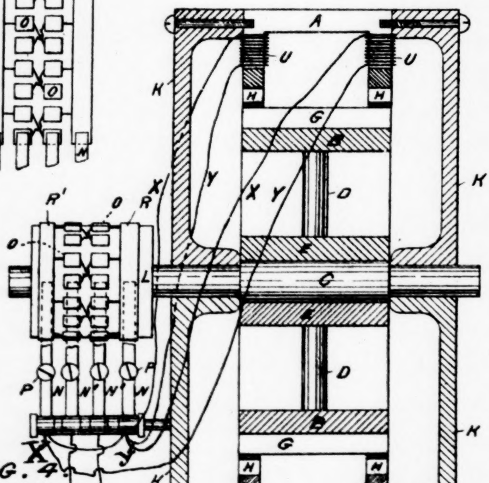

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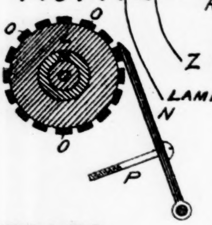
FIG. 4.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WITNESSES.

E. R. Knowles. C.E.
William H. Broadnax

INVENTOR.

Wm E. Sawyer By
Amos Broadnax Atty

4075

UNITED STATES PATENT OFFICE.

WILLIAM E. SAWYER, of New York, N. Y., assignor to Electro Dynamic Light Company, of New York.

Dynamo-Electric Machine.

Specification forming part of Letters Patent No. 237,632, dated February 8, 1881. Application filed December 20, 1878.

To all whom it may concern:

Be it known that I, William Edward Sawyer, of the city, county, and State of New York, have invented a new and improved dynamo-electric machine, of which the following is a description in such full, clear, concise, and exact terms as to enable any person skilled in the art or science to which it appertains or with which it it is most nearly connected to make and use the same, reference being had to the drawings accompanying and making part of this specification, and to the letters and figures of reference marked thereon, as hereinafter described.

The object of this invention is to simplify the construction, increase the efficiency, and decrease the resistance, and heat of the dynamo electric generating-machine.

Said invention consists, first, of a generator of electricity operating through the increasing and decreasing magnetism in the magnets by the approach and recession to and from the magnets of paramagnetic armatures; second, of a generator operating by the shifting of the magnetic force from and into different parts of the magnets; third, of a generator in which only the magnets are wound with the conducting-wire, thus avoiding the retarding effects which take place when both magnets and armatures are wound, as in the case of other dynamo-electric machines employed for electric lighting and electrolysis.

(Here follow diagrams marked pp, 4073 & 4074.)

Reference being had to the drawings, figure 1 is a side elevation of the generator with the disk K removed. Fig. 2 is a transverse vertical section through the same. Fig. 3 is a view of the annexed commutator developed, and Fig. 4 is an end view of the commutator wrapped around a rotating drum annexed to the generator.

The generator consists substantially, of the following principal parts:

First, of two rings, (shown in Figs. 1 and 2 of the drawings by H H.) To these rings are fitted a series of electro magnets or permanent magnets, A A A, projecting inward in the manner shown, the north pole of each magnet being connected to one of said rings, and the south pole to the other. One ring is therefore the north pole and the other the south pole of the entire machine.

Second, of two flanges or disks, K K, bolted to the magnets A, by which said rings and magnets are held in position around a center common to themselves, and the disks K, which are supported and held by legs I I, bolted to any suitable frame.

Third, of a barrel or cylinder, B, fitted with armatures G. This cylinder or barrel, with its armatures, rotates upon the center shaft, C, fitted into and carried by the hubs of the flanges K, the periphery or shell of the cylinder being supported by spokes D, as shown in the drawings.

The rings H are provided with projections F, arranged upon a common circle with the lower ends of the magnets, and between these projections and the poles of the magnets proper are coils of wire, S, creating an electro-magnet on the ring each side of the magnets A, the ring being thus converted into a succession of electro-magnets over the armatures G, which are, of course, arranged to swing clear of the projections F and the lower ends of the magnets A.

The operation is as follows: If A A are electro-magnets, as shown by the drawings, they will contain a slight residual magnetism. The armatures G, being in the position shown, satisfy the magnetic attraction of the magnets, and little or no magnetic force exists in the intermediate parts of the rings H, which are embraced by S F S. Now, as the armatures G come opposite the projections F on the rings, these projections become the poles of the magnets, and the magnetic force thus sent into the interior of the coils S generates currents in these coils, which being thrown by the commutator around the magnets A through the coils U, in the well-known manner, further magnetize them, until finally they are magnetized to saturation by the well-known process of accumulation.

The commutator shown by Figs. 2, 3, and 4 consists of two rows of insulated pieces, O O, connected interchangingly, as shown by Figs. 2 and 3. These pieces are fixed to an insulating drum, L, fitted on the sleeve M, carried by the shaft C. Upon this drum L are fitted two insulated rings, R R, connected to the pieces O O, as shown by Figs. 2 and 3 of the drawings, and upon the rings
4076 R and pieces O ride four springs, N N and N′ N′. Now, the
coils S are wound alternately in opposite directions to accord with the winding of the magnet-coils U and all the coils form one conductor, the two ends of which (shown by X Y) are connected electrically to the two outside springs, N N. The current in these coils is set straight by the two inner springs, N′ N′, being upon the pieces O. To one of springs N′ the external conductor Z is connected, and to the other spring N is connected one end of the conductor which constitutes and leads from all the coils U. The other end of the wire constituting the coils U forms the other pole of the external conductor, in which is placed the electric light or other apparatus to be worked. The tension of the springs N and N′ is adjusted by the screws P, substantially as shown by the drawings.

In concluding this description of my invention, I desire to say that I do not intend to limit the patent of which this specification is to be a part to any particular form of the invention or any part thereof, but intend to claim the principle or substance of that form—that is to say—

I claim—

1. A dynamo-electric generating-machine constructed of stationary magnets in which the magnetic force is continuous, such magnets being surrounded with conducting-coils, in combination
4077 with a rotating barrel of unwound armatures, as distinguished from the stationary magnets, and rotating barrel of armatures of electro-magnetic engines, in which the magnets are energized intermittently to produce motion.

2. The combination of the magnets A S F, connected and operating substantially as described.

3. The two rings H H connected by magnets and operating substantially as described.

4. The combination of magnets A, rings H, and armatures G, operating substantially as described.

5. The combination of a series of contiguous magnets, A, with a series of intervening sections of iron joining their poles over a rotating armature, substantially as described, for the purpose of inducing and accumulating their magnectic force, substantially as set forth.

6. A dynamo-electric generating-machine, consisting of united rings fitted with a succession of electro-magnets and combined with a succession of armatures rotating about a centre common to themselves, and the series of magnets.

7. In a dynamo-electric machine, a succession of electro-magnets fitted and connected upon stationary rims or rings and energized by a succession of unwound armatures rotating with the rims carrying the magnets.

Dated December 16, 1878.

WILLIAM EDWARD SAWYER.

Witnesses:
AMOS BROADNAX.
W. H. BROADNAX.

4079

UNITED STATES PATENT OFFICE.

S. GARDINER, JR., and L. BLOSSOM, of New York, N. Y.

Improved Electric Signal-Light.

Specification forming part of Letters Patent No. 20706, dated June 29, 1858.

To all whom it may concern:

Be it known that we, Sam'l Gardiner, Jr., and Levi Blossom, of the city, county, and State of New York, have invented a new and useful electric signal lantern or light; and we do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming a part of this specification, in which—

(Here follows diagram marked p. 4078.)

Figure 1 is a front view of a signal lantern or light constructed after our invention. Fig. 2 is a vertical longitudinal section of the same. Fig. 3 is a vertical transverse section of the same. Fig. 4 is a diagram illustrating a modification of our invention.

Similar letters of reference in each of the several figures indicate corresponding parts.

The nature of our invention consists in the combination of a platinum coil or its effective equivalent, which is illuminated by electricity, with a transparent signal-lantern, said combination being effected by arranging the coil within the lantern upon two conducting-wires which are connected with an electro-galvanic battery.

To enable others skilled in the art to make and use our invention, we will proceed to describe its construction and operation.

A represents a standard for supporting a signal-lantern, B, adapted for carrying out our invention successfully. This lantern has two or more of its sides formed of colored glass, one side being blue and the other red, or otherwise illuminated so as to be seen readily at a great distance. The central portion of the transparent sides is not colored, as shown at *a*, so that the intense light directly about the platinum coil may not be shaded, or be partially obscured. The lantern is provided with suitable reflectors, *b b*, and is ventilated by means of holes *c c* and spaces *d d* around the edges of the glass, as illustrated by the arrows.

C is the platinum coil. It should have the form of a circle and be arranged opposite the central uncolored portions, *a a*, of the glass sides, as shown. This coil rests upon two conducting-wires, D D, which extend down from the interior of the lantern to the battery, which is situated in the lower or any convenient part of the hull of the vessel, and is connected with a telegraphing-machine, so that the electric illuminating-current may be let onto the platinum coil or shut off from it at pleasure.

S. GARDINER, Jr. & L. BLOSSOM.

Electric-Signal Light.

No. 20,706. Patented June 29, 1858.

No. 286.
C.E. Light Co
v.
McK. Light Co
p. 4078

Fig. 1

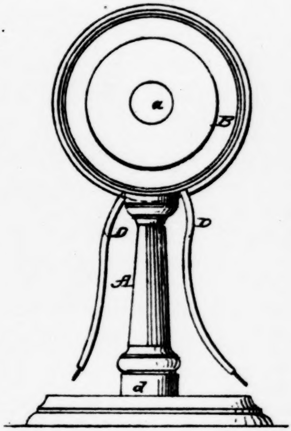

Fig 2

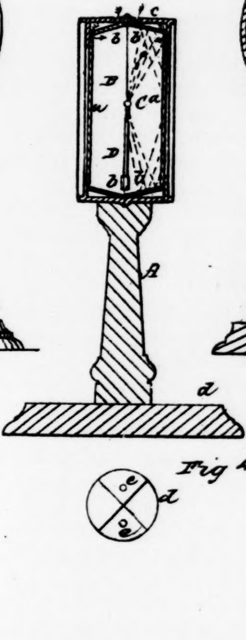
c
c
b
b
D
C
a
D
b
a
A
d

Fig. 3

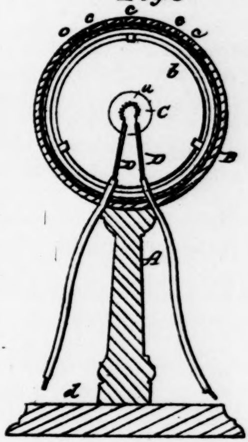
c
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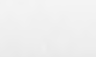
Fig 4



Instead of having the conducting-wires extend down to the battery, they may be cut off so as to just touch the base-plate *d* of the standard of the lantern. In this case said plate must be connected with the battery and be insulated at two points on its surface, in the manner shown at *e e*, Fig. 4, and the lantern and standard arranged to revolve.

By our invention the most intense and brilliant light can be constantly kept up, as the electric current is concentrated by the platinum coil in a manner that said coil will always be heated to the color of a brilliant white flame, which will be seen at a great distance through the unshaded central part of the lantern, and its reflected rays through the colored portions of the transparent front.

With our invention any desired signals may be transmitted from one ship to another, as follows: We will suppose that the captains of different ships have agreed between themselves that the appearing and disappearing of the signal-light twice shall indicate "distress," the appearing and disappearing of the light three times, "all right," and so on. Now, to accomplish these signals all that is necessary is for the captain or other person in charge of the matter to touch the keys of the telegraphic-machine the proper number of times and in the proper manner.

In case the signal-lantern is arranged to revolve, the same signals can be produced by the breaking of the current at intervals, which is effected by having the conducting-wires come at intervals in contact with the insulated portions of the base-plate.

The signal-lantern has two of its sides formed of different-colored glass, so that when used on a buoy the electric light may be seen by ships coming in and going out to sea.

The value of a sure signal-light cannot be estimated when the important office it is to serve is considered. We believe our signal-light can be depended upon, both as to its great intensity and as to its certainty of remaining always in force, there being no possible chance for it to cease so long as the battery is supplied and the electric current conducted to the platinum coil.

4080 This invention is perfectly applicable to the purpose of signal-lights on board of boats, ships, vessels, and buoys; also to stationary signals on land for military and scientific purposes; also for all stationary or floating light-houses for coasts and harbors.

What we claim as our invention, and desire to secure by letters patent, is—

The combination of a platinum coil, C, or its effective equivalent, which is illuminated by electricity, with a transparent signal-lantern, B, said combination being effected by arranging the coil C within the lantern B upon two conducting-wires, D D, which are connected with an electro-galvanic battery.

SAMUEL GARDINER, Jr.
LEVI BLOSSOM.

Witnesses:
GOODWIN Y. ATLEE.
H. H. YOUNG.

4082

UNITED STATES PATENT OFFICE.

STEPHANE ALEXANDROVITCH KOSLOFF, of Paris, France.

Improvement in Electric Lights.

Specification forming part of Letters Patent No. 166,877, dated August 17, 1875; application filed June 23, 1875.

To all whom it may concern:

Be it known that I, Stephane Alexandrovitch Kosloff, of Paris, in the Republic of France, have invented an improved electric lamp; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawing, which forms part of this specification.

My invention relates to certain improvements in that class of apparatus for the production of electric light wherein an electric current passes through and heats sticks of carbon placed in the circuit and hermetically closed in a globe filled with nitrogen-gas, and the object is to avoid several disadvantages heretofore existing.

Heretofore it has been usual to place the carbon on metal conductors, which served as supports, and were firmly attached to the carbons either by screws or otherwise. This joining together of two non-homogeneous substances, subject to different temperatures, caused the breakage of the carbon because of its not dilating in the same ratio as the metal, or because the dilatation of the metal was greater than that of the carbon, and the metal in heating detached itself gradually from the carbon and produced electric sparks. To remedy this difficulty one part of my invention consists in placing the carbon between two insulating-supports composed of porcelain, clay, glass, calcined magnesia, or other insulating substance, so arranged as to allow a slight movement of the carbon in the supports.

Another part of my invention relates to a means for preventing a difficulty which arises in cases where the metal is outwardly attached to the carbon in any way, in consequence of which the metal detaches itself in heating, and produces electric sparks and becomes melted. This part of my invention consists in introducing the metal into the carbon, whereby I obtain a better contact when the carbon is heated by the current, and also prevent the production of electric sparks; but in order to avoid putting the metal into direct contact with a white-heated carbon, I use thicker pieces of carbon provided with holes through their length and their thickness, which thicker pieces serve as conductors of the electric current, and not being such poor conductors as the thin sticks of carbon with which the light is to be produced, and which are introduced into the thicker pieces, heat to a less degree the metal introduced into them.

Another part of my invention consists in connecting the principal conductors with the metallic wires, which are inserted into the thick pieces of carbon by means of links of fine twisted wire, whereby sufficient motion is allowed them when in a state of dilatation, and whereby sufficient contact is insured without producing electric sparks. This mode of connection does not increase the loss of electric current, because the heat produced by an electric current passing through two pieces of metal not firmly attached to each other, but closely touching each other, is much smaller than the heat caused by contact with a white-heated body in a high temperature.

Another part of my invention relates to means for avoiding the inconvenience of the preparation of nitrogen gas and its introduction into the lamp after the air has been withdrawn from it; and it consists in the method of rarefying the air in the globe by means of the carbon which is heated by the electric current and produces the light. By dilating the air it is caused to escape out of the globe through a cup-valve surrounding the supporting column upon which the globe rests, which valve prevents the air from again entering the globe. The small quantity of oxygen remaining in the rarefied air in the globe is transformed into oxide of carbon. In order to have as little air as possible in the globe, I make the supporting column nearly as large in diameter as the globe itself, so as to reduce the dimensions of the air-space, and also of sufficient height to enable it to support the bearers carrying the sticks of carbon which produce the light. The supporting column is made of porcelain, clay, calcined magnesia, crystal, or other suitable insulating substance, provided with tubular openings or grooves for the passage of the metallic conductors, or of carbon furnished with insulators, when such conductors are used instead of metallic ones. The supporting column may be made of metal, if de-
4083 sired; but in such case it should be provided with insulators, in order that the currents may meet in the sticks of carbon. The globe and supporting column are of sufficient length according to the strength of the light to be produced, to prevent the valves from being exposed to too great a heat, and to allow of the employment, as a hydraulic closing, of any liquid, which, being exposed to a certain heat, will not produce vapors which will consume the carbon. For this purpose I entirely avoid the use of mercury.

Another part of my invention relates to a mode of overcoming a difficulty which may arise where the electric current is not sufficiently strong to heat a thick stick of carbon; and it consists in the employment of a number of thin sticks of carbon, arranged so as to be heated successively, and to provide for the automatic passage of the electric current from one to another. The wires which traverse the thick pieces of carbon may be inserted not at the same height, but one slightly lower than the next preceding one. In case of breakage of one of the thinner portions the large or thick end, being fastened on one side only, will incline toward the link or ring connection of the second carbon, and, by means of its hook-shaped wire or plate, is placed in connection with said second carbon, and the current being interrupted in the first carbon is communicated to the second; and this operation is repeated in case of the breakage of the second or any succeeding carbon. In lamps containing several carbons the insulators, between which the thick or large ends of the carbons rest, are of rounded form, with small openings, provided with means for preventing said thick ends from descending too low. In such lamps one pole is in communication with the lower ends of all the carbons, and the other pole communicates with the carbon, which is to be lighted first—that is, the one in which the metallic wire is placed at the highest point.

When it is not desirable to use the automatic mechanism in lamps containing several carbons I employ a commutator, where one pole is in communication with the lower end of all the carbons, while the other pole may be put into communication with each series of carbons in different lamps having separate conductors. The placing of the lamps in the circuit may be effected in two ways—namely, either by placing one series of lamps united by a metallic wire, in such a manner that the current will traverse all the carbons, the conductor of one pole being in communication with the first lamp, and the conductor of the other pole being in communication with the last lamp, or by subdividing the current—that is to say, the current from one pole is subdivided from one point and conducts the current by separate conductors to each lamp, and the current of the other pole subdivided in the same way meets the current of the first pole in each lamp.

In order to enable those skilled in the art to which my invention appertains to more fully understand the same, I will describe in detail the accompanying drawing, in which—

(Here follows diagram marked p. 4081.)

Figure 1 is a sectional elevation. Fig. 2 is a perspective view of the upper end. Fig. 3 is a sectional view taken in the line 1 2 of Fig. 1. Fig. 4 is a sectional view taken in the line 3 4 of Fig. 1.

a represents a vertical supporting rod; *b*, nuts for retaining the insulating-plate; *c*, insulating-plate, having four holes for the passage of metallic pins; *d*, large ends of carbon, bored throughout their whole length and thickness by a drill of the same dimensions as the carbon *f* and of the wires *e* inserted into these large ends; *e*, hooks; *f*, carbon pins driven into the large ends, and intended to produce the light; *g*, conductor of one pole; *g'*, conductor of the other pole. These two conductors are of copper, and may be silvered or platinized. They are inserted in a groove in the column *h*, except in the lower part, which allows vulcanized india-rubber to pass between the insulating-piece and the metal conductors, which may be afterward bound with metallic wires. *h*, a column of porcelain or other suitable substance, serving as a support, and also to leave the least possible air in the globe; *i*, porcelain or other ring, having a hole in it, and serving as the base of the apparatus, and provided with grooves for the passage of the conductors *g* and *g'*; *j*, porcelain basin or bowl, the cover of which is bored for the passage of the glass globe *k*, which rests on the piece *i*, and is kept steady by springs *l*. The bowl *j* has holes, through which pass the exterior conductors *m m'*, which are connected with the interior

No: 286.
C. E. Light Co.
v.
McK. Light Co. } p 4081.

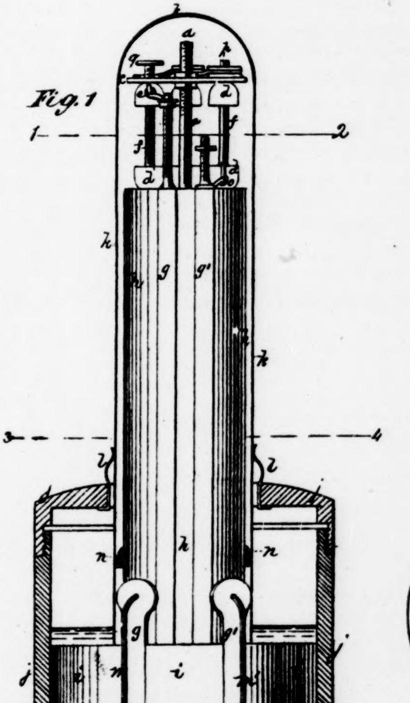
S. A. KOSLOFF.

Electric-Light.

No. 166,877.

Patented Aug. 17, 1875.

Fig. 1



l
a
p
q
d
f
1
2
h
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g'
k
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m'

Fig. 2

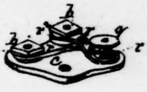


Fig. 3

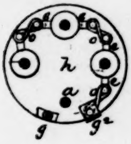
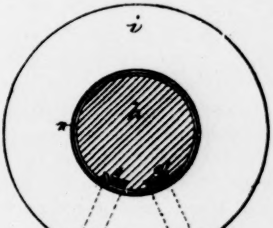


Fig. 4



Witnesses:
Fred Haynes
Ferd. Tusch

S. A. Kosloff
by his Attorneys
Brown & Allen

conductors g. n, a leather ring, cupped in the form of a valve, allowing air to pass out of the globe, but preventing it from entering.

The large ends of the carbon d, which are below, are placed upon the column h, and are provided with metal hooks e, which are split and separated when the links or connections o are put in their places, to cause the current to pass, and to communicate it to the conductor g' in such manner that the carbons are not insulated as long as the large ends of the carbons above, bearing the screwed metal pin p', which enter in the insulating-plate c, do not touch one another, and it is only the first carbon intended to burn which is in communication with the conductor g by the aid of a hook, e, and the connection o. This first carbon carries a washer or perforated disk, q, screwed on the upper part of the pin p, but only descending to the plate c.

The second carbon upon the pin p carries a washer, q, upon which is placed a plate, r, having two holes, the one large, r^1, and the other small, r^2, and retained by a nut, b. r^2 is bound between the washer and the screw, while r^1 allows the pin p of the first carbon to pass through without touching it. If the first carbon breaks, the large end of the carbon e will descend and bring down the
4084 ring q upon the piece r, which will establish a current between the first and the second carbon, and so on throughout. We place liquid in the bowl j, in such manner as to slightly cover the lower edge of the globe k. I employ, by preference, olive-oil, because it disengages no vapors when at a certain degree of temperature.

I claim—

1. The carbon electrodes provided with insulated supports independent of the metallic conductor, substantially as herein described.

2. The combination of the carbon-pins f, having the enlarged ends d, with the metal conductors e, inserted into the said enlarged ends of the carbons, substantially as shown and described, for the object specified.

3. The combination of the carbon-pins f, having the enlarged ends d, the wires e, and the links o, flexibly connecting said wires and the principal conductors, as herein shown and described.

4. The supporting column h, arranged within and filling a portion of the globe or cover k, substantially as and for the purpose herein specified.

5. The combination of the globe k, the column h, and the valve n, surrounding said column between it and the globe, and constructed to permit the escape of the dilated air from the globe, and prevent the entrance of the external air, substantially as shown and described.

6. The combination of the thin sticks of carbon f, their enlarged ends d, the wires e, inserted in said enlarged ends, the flexible con-

nections *o*, the insulating plate *c*, the plates *r*, screw-pins *p*, washers *q*, and nuts *b*, substantially as and for the purpose described.

7. The combination, with the series of carbon electrodes, and a flexible connection communicating with the electric conductors, and constructed to automatically pass the electric current from one carbon electrode to the other in case of the breakage of either, as set forth.

STEPHANE ALEXANDROVITCH KOSLOFF.

Witnesses:

A. LE BLANC.
E. PAGÉS.

H. WOODWARD.

ELECTRIC LIGHT.

No. 181,613. **Patented Aug. 29, 1876.**

FIG. 1.

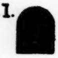


FIG. 2

FIG. 3.

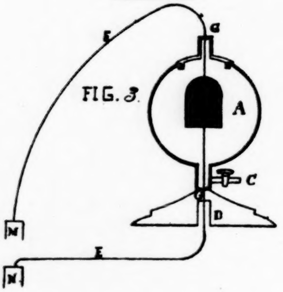
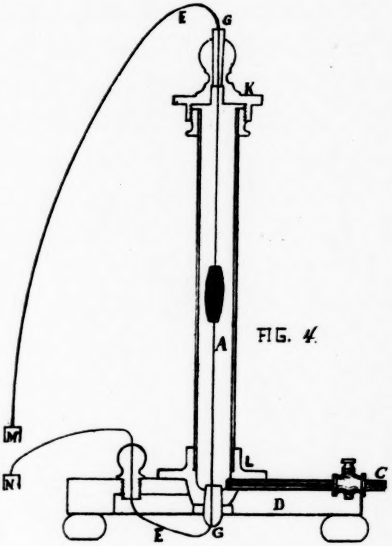


FIG. 4.


E
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L
C
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E
G

FIG. 5.

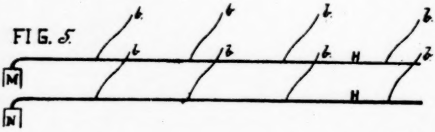
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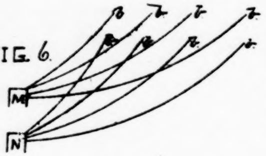
FIG. 6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b
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N

No. 286.
C.E. Light Co.
v.
McK. Light Co.
} p. 4085

WITNESSES

Geo. T. Smallwood

John J. Roby

INVENTOR

Henry Woodward

By John J. Halsted
Attorney

4086 UNITED STATES PATENT OFFICE.

HENRY WOODWARD, of Toronto, Ontario, Canada, assignor, by mesne assignments, to Rupert Mearse Wells, Thomas Richard Fuller, and Ernest Heimrod, of same place, and Charles H. Woodward, of Lindsay, Canada.

Improvement in Electric Lights.

Specification forming part of Letters Patent No. 181,613, dated August 29, 1876; application filed January 4, 1875.

To all whom it may corncern:

Be it known that I, Henry Woodward, of the city of Toronto, county of York, in the province of Ontario, Canada, have invented new and useful improvements in the art or process of obtaining artificial light by means of electricity; and I do hereby declare that the following, taken in connection with the drawings which accompany and form part of this specification, is a description of my invention sufficient to enable those skilled in the art to practice it.

In the first place, I use a gas-engine or other suitable motive power, for the purpose of rotating a magneto-electric machine, and at such a velocity as shall create electricity sufficient to heat certain pieces of carbon hereinafter described. The magneto-electric machine should be of sufficient power for the purpose of heating the carbon to a state of incandescence. A piece of carbon of suitable size is scraped and shaped until fitted for the purpose; one pole is then attached to the top of the carbon, and the other to the bottom thereof, by suitable electrodes. It is then inclosed in a globe or other vessel, either of glass or other suitable material. The air is then exhausted from the said globe or vessel after it has been hermetically sealed at the ends, and the globe is then filled with a rarefied gas that will not unite chemically with the carbon when hot. Electricity is now supplied, and in sufficient quantity to heat the carbon within the vessel to a state of incandescence. The rarefied gas previously introduced now becomes luminous, and constitutes the light herein designated as "Woodward's electric light."

This arrangement and process will give a light of any required intensity, and there is, practically, no limit to the number of lights that may be obtained from one magneto electric machine.

In the accompanying drawings, the same letters of reference indicate the same parts in all the views, and also in this specification.

(Here follows diagram marked p. 4085.)

Figure 1 is an elevation or front view of a piece of carbon, and is marked B. It is supposed to be scraped and shaped until suitable for the required purpose.

Fig. 2 is also an elevation or front view of a piece of carbon with the electrodes E E attached thereto, leading to and from the positive and negative poles of the battery, one being attached at the top and the other at the bottom of the carbon.

Fig. 3 is a sectional elevation, showing a globe marked A, but which may be a vessel of any other suitable form. The prepared carbon B is also shown therein, with the aforesaid electrodes E E attached thereto; showing, also, a tube, C, with an air-tight stopcock, to be used in exhausting the air from the globe A, and for the injection of rarefied gas into the same; showing, also, the hermetical sealing of said vessel at the ends G G of the tubes, and showing, also, the stand D.

Fig. 4 is a sectional elevation, showing the adaptation of another form of vessel, A. This drawing is on a larger scale, in order to show the manner of closing the ends of the vessel, which is done by brass sockets, that at the top being marked K, and that at the bottom being marked L; showing, also, a carbon, B, different in form from that in the other vessel, and having the two electrodes E E running to and from the poles N and M.

Fig. 5 is an elevation, showing one mode of connecting the various lights with the machine by means of two trunk-wires or electrodes, H H, running from the positive and negative poles M and N of the machine, with branches *b b*, &c., therefrom, to each light.

Fig. 6 is also an elevation, showing another method of connecting the lights with the machine, each light having a distinct
4087 wire, *b*, running to each pole M N of the machine or battery.

Having thus described my invention, I claim—

A carbon, B, in combination with a lamp or other suitable vessel, A, filled with rarefied gas, possessing the property of not chemically combining with the carbon when in a state of incandescence, in connection with the described arrangement and mode of connection of the electrodes E E with the carbon, all as shown and set forth.

HENRY WOODWARD.

Witnesses:
WILLIAM FITCH.
GEO. T. SMALLWOOD.

4090

United States Patent Office.

William E. Sawyer, of New York, and Albon Man, of Brooklyn, N. Y.

Improvement in Electric Lamps.

Specification forming part of Letters Patent No. 205,144, dated June 18, 1878; application filed May 16, 1878.

To all whom it may concern:

Be it known that we, William Edward Sawyer, of the city, county, and State of New York, and Albon Man, of the city of Brooklyn, county of Kings, State of New York, have invented certain new and useful improvements in electric lamps, of which the following is a full, clear, and exact description.

At the present day it is not new to produce a light by causing the electric current to heat a carbon conductor to incandescence in a vacuum, or in nitrogen, or in other gas; but no lamp has yet been devised which would be practically operative, and for these reasons: First, the methods that have been employed for charging the lamp with the artificial atmosphere—such as the displacement of mercury, water, or air by the gas, or the combustion of phosphorus in the lamp—are imperfect; a perfect vacuum is unattainable; some oxygen or other element or compound remains in the lamp, and slow consumption or disintegration takes place, for the remanent gas or vapor other than nitrogen or hydrogen attacks the carbon, oxygen forming with it carbonic acid or oxide, which in turn is decomposed, with the result of depositing the carbon upon the globe and setting free the oxygen to attack fresh carbon; second, it has been found practically impossible, under the varying degrees of heat and pressure, to maintain perfect joints, and the result is that expansion of the artificial atmosphere by the heat from the luminous conductor expels a portion of the same, and the contraction of the atmosphere upon cooling causes a portion of the external air to penetrate the globe, thus supplying oxygen which at the next lighting feeds upon the carbon; third, the unequal expansion of the carbon and its holders has resulted in fractures of the former, so that however perfect the atmosphere in the globe the lamp has never been permanent.

To obviate these several difficulties is the object of our invention.

To charge our lamp we prefer the employment of nitrogen gas, and this we produce in the lamp by our improved process in a state of great purity. As a safeguard against an infinitesimal leakage we prefer to place in our lamps a small quantity of sodium, potassium, or other agent having a great affinity for oxygen, whose oxidation, unlike the oxidation of phosphorus, produces no vapor, but a solid not easily changed by heat. As an additional safeguard we prefer to place in our lamps a quantity of freshly-burned lime, so that any traces of carbonic-acid gas which might suffer the decomposition and depositing hereinbefore mentioned may be quickly absorbed and rendered harmless. To make our lamp perfectly air-tight we have recourse to certain fittings to the opening at the base of the globe, which will be described in detail hereafter. To guard against great heating and unequal expansions at the joints, which would emperil the sealing of the lamp and soon render it useless, we isolate the incandescent carbon from the lower part of the globe, where the joints are situated, by a disk or diaphragm of some refractory substance—preferably soapstone or porcelain—whereby we prevent all downward radiation of the heat and keep the joints comparatively cool at the same time that the upper part of the globe may be very hot. Furthermore, to prevent conduction of the heat from the incandescent carbon to the joints by the metallic connections communicating therewith, we arrange the two conductors leading upward from the base in a spiral, volute, or fluting form, so that we obtain considerable length of conductor in a limited space, and very little of the heat reaches the base. By means of the several devices shown and described we have succeeded in obtaining a permanently airtight lamp. Our arrangement for avoiding fracture of the carbon will be fully described hereinafter.

(Here follow diagrams marked pp. 4088 & 4089.)

In the drawings accompanying and forming a part of this specification, figure 1 is a side view and Fig. 3 a partial front view of the lamp. Figs. 2, 6, and 7 are views of parts thereof. In Figs. 4, 5, and 8 we have indicated possible modifications of the lamp; and in Fig. 9 is shown the general arrangement of apparatus for charging the lamp with the artificial atmosphere in which the carbon is preserved.

4091 Referring to Figs. 1 and 3, A is the glass globe provided with a rim or flange, A′, (better shown in Fig. 6,) by means of which it is clamped to the glass base or stopper B. (Better shown in Fig. 7.)

We have shown the globe in the form of a tube closed at one end; but it is clear that its shape may greatly differ from that shown. The glass may be "diamond-cut" to effect diffusion of the light, or translucent to soften it; or the globe may be surrounded by a second globe possessing these characteristics, and a second globe would, in fact, be necessary in a lamp placed out-of-doors or subject to wetting, as the heated globe A, if unprotected, would be in great danger of breakage.

To the base of the globe is ground the glass stopper B (better shown in Fig. 7) with great nicety, in order that the fit may be perfect.

Slipping over the top of the globe A is a brass flange, L, shown partially cut away, which bears upon the rim A,′ to bring the globe firmly down upon the stopper B, the pressure upon the rim of the globe being softened and equalized by the cushioned-flange of wood, paper, or other yielding substance, P.

Under the stopper B is placed, first, a flange of wood or other

2 Sheets—Sheet 1.

W. E. SAWYER & A. MAN.

Electric Lamp.

No. 205,144. Patented June 18, 1878.

No. 286
C. E. Light Co.
v.
McK. Light Co.
} p 4088

Fig. 1.

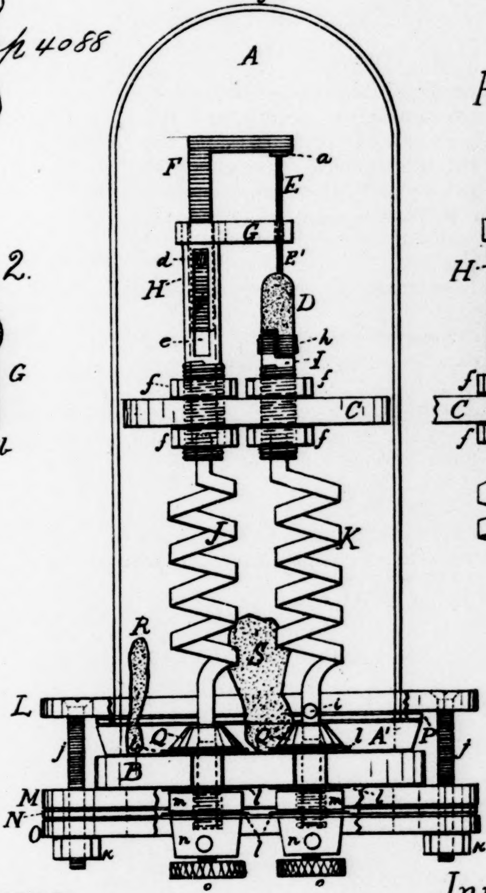
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Fig. 2.

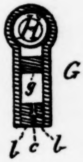
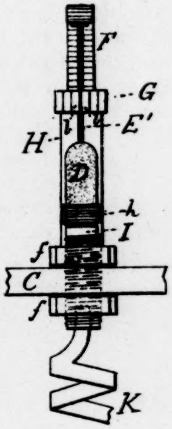


Fig. 3.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C
f
K

Witnesses:
Wm. H. Church,
George. H. Porter

Inventors:
W. E. Sawyer.
Albon Man

No. 286
C. E. Light Co.
v.
McK. Light Co.
} p. 4089

2 Sheets—Sheet 2.

W. E. SAWYER & A. MAN.
Electric Lamp.

No. 205,144. **Patented June 18. 1878.**

Fig. 4.

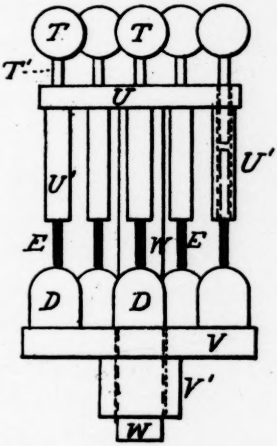
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Fig. 6.

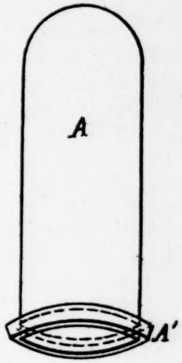


Fig. 7.

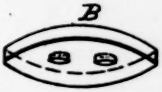


Fig. 5.

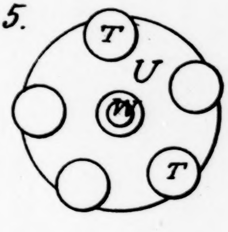


Fig. 8.

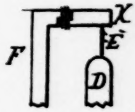
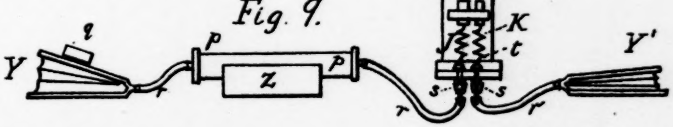


Fig. 9.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Witnesses:
Wm. H. Church,
George. H. Porter

Inventors:
W. E. Sawyer.
Albon Man

yielding substance, M; second, a flange of spring-rubber, M; and, last, a flange of brass, O, all shown partially cut away. Through all these flanges and the flange L go the bolts *j j*, of which there may be any desired number, so distributed around the circle as to equalize the pressure upon the rim A′ and stopper B. The bolts *j j* are secured in the usual manner by nuts *k k*. The flange P softens the pressure upon the rim of the globe A′, preventing fracture. The brass flange L yields to any inequalities which may exist. The wooden flange M softens the pressure upon the stopper B, preventing fracture thereof, while it is unaffected by any heat that may there exist; and the rubber flange N, protected from heat, acts as a spring to yield to slight unequal expansions and maintain a perfect contact between A′ and B. The rubber flange may, however, be omitted, and the form of the stopper B may be changed to that of a stopper ground into the end of the globe A, as stoppers are ground into bottles.

In setting up the lamp, we slightly coat the lower ground edge of the rim A′ with fir-balsam, or some cement, in order the better to insure that hermetical sealing which is indispensable to the preservation of the incandescent conductor.

Through the stopper B are drilled two holes, Fig. 7, through which pass the bolts Q Q, protected or not by a cloth or paper lining. These bolts are tubes, and their function is of the greatest importance. The bolt-heads are accurately fitted to the upper surface of the stopper, and under them, coated with balsam or some cement, are thin paper or tin-foil washers *l l*. The nuts *m m* are accurately fitted to the under surface of the stopper, and under them are similar washers *l l*, similarly prepared. Thus arranged, the bolts are permanently fixed to the base, and when the lamp is charged with the artificial atmosphere required the binding-posts *n n*, whose set-screws are *o o*, similarly guarded by washers *l l*, are set up upon the bolts' ends, whereby the lamp is hermetically sealed.

Entering the bolt-heads Q Q, so as to form a perfect connection with them, are two tubes, J K, arranged fluting, volutely, or spirally, as desired, the tube K being closed at the top, but provided with an opening, *i*, and the tube J being continuous, so that communication with the top of the lamp, when the binding posts *n n* are removed, is by way of the tube J, and to the base of the lamp by tube K at the point *i*. The object of this arrangement will hereinafter be made apparent.

C is a disk, of soapstone, porcelain, or other refractory substance, not readily fractured by heat, which almost entirely fills the globe A at or near the middle thereof. This, like the glass stopper B, is perforated with two holes, through which pass the metal tube H and the metal rod I, both of which are provided with a screw-thread at their lower ends. The tube H and the rod I are firmly fixed to the disk by means of nuts *f f f f*, as will be comprehended without further explanation. Into the lower ends of H and I, and firmly fixed thereto in any manner whatsoever, enter the conducting-tubes J and K. Let into the rod I is a short stick of carbon, D, rounded at the top, which we prefer to fasten to the rod by winding around the two the naked wire *h*, which may be of copper, silver, or platina.

Sliding up and down in the tube H is a rod, F, bent at right angles at the top, so as to bring the extremity on a line above the carbon D. The rod F is prevented from turning in the tube H by the pin *d*, fixed to the rod, and working in the slot *e*.

The light is produced by the heating of the small carbon rod E at the point E′, between the clamp G and the top of carbon D, connection with the small carbon E being had both through clamp G and the platina piece *a* on bent rod F. The rod F exerts a pressure upon the carbon E, which continues the same without regard to the length of the carbon, and thus, should fracture or a slight consumption of the carbon occur at the first lighting or any subsequent lighting of the lamp, the necessity of taking down the same, renewing the carbon, and recharging the globe, is obviated, inasmuch as the weight of the rod F gently forces the carbon through the clamp G until a new contact between E and D is established. The construction of the clamp G is shown in Fig. 2, which is a top view of the same. It consists of a copper or silver strip bent around the tube H and fixed to the same either by a pin or by its own pressure. At the end of the clamp are pinned two pieces of platina or iridium, *b b*, which may or may not touch each other, but each of which is slightly grooved to form an opening, *c*, through which the carbon rod E may pass, 4092 and in which it may be held in place. The copper or silver strip which constitutes the main portion of the clamp, serves the purpose, through its expansibility, of increasing and lessening the distance between the platina pieces *b b* according to the degree of heat experienced, thereby in great measure avoiding fracture of the carbon at E′ when intensely heated by the current.

In setting up the lamp we prefer to place inside the globe a lump of sodium or potassium, R, and one or more lumps of freshly-burned lime, S, although we do not confine ourselves to the introduction of these substances. Sodium and potassium being conductors of electricity may be protected from the conductors to the carbon, if deemed necessary, by inclosing the same in a bag of cloth, or in a glass tube open at one end.

We are aware that phosphorus has been placed in sealed lamps to remove the oxygen by its slow combustion; but the phosphorus acid evolved is not only fatal to the carbon when intensely heated, but beclouds the globe and obscures the light. Neither sodium nor potassium exerts any such deleterious influence, the product of oxidation being a solid, incapable, under the circumstances, of yielding either gas or vapor of any kind; hence the use of such by us as a safeguard in the lamp. Should carbonic-acid gas exist or at any time be evolved in the lamp it is quickly taken up by the lime, or by the soda or potassa formed by oxidation of the sodium of potassium.

In Figs. 4 and 5 we have indicated a modification of our lamp to the chandelier form.

We may arrange any number of carbons, D and E, around a circle in the form shown in Figs. 1 and 2, having for each a feeding device, F G, the whole being in a single globe, or we may arrange the chandelier as shown in Fig. 4, U being a metal disk provided with five or more or less tubes, U′, in which slide the small carbon rods E E, which are forced into contact with the lower carbons, D D, by the downward pressure of rods T′, surmounted by the weights T T. All of the lower carbons, D, connect with the disk V, to which is fixed tube V′, and through this tube and the disk, but insulated therefrom, passes the conductor W, which is attached to the upper disk, U, and is therefore in connection with all the small carbons E.

In Fig. 8 we have indicated a modification of the single-carbon lamp, the clamp G being dispensed with and the bent rod F being provided, like the rod I of Fig. 1, with a carbon piece, X, wired to it precisely as carbon D is wired to rod I. The lamp being set up the next important thing is to charge it with the atmosphere, which will prevent consumption of the carbon, and we will now proceed to describe in detail our improved process for so charging the lamp.

The various methods of manufacturing nitrogen gas are well known.

Having dried and purified the gas until it stands all tests we pass it into a dry receiver, preferably a bag of vulcanized rubber. Referring, now, to Fig. 9: Into a glass tube, *p p*, in a furnace, Z, by means of which the tube may be heated to any desired extent, we place a quantity of sodium, or potassium, or other agent having a great affinity for oxygen, whose oxidation produces a solid. If deemed advisable we may add to the same a purifying agent or agents. Heat, while not essential, greatly facilitates the operation, and therefore, even with potassium, we prefer to employ the furnace. To one end of the glass tube *p p* by means of a flexible tube, *r*, we attach the receiver Y, filled with nitrogen, and having removed the binding-posts *n n*, Fig. 1, from the lamp, we connect the other end of the tube *p* by means of a flexible tube, *r*, and nipple *s* with the bolt Q, which connects with tube J leading up to the top of the lamp. We then by means of weight *q* force a sufficient quantity of the nitrogen through the tube *p* and the lamp to greatly dilute and mostly displace the atmospheric air contained therein. The empty closed receiver Y′ we then attach by a flexible tube, *r*, and nipple *s* to the bolt Q, which is connected to conductor K of the lamp, and the lamp now being in a closed circuit of nitrogen gas the operation of purification begins. The gas passes slowly from receiver Y through the tube *p;* thence through the tube J to the top of the lamp at the point *u*, and thence down and outward at the point *t* into the receiver Y′, and from Y′ by the reverse action it is repassed into receiver Y. This transference is repeated until there is no further evidence of oxidation, when, the receiver Y′ being empty, a pressure is exerted upon the receiver Y and maintained so as to cause a slight escape of gas from the lamp during the time that Y′ is disconnected, and the binding-post being put onto the bolt Q connecting with conductor K. The nipple *s* is lastly disconnected from the bolt Q of tube J, and the binding-post for that tube put on, when the lamp is ready for use and will remain so for an indefinite period, the line S in the lamp absorbing any traces of carbonic-acid gas that may be present or evolved, and the sodium or potassium burning out any traces of oxygen that may enter during the closing of the tube J.

By the process described the lamp may be charged with absolutely pure nitrogen gas, and it is clear that any number of lamps may be placed in the circuit and simultaneously charged, the gas in transference passing seriatim through the lamps.

Having thus fully described our invention, what we claim as such and desire to secure by letters patent is—

1. An electric lamp in which the globe and stopper, both of glass or other vitreous substance, are ground together and held together by a clamping device.

4093 2. In an electric lamp, the combination, with suitable conductors of electricity, of an inclosing-globe provided with a rim or flange, A′, forming an integral part of such globe, as an for the purpose specified.

3. The combination of the vitreous globe A of an electric lamp and the cushion P, placed, as shown and described, above the vitreous flange thereof, for the purpose of supporting a clamping device.

4. The combination of the vitreous globe A of an electric lamp and the cushion N, placed, as shown and described, under the stopper thereof, for the purpose of supporting a clamping device.

5. The combination of the globe of an electric lamp and the two cushions N and P, placed, as shown and described, for the purpose of supporting a clamping device.

6. In an electric lamp, a tube bolt, Q, and binding-post *n*, in combination with a packing, *l*, under said binding-post.

7. In an electric lamp, a tube-bolt, Q, nut *m*, binding-post *n*, and packings *l l l*.

8. The combination of the clamp G and the cross-piece *g*, as and for the purpose specified.

9. In an electric lamp, a tube leading from an external connection to or near to the top of the globe, and having an opening thereat, in combination with an opening at or near to the base of the globe, for the purpose of facilitating the filling of the globe with a carbon-preservative atmosphere, substantially as shown and described.

10. In an electric lamp, two unobstructed tubes leading from external connections into the globe thereof, and so arranged as to facilitate the charging of the globe with a carbon-preservative atmosphere.

11. In an electric lamp, a diaphragm obstructive of radiant heat interposed between the luminous part or parts of such lamp, and the air-tight joint or joints thereof, as and for the purpose specified.

12. An electric lamp within which the conductors leading from the air-tight joint or joints thereof to the luminous part or parts thereof are so formed, lengthened, or broadened as to have great radiating surface, so that conduction of heat from such part or parts to such joint or joints is in great measure, if not wholly, prevented.

13. In an electric lamp, the long coiled conductor J, opening at its upper end, and connecting with one electrode of such lamp.

14. In an electric lamp, the long coiled conductor K, opening at the base of such lamp, and connecting with one electrode thereof.

15. In an electric lamp, an absorbent of carbonic-acid gas.

16. In the sealed globe of an electric lamp, containing an azotic or other carbon-preservative atmosphere, an absorbent of carbonic-acid gas.

17. In an electric lamp, an agent having a great affinity for oxygen whose oxidization produces a solid unalterable by the natural heat in the lamp, such as sodium or potassium.

18. The combination, in an electric lamp, of an absorbent of carbonic-acid gas and an agent having a great affinity for oxygen whose oxidization produces a solid unalterable by the natural heat in the lamp, such as sodium or potassium.

19. A carbon rod, piece, or pencil heated to incandescence in an atmosphere deprived of oxygen, in which atmosphere is permanently an oxidizing agent whose oxidization produces a solid, which agent may be sodium or potassium, or other readily oxidizable metal.

20. A carbon rod, piece, or pencil heated to incandescence in an atmosphere deprived of oxygen, in which atmosphere is permanently an absorbent of carbonic-acid gas.

21. A carbon rod, piece, or pencil heated to incandescence in an atmosphere deprived of oxygen, in which atmosphere is permanently an oxidizing agent, such as sodium, potassium, or other readily oxidizable metal, in combination with an absorbent of carbonic-acid gas.

22. A sealed electric lamp inclosing an agent or agents for purifying the atmosphere contained therein from oxygen or oxygenic gases.

23. The herein-described method of charging an electric lamp with a carbon-preservative atmosphere, consisting in placing the lamp in the circuit of a purifying agent or agents and two gas-receivers, one of which is primarily preferably filled with the carbon-preservative gas and the other empty, and forcing the gas back and forth from one receiver to the other, each time through the lamp and the purifying agent or agents, until the atmosphere becomes pure or nearly so.

24. The herein-described method of charging an electric lamp

with a carbon-preservative atmosphere, consisting in placing the lamp in the circuit of a purifying agent or agents and two receivers, one of which is primarily preferably filled with a gaseous medium and the other empty, and forcing the gaseous medium back and forth from one receiver to the other, each time through the lamp and the purifying agent or agents, until the atmosphere in the lamp becomes pure, or nearly so.

25. The method of charging an electric lamp with a carbon-preservative gas by intermittently passing a purified atmosphere, or an atmosphere undergoing purification, into the globe thereof, and thereby successively diluting and purifying the contents thereof, until finally all or nearly all the oxygen is removed therefrom.

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No. 286
C. E. Light Co.
v.
McK. Light Co. } p. 4094

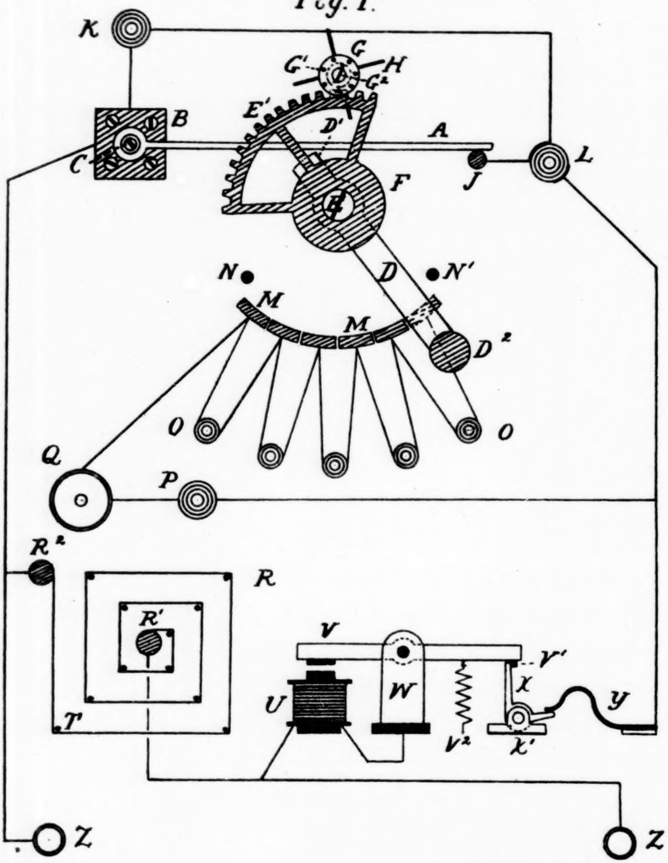
2 Sheets—Sheet 1.

W. E. SAWYER & A. MAN.

Electric-Lighting System.

No. 205,303. Patented June 25, 1878.

Fig. 1.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R. M. Stratton

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Albon Man

No. 286.
C. E. Light Co.
v.
McK. Light Co } p. 4095

2 Sheets—Sheet 2

W. E. SAWYER & A. MAN.
Electric-Lighting System.

No. 205,303. **Patented June 25, 1878.**

Fig. 2.

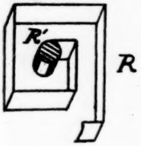

Fig. 3.

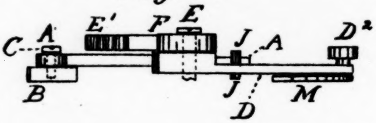
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Fig. 4.

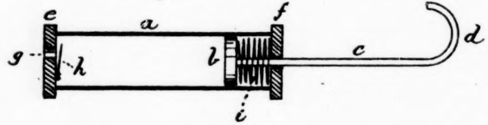
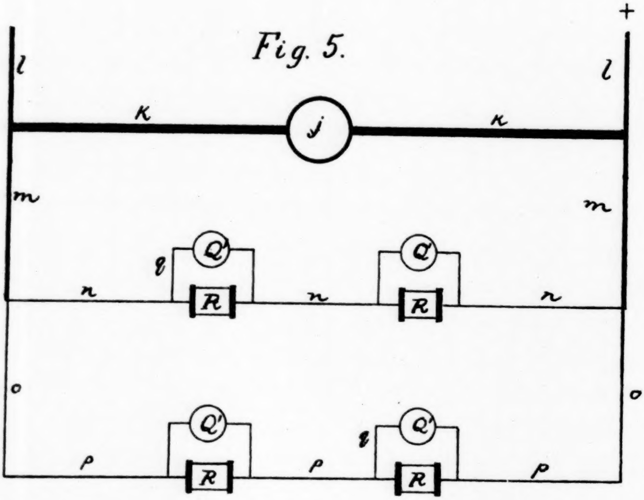


Fig. 5.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4096

UNITED STATES PATENT OFFICE.

WILLIAM E. SAWYER, of New York, and ALBON MAN, of Brooklyn, N. Y.

Electric-lighting System.

Specification forming part of Letters Patent No. 205,303, dated June 25, 1878; application filed May 31, 1878.

To all whom it may concern:

Be it known that we, William Edward Sawyer, of the city, county, and State of New York, and Albon Man, of the city of Brooklyn, county of Kings, and State of New York, have jointly invented certain new and useful improvements in electric-lighting systems, of which the following is a full, clear, and exact description.

In another application filed by us we have shown and described an electric lamp in which light is produced without consumption of the carbon producing it.

The object of our present invention is to provide for such a distribution and application of the electric current as will render our own or any other lamp practically operative upon an extensive scale.

Our system consists in (first) a new arrangement of electrical circuits, which are in part (second) composed of conductors diminishing in transverse mass as they increase in length, and in part (third) of conductors having great radiating-surface, provided with (fourth) safety-switches to guard against the dangers of short-circuiting in connection with (fifth) lamps and lamp-lighting devices, by means of which the lamps are lighted and extinguished without danger of fracturing the carbons thereof, or of interrupting or changing the resistances of the circuits.

(Here follow diagrams marked pp. 4094 & 4095.)

In the drawings accompanying and forming a part of this specification, figure 1 is a general view of the arrangements at each lamp, including a top view of the lamp-lighter and a side view of the safety-switch. Figs. 2 and 3 are other views of parts of Fig. 1, and in Fig. 4 is outlined a modification which may be made of a part of the lamp-lighter. Fig. 5 is a diagram of the circuits, showing the combination of several of the sets of apparatus shown in Fig. 1.

Referring, first, for convenience of description to Fig. 5, *j* is a generator of electricity supplying the outletting conduits or conductors *k k*, which branch into conductors *l l m m*, the continuations of which are shown only in the case of conductors *m m*, the circuits of conductors *l l* being merely indicated by the + and — signs. There may be any number of branches *l l m m* leading from the outletting conduits according to the volume of current supplied by the generator *j*. The outletting conduits *k k*, as indicated by the thickness of the lines, are large, in order, without heating and consequent waste, to conduct the great quantity of current supplied. It is clear that all the conductors may be of uniform size; but the expense of such, as against conductors diminishing in transverse mass as they extend outward, is so considerable that we have adopted the latter plan. Therefore we make the first sections, *m m*, of the circuits smaller than the outletting-conduits, and the next sections, *o o*, still smaller, and so on indefinitely. In the cross-branches *n* and *p* in circuits *q q*, derived by means of resistances R R, we place the electric-lighting apparatus of our invention, Q′.

Referring now to Figs. 1, 2, and 3, Q is the lamp; A D M, the lamp-lighter; U V X, the safety-switch, and R the resistance. (Shown in Fig. 5.)

In the lamp of our invention hereinbefore mentioned, which we prefer in all cases to employ, a small piece of carbon is heated to incandescence in an atmosphere with which it will not chemically combine. Other attempts to produce such a lamp have been made, but among other things it has been found almost impossible to prevent fracture of the carbon. The fracturing of the carbon is mainly due to sudden changes in temperatures. While it becomes soft and pliable under the heat of the current at ordinary temperatures, it is extremely brittle, and instantaneous heating from its normal condition to a temperature of from 5,000° to 40,000° Fahrenheit tends to disrupt the particles and establish the voltaic arc by which in a moment the carbon is destroyed. The lamp-lighter avoids this difficulty. Again, an accidental short circuit may occur with the result of supplying so much current to the lamp as to volatilize or destroy the carbon unless instantly and automatically checked, and this danger is provided against by the safety-switch. To avoid undue electrical heating from accidental or other causes in the conductors, and the great resistance occasioned by the heating of a
conductor, especially when in the form of a rheostat, we con-
4097 struct our artificial circuits, rheostats, or resistances R, of flat
or ribbon wire, in order that they may present considerable radiating surface, and thereby keep cool when otherwise they might be melted by the electric heat.

The connectors Z Z of Fig. 1 indicate the points at which the lighting-circuits leave the branches *n* and *p* of Fig. 5.

A is a flat metallic spring-lever fixed to holder B by screw C, and making connections, when the lamp Q is not in circuit, with contact-point J.

D is a lever provided with finger-piece D^2, working on screw or stud E. When the lever D is in the position shown, its rounded extremity D′ is clear of spring-lever A; but when moved to the left the end D′ makes connection with the spring-lever and simultaneously lifts the latter from its connection with contact-point J.

Fixed to the lever D is a mutilated spur-wheel F, the teeth E′ of which mesh into the pins G′ of pinion G. The pinion G, rotating on screw or stud G^2, carries with it a fan, H, situated below the pinion; but as the construction of such mechanism is thoroughly understood, we have not deemed it necessary to illustrate the same in detail. The object of the fan is to retard the movements of the lever D, and thus compel the person lighting a lamp to "turn on" the current gradually. Any other means of insuring a gradual movement of the mechanism will answer the purpose; and, as an example, we have indicated in Fig. 4 a modification that may be made in this apparatus, *a* being a tube of glass or metal, in which travels a plunger, *b*, on piston-rod *c*, provided with finger-hook *d*. The piston-rod works loosely in the tube-head *f*, and the plunger is pressed toward tube-head *e* by coiled spring *i*. In the head *e* is an opening, *g*, provided with a valve, *h*. This device may be attached to the apparatus of Fig. 1, so that, for instance, when the plunger is drawn into the position shown, a catch shall take hold of the lever D, and the piston-rod being released and the valve *h* closing, the slow escape of the air as the plunger is followed up by spring *i* may cause the piston-rod to slowly move the lever D and light the lamp. The piston-rod *c* disengaging when the lamp is lighted, all that is necessary in order to put out the light is to move the lever D back to the position it occupies in Fig. 1, and this may be arranged to be accomplished by a second catch upon the piston-rod *c*, and the same movement of the rod as that which takes place upon lighting the lamp; but since, as before observed, any retarding device will answer the purpose, we have not deemed it necessary to enter into the details of modifications, which would only needlessly cumber our specification.

Recurring to Fig. 1, K and L are resistances of, say, fifteen ohms each. P is a resistance of, say, twenty ohms; and O O are five resistances of, say, two ohms each. N and N′ are stops for lever D. M M are six metallic contact-pieces, with which lever D makes connection as it is moved, which contact-pieces are connected, as shown with the five resistances O O. All of these resistances may be of the character of resistances R, which, as better shown in Fig. 2, is a flat wire or ribbon of metal. This ribbon is wound over pins T, fixed to any suitable insulating-base. The connectors R R′ may be of any desired form. Being in the shape of a ribbon, the conductor constituting the resistance has a large radiating-surface, and a space being left between each layer to permit of free access of air any heat which may be evolved is rapidly dissipated. The resistance R operates to divert a portion of the current flowing in the branches into the lamp Q. In many cases it may be omitted.

The safety-switch is of the simplest construction. U is an ordinary electro-magnet; V, an ordinary armature-lever; W, a standard, in which the armature-lever is pivoted, and V^2 a retractile spring. The pin V′, fixed to the lever V when the lever is not actuated by the magnet U, serves to hold the bent lever X, working in its bearing X′, in the position shown in the drawings. When, however, the lever V is attracted by magnet U, the pin V′ is lifted and the lever X, actuated by spring Y, escapes from its imprisonment.

The operation of the switch is as follows: When the proper strength of current is supplied to the lighting-circuit, the spring V^2 is so adjusted that the lever V does not respond to magnet U; but when from any cause there is an increase in the current which might injure the lamp or other apparatus or other lamps in circuit, the retractile force of the spring V^2 is overcome by the attractive force of the magnet, and the circuit through spring Y, lever X, armature-lever V, standard W, and the magnet is instantly broken by the release of lever X.

In the place of the safety-switch we may interpose in the circuit a section of a conductor more readily fused than the conductors constituting the rest of the circuit, so that when there is too much current this section shall be instantly melted and the continuity of the circuit destroyed.

The operation of our apparatus is as follows: The current enters the resistance R from the points Z Z. From the resistance at the points R′ and R^2 the current divides, the required portion entering the lighting-circuit. When the lever D is in the position shown, the current passes from the point R^2 to the spring-lever A, contact-point J, resistance L of fifteen ohms, and thence through spring Y, levers X and V, standard W, and magnet U to the point R′. In this position of the lever D the lamp is not in operation, and the resistance of the circuit is fifteen ohms, (disregarding everything excepting resistance L.) To light the lamp, the lever D is moved
to the left, and while it is still in connection with the first
4098 contract-point, M, its end D′ makes connection with spring-
lever A, and the connection between A and J is broken.
Without having been interrupted the circuit of the lighting apparatus is now divided into two sub-circuits, one of which is from the point R^2 by way of spring-lever A, resistance K, of fifteen ohms, resistance L, of fifteen ohms, and the safety-switch, to point R; total resistance of the sub-circuit thirty ohms. The other sub-circuit is from the point R^2 by way of spring-lever A, lever D, the first contact-point M, the five resistances O O, of two ohms each, the lamp Q, resistance P, of twenty ohms, and the safety-switch to point R; total resistance thirty ohms the resistance of the lamp while the carbon is cool being practically *nil.* The lighting-circuit being now divided into two sub-circuits of thirty ohms resistance each, the resistance of the circuit is still fifteen ohms, and although the lamp has been introduced, no disturbing influence has been exerted upon other lamps or circuits. The current flowing through the lamp begins to heat the carbon, which rapidly acquires resistance, and the resistance of the carbon increases in proportion to the movement of the lever D over the contact-points M until all of the five resistances O, of two ohms each, have been cut out of circuit, and the lamp is left in circuit with the resistance P, of twenty ohms; but the resistance of the lamp is now ten ohms, so that the total resistance of the sub-circuit of the lamp is still thirty ohms, and, the resistance of the other sub-circuit remaining unchanged, the joint resistance is as at the outset fifteen ohms.

It will thus be seen that the lamp-lighter of our invention not only prevents the too sudden heating of the carbon, but completely obviates the disturbing influences of changes in resistance which have heretofore accompanied the lighting or extinguishing of a lamp.

The application of the lamp-lighter to electric lamps in which the light is produced by the voltaic arc by removing resistances from the circuit in proportion as the carbons separate will be comprehended without further explanation.

Recurring now to Fig. 5, in which we have shown more than one branch from a single source of electricity, and more than one lamp in each branch, we are aware that it is not new to place a number of lamps in series in the circuit of a generator. or to divide the current among several conductors, each containing a single lamp, or to divide the current among several cross-branches, *n p*, each containing a single lamp. It is new, with us, however, to divide the current among several conductors, or several cross-branches, each containing two or more lamps, and lest the advantages of our arrangement may not be apparent we will proceed to explain the same in detail.

It is well understood, first, that to produce a good electric light a current of electricity combining considerable intensity is indispensable; second, in dividing the electric current among a large number of lamps, if there is a conductor from the generator to each lamp, or a cross-branch to each lamp, the quantity of current supplied must be very great, and in the event of a short circuit occurring in any lamp the result would be disastrous to the lamp, if it would not extinguish all the other lamps; third, in placing a large number of lamps in series, each lamp having a considerable resistance, the intensity of the current, in order to overcome the combined resistances, must be very great, and to obtain the proper current is far more expensive than it is to obtain a current of greater quantity with less intensity.

To illustrate the disadvantages attending the placing of very many lamps in series, let it be assumed that there are one hundred lamps in circuit, and that the resistance of each lamp is ten ohms, then the combined resistance of all the lamps is one thousand ohms, and this in the service of current for electric lighting is impractical. Suppose, now, that there are one hundred conductors leading from the generator, and that in each conductor there is a single lamp of ten ohms resistance, then the joint resistance of the one hundred lamps is the tenth of an ohm. Not to mention the wear and tear upon the generator of so slight a resistance, let it be supposed that a short circuit occurs in one of the lamps—as, for instance, by an accidental connection across the terminals of the resistances K, L, and P, thus cutting out those resistances—then the resistance of its conductor becomes *nil*, and not only are all the other lamps deprived of the current, or the greater portion thereof, but the short-circuiting lamp circuit receives so much current that the lamp is destroyed, even should there be no other disastrous result. If to avoid this we increase the resistance of the conductors, artificially or otherwise, outside of the lamps, we simply waste current in overcoming the added or artificial resistances which clearly would be costly, and consequently impractical. Adopting, finally, our plan, let it be supposed that there are ten conductors or cross-branches, *n p*, leading from the generator, each containing ten lamps of ten ohms resistance each. The combined and joint resistance of the circuit of the generator is ten ohms: —$\frac{10 \times 10}{10} = 10$. The resistance of the circuit is better suited to the generator, and should a lamp short-circuit the result would not be disastrous. On the contrary, it could hardly be detected. The very slight proportion of current taken from the ninety lamps in the nine perfect conductors, and the very slight proportion of current added to the nine lamps in the conductor containing the short-circuiting lamp would have no appreciable effect upon either the ninety or nine.

In concluding the description of the system of our invention we remark, first, that there may be in each lamp-lighter any number
of resistances O, of any number of ohms, or parts of an ohm,
4099 resistance each; second, that the lever D may further operate
to cut out resistances K and L, and, finally, to break their circuit altogether, reducing, while doing so, the resistance of the circuit of lamp Q; third, that everything in the lamp-lighter, excepting the *the* lever D, resistances O O, and lamp Q, may be omitted, since the resistances O O may be *be* increased to such an extent that when they are all in circuit the current will be too weak to heat the carbon, and removing them from the circuit will add resistance to the carbon by its heating in proportion as they are removed.

Having thus fully described our invention, what we claim as new, and desire to secure by letters patent, is—

1. The combination, with an electric lamp, of a switch, which in lighting the lamp gradually removes a resistance for the circuit thereof.

2. The combination, with an electric lamp, of a switch, which, while preserving the continuity of the circuit, gradually removes a resistance from the circuit of the lamp.

3. The combination, with an electric lamp, of a resistance in the circuit thereof which is lessened as the resistance of the lamp is increased.

4. The herein-descri-ed method of lighting an electric lamp, consisting in causing the flow of current in such lamp to increase in strength slowly.

5. In an electric-lighting system, two or more conductors supplied with electricity by the generator of electricity which is the common source of supply for such system, and in each of these conductors, or in circuits derived therefrom, two or more electric lamps, the same being so arranged for the purpose of insuring the necessary distribution and subdivision of the current without artificial lengthening of the circuits by the introduction of resistances which would only waste the current, as set forth.

6. In an electric-lighting system, rheostats, resistances, &c., having great radiating-surfaces, the same being preferably constructed of a thin flat conducting medium, to which the air is given free ac-

cess, so that the heat generated by the current is rapidly radiated or conducted off.

7. In an electric-lighting system, an electrial apparatus energized by the current flowing in such system, which, when there is an abnormal flow of current in a part or parts of such system, automatically operates to disrupt, disconnect, or change the circuit of such part or parts.

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ALBON MAN.

Witnesses:
WM. H. CHURCH.
R. M. STRATTON.

4101

UNITED STATES PATENT OFFICE.

WILLIAM E. SAWYER, of New York, and ALBON MAN, of Brooklyn, N. Y.

Electric Lamps.

Specification forming part of Letters Patent No. 210,809, dated December 10, 1878; application filed November 5, 1878.

To all whom it may concern :

Be it known that we, William Edward Sawyer, of the city, county, and State of New York, and Albon Man, of the city of Brooklyn, county of Kings, State of New York, have invented certain new and useful improvements in electric lamps, of which the following is a full, clear, and exact description.

In letters patent of the United States No. 205,144, dated June 18, 1878, granted to us, we have shown and described an electric lamp differing not essentially, in so far as its main features are concerned, from that of our present invention, the object of which is to produce a lamp more tasteful in appearance and better adapted to afford a successful electric light

(Here follows diagram marked p. 4100.)

Referring to the drawings accompanying and forming a part of this specification, figure 1 is a sectional view of the lamp, and Fig. 2 a cross-section of a part thereof. In Figs. 3 and 4 we have indicated modifications which may be made in the form of the internal conductors.

A is a glass globe, provided with a flange, B, substantially as shown and described in the letters patent referred to.

C is the stopper; *a a* are the tubular bolts passing through the same, and *f* and G are cushions to soften the pressure upon the glass flange and stopper of the two metal flanges D and F, drawn together by bolts *e e*, the whole of which has been fully described and claimed in the above-mentioned letters patent as the clamping device of our invention, and of which we do not deem it necessary, therefore, to enter into a detailed description here. The tube-bolts *a a* are provided with ordinary stop-cocks, *b b*, the construction of which is well known. Over the outer ends of these bolts, stop-cocks and all, are the metal caps *c c*.

In charging a globe with an artificial atmosphere—such, for instance, as described in the above-mentioned letters patent—a long tube is passed through one of the tube-bolts *a*, so as to reach the upper portion of the globe, space being provided therefor. The lamp then being inverted the artificial atmosphere, entering by way of the other tube-bolt *a*, displaces the gaseous contents of the globe, which flow out by way of this long tube. When the globe is sufficiently well charged, and while the flow still continues, the

W. E. SAWYER & A. MAN.

Electric-Lamp.

No. 210,809. **Patented Dec. 10, 1878.**

No. 286.
C.E. Light Co
v.
McK. Light Co
} p. 4100

FIG. 3.

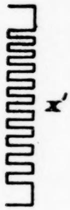
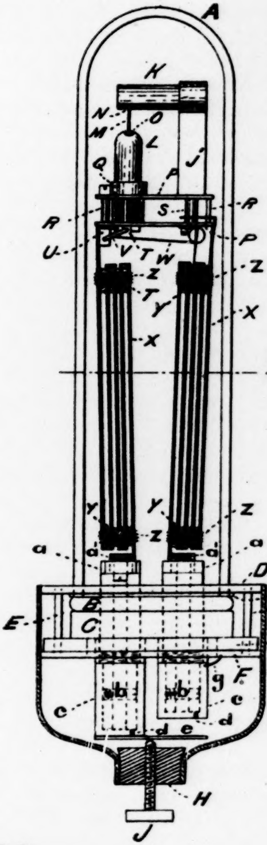


FIG. 1.


A
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N
O
M
L
Q
J'
P
S
R
R
U
V
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W
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Y
X
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a
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FIG. 2.

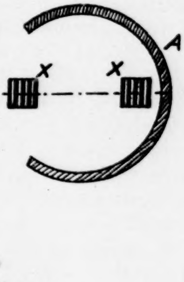
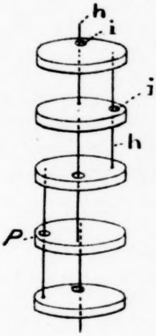


FIG. 4.



WITNESSES.

Wm. H. Church
E.R. Knowles.

INVENTORS

William Edward Sawyer
Albon Man

long tube is slowly withdrawn, the outward flow of the gas preventing the entrance of atmospheric air during the operation. The long tube having been withdrawn, the stop-cock through which it had passed is closed. To fully seal the joint we pour melted beeswax into the opening outside of the stop-cock, and filling the nut *c* with melted beeswax we screw it up, so as to incase the entire external end of the tube with the beeswax, an opening, *d*, in the end of the cap permitting superfluous wax to exude. Thus the joint is hermetically sealed. To seal the outer tube-bolt, we close its stopcock *b*, disconnect the charging apparatus, and proceed to treat the bolt and cap as in the first instance. To further hermetically seal the entire globe, as by a hydraulic joint, we have recourse to a spun-metal cap, G′, fitting closely to the flange D, and held in place to it, if desired, by suitable pins or screws. The lower and smaller end of the spun cap, which is made open, is fitted with an insulating-plug, H, through which passes a metal screw, I, which, when all is in place, makes contact with metal strip *e*, fixed to a cap, *c*. The other cap *c* is connected by wire *g* with flange F, thence, by way of bolts E E, with flange D, and thence with cap G′. Thus to make connection of the lamp with a chandelier or a bracket, a metal arm of which is provided with an opening containing an exposed insulated contact-joint in its center, the two constituting the terminals of the conductors leading from the generator, all that is necessary is to screw the smaller end of the spun cap into the same until the insulated contact-joint and the screw I make connection, the electric current passing in by way of the spun cap and leaving by way of the screw I, or *vice versa*.

The application of the spun cap G′ is as follows: The lamp is first perfectly charged and the caps *c c* are put on, as already described. The spun cap G′ is then filled, or partially filled, with melted beeswax, and the lower extremity of the globe A, the stopper C, the clamping device, and all the parts appertaining
thereto are sunk into this fluid mass, which, upon cooling,
4102 effectually seals the lamp. We have spoken of beeswax as
the sealing agent; but it is clear that any other easily-fused material, or even an oil or other liquid, will answer the purpose equally well.

The spiral internal conductors shown and described in the letters patent referred to are somewhat unsightly. In place of them, we prefer the long conductors X X, (referring to Figs. 1 and 2), which are made of a copper ribbon polished or electroplated and folded in the manner shown, so as to form square gridiron-shaped uprights. These are screwed at their lower extremities to the tube-bolts *a a* by screws *á á*. To prevent electrical connections at the bends or at intermediate points, we place in the same small pieces of mica Y Y Y Y, and to render the rods firm and substantial we bind them at the ends with insulated wires Z Z Z Z. These conductors meet all the requirements of the spiral conductors of the letters patent referred to, and are much more pleasing to the eye. If desired, they may be constructed as shown in Fig. 3.

The diaphragm, to prevent downward radiation of the heat, as fully set forth in the aforesaid letters patent, may be of any infusible opaque insulating substance, or of metal, as shown in the present application. In our present invention it consists of two metal plates, P P, held together by bolts R R. The lower plate absorbs any possible radiation from the upper plate; but we may use more than two plates, or a single plate, if desired. Joining the two plates is a tube-bolt, Q, in which the round metal bar or rod L is free to slide. The bar L is capped with a platinum or iridium contact-piece, O. and is actuated by means of spring W, acting upon stirrup V, which has a bearing in the groove T of rod L, and is pivoted in nut U, to which the upper extremity of one of the conductors X is connected. The rod L thus allows for any contraction or expansion of the carbon pencil M. For this rod we have chosen the term the "anvil" of the lamp. The hammer consists of a metal bar, K, provided also with a platinum or iridium contact-piece, N, and it is held firmly in place by standard J′, to which, by way of its extension S, one of the conductors X is connected. The hammer-standard and its conductor are insulated in any of the well-known ways, preferably by the interposition of layers of mica at the points of contact.

The contact-points N and O may be of carbon, although we prefer platinum or iridium. In the drawings we have shown a method of combining several of the diaphragm-disks P, of metal, so as to constitute the conductors of the lamp. The disks are held together by small rods *h*, alternate plates being electrically connected, as shown, and insulated from the intermediate plates by the rods *h*, passing through the holes *i*, but not touching the sides thereof. The importance of a number of plates, P, to prevent downward radiation of heat is manifest.

To charge the globe we proceed as follows: The lamp being connected with a hydrogen-generator, we first exhaust the air, then we charge the globe with pure dry hydrogen; again we exhaust and charge with hydrogen, and this operation we repeat until the original gaseous contents of the globe are entirely replaced by the hydrogen. We then, in place of the hydrogen, connect the lamp with a generator of pure dry nitrogen, keeping the globe A constantly heated by having it immersed in a bath of hot water, exhausting the hydrogen. We fill the partial vacuum with nitrogen, or we may do it by displacement, and this operation we continue until the globe contains nothing but nitrogen, excepting such gases as may be occluded by the inclosed materials. To drive these out, we pass an electric current through the conductors *x x*. The carbon pencil M is intensely heated, and considerable heat having extended throughout all the inclosed material, thus driving out occluded gases, the operation of exhaustion and refilling with nitrogen is continued until finally all the elements of danger are eliminated from the lamp.

Having thus fully described our invention, what we claim as such, and desire to secure by letters patent, is—

1. In an electric lamp, the cap G′, provided with an insulated

contact, J, for the purpose of establishing the electric connection of the lamp with the terminals of the conductors leading from the generator when the lamp is set in a suitable holder, substantially as shown and described.

2. An internal conductor in an electric lamp consisting of strips of metal fluted or plain, insulated at their ends or heads with slips of mica or other suitable insulating material, and bound together to insure solidity of construction.

3. In an electric lamp, the combination of the diaphragm P, standard J′, sliding bar L, spring W, and stirrup V, in the manner substantially as described.

4. A sliding anvil, L, held in a socket, Q, and supported by a spring to carry the burner M and hold it against the hammer K, the contact-points to be of platinum or iridium, substantially as described.

5. The herein-described method of charging the globe of an electric lamp with nitrogen, consisting, first, of replacing the original gaseous contents of the globe with hydrogen, and then replacing the hydrogen with nitrogen.

6. In an electric lamp, two or more diaphragm-disks, as and for the purpose specified.

WILLIAM EDWARD SAWYER.
ALBON MAN.

Witnesses:
WM. H. CHURCH.
E. R. KNOWLES.

4107

United States Patent Office.

William E. Sawyer, of New York, N. Y.

Electric Lamp.

Specification forming part of Letters Patent No. 219,771, dated September 16, 1879. Application filed April 23, 1879.

To all whom it may concern:

Be it known that I, William Edward Sawyer, of the city, county, and State of New York, have invented certain new and useful improvements in electric lamps and switches therefor, of which the following is a full, clear, and exact description.

My invention relates to that class of electric lamps in which light is produced by the incandescence of a solid conductor, notably of a carbon pencil interposed between two large carbon electrodes, and constituting a part of the electric circuit.

The general principles upon which such lamps are constructed and operate are sufficiently well understood to render a detailed description here unnecessary; and many of the features connected with the lamp of my present invention are fully shown and claimed in letters patent of the United States No. 205,144, dated June 18, 1878, granted jointly to me and Albon Man, of Brooklyn, New York.

Experience has shown that the carbon pencils employed in lamps of this description after a time cease to maintain a perfect contact or connection with their carbon-holders. The result is the development of the voltaic arc, and, because of the consequent instantaneous shortening of the carbon pencils by disintegration, the lamps must be taken apart, new pencils substituted, and the sealing-globe refilled with a carbon-preservative atmosphere. Experience has further shown that this shortening of the carbon pencil occurs usually at its contact with the upper holder, probably on account of the concentration of heat at that point, and that the shortening is limited in extent to one thirty-second of an inch.

In the poorest lamps of the incandescent order the life of a pencil of carbon prior to the occurrence of the voltaic arc is about five hours. In the best lamps the life of the pencil is in excess of two hundred hours. In some a life of probably a thousand hours will be attained, and it is barely possible that in some lamps the arc may never occur; but practically the manufacture of electric lamps for lighting by incandescence unprovided with a remedy for such destructive changes is so uncertain as to greatly impair the chances of the general introduction of electric lighting.

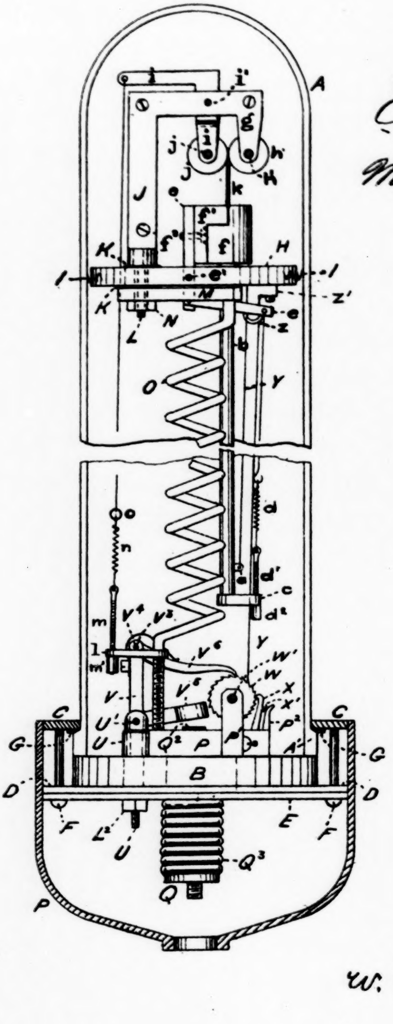
In my present invention I aim directly at this evil, correcting it whenever the voltaic arc occurs by at once establishing new points of contact. I place in the sealed globe a long pencil of carbon, which is fed up from the outside magnetically when necessary, and

4 Sheets—Sheet 1.

W. E. SAWYER.
Electric-Lamps.

No. 219,771. Patented Sept. 16, 1879.

FIG. 1.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L²
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F
U
Q³
Q
P

No. 286
C.E. Light Co.
v.
McK Light Co
p. 4103

WITNESSES.
G. W. Sawyer
Wm Sharp.

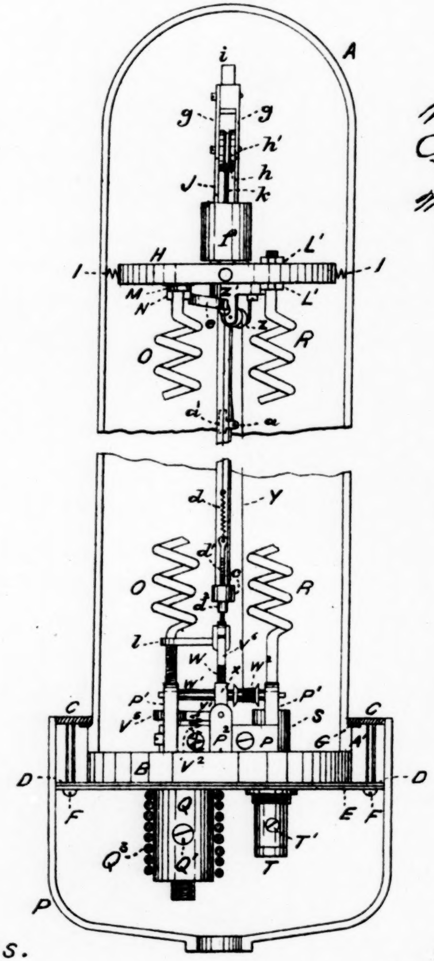
INVENTOR.
W. E. Sawyer.

4 Sheets—Sheet 2.

W. E. SAWYER.
Electric-Lamps.

No. 219,771. **Patented Sept. 16, 1879.**

FIG. 2.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C
C
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D
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E
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Q⁵
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T
P

No. 286
C E Light Co
v.
McK Light Co } p 4104

WITNESSES.
G. W. Sawyer.
W. Sharp

INVENTOR.
W. E. Sawyer.

4 Sheets—Sheet 3.

W. E. SAWYER.
Electric-Lamps.

No. 219,771. Patented Sept. 16, 1879.

No. 286.
C.E. Light Co.
v.
McK. Light Co.
p 4105

FIG. 3.

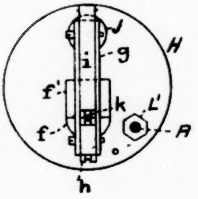
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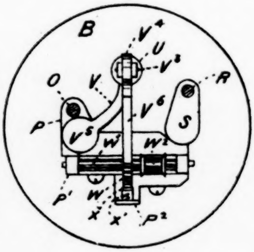
FIG. 4.


B
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V5
S
W'
W2
P'
W
X
X'
P2

WITNESSES.
G. W. Sawyer.
W. Sharp

INVENTOR.
W. E. Sawyer.

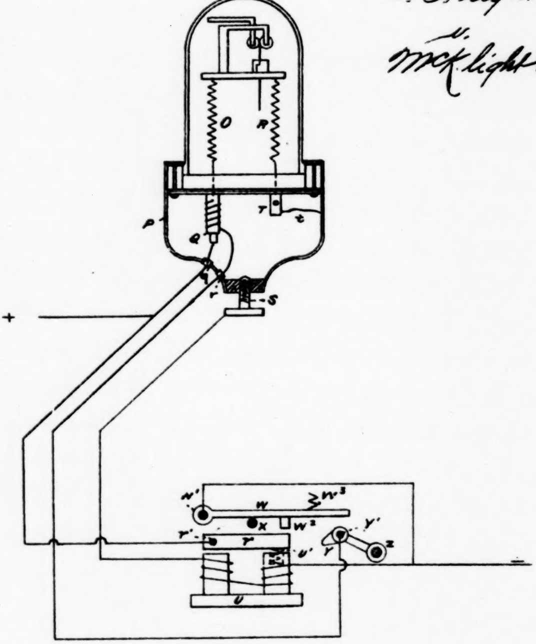
4 Sheets—Sheet 4

W. E. SAWYER.
Electric-Lamps.

No. 219,771. Patented Sept. 16, 1879.

FIG. 5.

No. 286
C. E. Light Co
v.
McK light Co.
p. 4106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W³
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W²
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WITNESSES.
G. W. Sawyer.
W. Sharp.

INVENTOR.
W. E. Sawyer.

a lamp equipped with a pencil seven inches long will be equivalent to at least two hundred and twenty-four of the ordinary lamps, that being the number of times that new points of contact may be established. Hence it follows that as the poorest of the ordinary lamps will run for five hours without the occurr*a*nce of the voltaic arc, an equally poor "feeder" lamp provided with a pencil of carbon seven inches long will run for eleven hundred and twenty hours before renewal of the pencil will be necessary, or, say three hours a day for a year, and the best lamp will have a life of forty-four thousand eight hundred hours, or forty years with an average use of three hours per day.

(Here follow diagrams marked pp. 4103, 4104, 4105, & 4106.)

In the drawings accompanying and forming a part of this specification, figure 1 is a side view of the lamp; Fig. 2, a front view; Fig. 3, a top view of the upper works; Fig. 4, a top view of the feeding mechanism; and Fig. 5, a view of the lamp and its feeding-switch with their connections.

Like letters indicate like parts in all the drawings.

Referring to the drawings, Figs. 1, 2, 3, and 4, A is a glass globe, provided with a rim, A′. B is a glass stopper, ground to the same. C is a metal flange, supported on the rim A′ by any cushioning material, G. D is a wooden flange or cushion, supporting the metal flange E on stopper B. F F are screws, by which the flanges C and E are drawn together to clamp the stopper to the globe. All of this is fully shown and described in the letters patent hereinbefore referred to,

H is a copper diaphragm, into which are let three coiled springs, I, which keep the diaphragm from jarring against the glass, and at the same time hold it firmly in position. Passing through the diaphragm and secured by the nuts L′ is a long coiled copper tube, R, the lower end of which is brazed into off-set nut S, which is drawn to the stopper B by tubular bolt T, in which is a stop-cock, T′.

4108 In charging the globe with a carbon-preservative atmosphere, the gas enters the tubular bolt T, and passes upward through the off-set nut and the coiled tube R to the top of the globe, thus displacing the air, which finds its exit by way of the opening and stop-cock Q′ of the tubular bolt Q, which will be more fully described hereinafter.

Passing through the diaphragm and insulated from the same by mica washers K K is a standard, J, whose bent arm *g* carries a grooved carbon roller, *h*, pivoted at *h′*. Pivoted at *i′* in the bent arm *g* is a second bent arm, *i*, which carries a second grooved carbon roller, *j*, pivoted at *j′*. The standard J is clamped to the diaphragm by nut N on the bolt-extension L of the standard, the offset-piece M under the nut N serving as a connection with the long coiled solid conductor O, the lower end of which screws into the brass offset P, which serves both as the frame-work for a part of the feeding mechanism and as a nut for the tubular bolt Q.

Fixed to coiled conductor O is an arm, *l*, to which is attached the adjusting screw and nut *m m'*, by means of which the tension of spiral spring *n*, connecting with bent arm *i*, is regulated so as to bring the two carbon rollers *j h* together with the requisite pressure, the glass link *o* insulating the arm *l* from the bent arm *i* by way of spring *n*.

Screwing into and through the diaghragm H, on a line with the groove in the carbon rollers *j h*, is a slotted tube, *b*, in which travels a plunger, *a'*, to the offset *a* of which is attached a fine steel wire, Y, which passes upward over pulley Z, pivoted in Z', and thence downward over insulating wooden drum W^2 on shaft W^1, which rotates in standards P^1 P^1 of offset P. Surrounding the end of tube *b* which projects above the diaphragm is a carbon piece, *f*, cut away, as shown.

Pivoted in the diaphragm at *e'* is a bent arm, *e*, to which is fastened carbon piece f^1 by screw f^2. Fixed to the lower end of tube *b* is an arm, *c*, to which is attached the adjusting screw and nut d^1 d^2, by means of which the tension of spiral spring *d*, connecting with bent arm *e*, is regulated so as to bring the carbon jaws $f f^1$ together with the requisite pressure. Inclosed in the tube *b*, and passing between the carbon jaws $f f^1$ and the carbon rollers *j h*, is the long pencil of carbon *k*, by the incandescence of which, in that section which is between the jaws and the rollers, the light is produced; and by the rotation of the drum W^2 this pencil of carbon is fed upward as frequently as may be desired, the rollers *j h* turning slightly to allow for expansion and contraction of the pencil when heated and cooled.

Through the stopper B passes a third bolt, U, secured by nut L^2, and in the upper end of this bolt, at U', is pivoted a bent arm, V, to which is fixed a silver-plated iron disk, V^5, so as to bring the same directly over the end of tube-bolt Q. The tube-bolt Q is of soft iron, and being wound with insulated wire Q^3 constitutes an electro-magnet, one of the poles of which appears at Q^2. The armature V^5 is normally kept away from the magnet Q by spiral spring V^2, which is held in place by pin V^1 in bent arm V, the range of its movement being limited on the one hand by its coming in contact with the pole of the magnet Q^2, and on the other by the shape of that portion of the bent arm V which plays in bolt-head U.

Pivoted in bent arm V at the point V^3 is a pawl, V^6, which engages in the teeth of ratchet-wheel W on shaft W^1, and this pawl is held to its bearing by spring V^4, screwed to the bent arm. Thus at every vibration of the armature V^5 the pawl V^6 moves the ratchet-wheel one tooth, and thereby winds the wire Y upon the drum W^2 and feeds the carbon pencil upward, as will readily be understood without further explanation.

The pawl X, actuated by spiral spring X' from standard P^2, simply locks the rachet-wheel against back action as the pawl V^6 causes it to rotate.

The methods of making the several joints of the lamp air-tight are fully set forth in the letters patent hereinbefore referred to, and in letters patent No. 210,809, dated December 10, 1878, granted jointly to me and to Albon Man, of Brooklyn, New York; and as the same constitute no part of my present invention, I have deemed it unnecessary to again describe them.

Referring now to Fig. 5, in which the connections of the lamp with its feeding-switch are shown, p is a spun metal-cup enclosing the entire base of the lamp, and provided with a threaded opening, by means of which it is screwed to any fixture, s. The current coming from the + point is conducted through the insulating-piece q to the magnet Q, and passes thence by way of conductor O, the carbon pencil k, and conductor R to the bolt T, thence to the spun-metal cup, standard s, and the coils of the electro-magnet u outward to the — point. The armature v of magnet u, pivoted at v', is thus drawn away from the stop x against the force of spiral spring u', let into one of the poles of the magnet. Connected with the armature v outside of the lamp is the conductor leading to magnet Q. When the magnet u is not energized its armature v, forced upward by spring u', makes connection with the contact-piece w^2 of lever w, which is pivoted at w^1, and normally forced against stop x by spring w^3, and in that relation the current passes from the + point around the lamp to armature v, lever w, and outward at the — point. When the circuit of the carbon pencil k is broken the armature v is released and the above circuit established, thus preventing interruption of the light in other lamps in circuit.

One end of the helix of magnet Q is connected with the magnet, as shown. The other end passes through insulating piece r in spun cup p, and thence to crank z, provided with cam y on pin y'. To
energize the magnet Q and feed up the carbon pencil, the
4109 crank z is — lever w, raises the latter from its connection with
armature v; and instead of the current flowing from the +
point to armature v, lever w, and outward at — point, it flows by way of the helix of magnet Q to cam y and lever w outward, thus energizing magnet Q and moving the ratchet-wheel, which feeds the carbon pencil one tooth, and so on until the circuit of the carbon pencil is re-established, when armature v is again attracted and the lamp once more operates.

In describing the lamp of my present invention, I have not considered it necessary to show its combination with a switch for graduating the light, or to indicate the many changes that may be made in the feeding-switch, such as rendering its action automatic by means of an electro-magnetic vibrator or of a circuit-breaker operated in any manner and controlled by magnet u. If desired, the feeding-switch may be combined in the base of the lamp, and there may be two magnets, one, so long as the circuit of the pencil of carbon exists, operating to open the circuit of the other or feeding magnet, and, when the circuit of the carbon pencil no longer exists, operating to permit the feeding-magnet to vibrate its armature until the circuit of the pencil is re-established.

I would have it understood that I disclaim in my present application the broad matter of a switch operating when the circuit of a lamp is interrupted to cut out, short-circuit, or throw a shunt around the lamp.

Having thus fully described my invention, what I claim as such, and desire to secure by letters patent, is—

1. In an electric lamp, the combination, first, of the diaphragm H, tube *b*, hinged piece *e*, and jaws $f\ f^1$; second, of the diaphragm H, tube *b*, hinged piece *e*, jaws $f\ f^1$, and spring *d;* third, of the diaphragm H, the tube *b*, and the two carbon-holders *h* and *j;* fourth, of the diaphragm H, the two carbon-holders f^1 and *j*, free to move laterally, and the two carbon-holders *f* and *h*, prevented from moving laterally; fifth, of the two holders f^1 and *j*, free to move laterally, and the two holders *f* and *h*, prevented from moving laterally.

2. In an electric lamp in which light is produced by the incandescence of a carbon piece, rod, or pencil, the combination, first, of the carbon-holding tube *b*, the jaws $f\ f^1$, the carbon piece, rod, or pencil *k*, the follower or plunger a', the flexible wire Y, the pulley Z, and the drum W^2, constructed and operating substantially as shown and described; second, of the standard J, the rigid carbon-holder *g*, and the jointed carbon-holder *i;* third, of the carbon-holding tube *b*, the upper and lower contact jaws, $f\ f^1$ and *h j*, and an electric apparatus operating to feed the incandescent carbon piece, rod, or pencil to a new contact when required or desired; fourth, of the tubular conductor R, the offset-nut S, and tube-bolt T; fifth, of the bolt Q, offset-nut P, standards $P'\ P'$, shaft W^1, and ratchet-wheel W; sixth, of the magnet Q and bolt U, passing through the stopper B of the lamp, as and for the purpose specified.

3. In an electric lamp in which light is produced by the incandescence of a carbon piece, rod, or pencil, the combination of the diaphragm H and springs I, as and for the purpose specified.

4. The feeding-switch *u*, *v*, *w*, and *y*, in combination with the magnet Q.

5. The combination, with an electric lamp in which a carbon rod, piece, or pencil is fed to a new contact when required or desired, of a switch which shifts the current into and from the coils of an electro-magnet by which the feeding mechanism is actuated without destroying the continuity of the circuit.

WILLIAM EDWARD SAWYER.

Witnesses:
W. SHARP.
THOS. CROCKER.

4111

United States Patent Office.

Thomas A. Edison, of Menlo Park, New Jersey.

Electric Lamp.

Specification forming part of Letters Patent No. 223,898, dated January 27, 1880. Application filed November 4, 1879.

To all whom it may concern:

Be it known that I, Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, have invented an improvement in electric lamps, and in the method of manufacturing the same, (case No. 186,) of which the following is a specification.

The object of this invention is to produce electric lamps giving light by incandescence, which lamps shall have high resistance, so as to allow of the practical subdivision of the electric light.

The invention consists in a light-giving body of carbon wire or sheets coiled or arranged in such a manner as to offer great resistance to the passage of the electric current, and at the same time present but a slight surface from which radiation can take place.

The invention further consists in placing such burner of great resistance in a nearly-perfect vacuum, to prevent oxidation and injury to the conductor by the atmosphere. The current is conducted into the vacuum-bulb through platina wires sealed into the glass.

The invention further consists in the method of manufacturing carbon conductors of high resistance, so as to be suitable for giving light by incandescence, and in the manner of securing perfect contact between the metallic conductors or leading-wires and the carbon conductor.

Heretofore light by incandescence has been obtained from rods of carbon of one to four ohms resistance, placed in closed vessels, in which the atmospheric air has been replaced by gasses that do not combine chemically with the carbon. The vessel holding the burner has been composed of glass cemented to a metallic base. The connection between the leading-wires and the carbon has been obtained by clamping the carbon to the metal. The leading-wires have always been large, so that their resistance shall be many times less than the burner, and, in general, the attempts of previous persons have been to reduce the resistance of the carbon rod. The disadvantages of following this practice are, that a lamp having but one to four ohms resistance cannot be worked in great numbers in multiple arc without the employment of main conductors of enormous dimensions; that, owing to the low resistance of the lamp, the leading-wires must be of large dimensions and good conductors, and a glass globe cannot be kept tight at the place where the wires pass in and are cemented; hence the carbon is consumed, because there must be almost a perfect vacuum to render the carbon stable, especially when such carbon is small in mass and high in electrical resistance.

The use of a gas in the receiver at the atmospheric pressure, although not attacking the carbon, serves to destroy it in time by "air-washing," or the attrition produced by the rapid passage of the air over the slightly-coherent highly-heated surface of the carbon. I have reserved this practice. I have discovered that even a cotton thread properly carbonized and placed in a sealed glass bulb exhausted to one-millionth of an atmosphere offers from one hundred to five hundred ohms resistance to the passage of the current, and that it is absolutely stable at very high temperatures; that if the thread be coiled as a spiral and carbonized, or if any fibrous vegetable substance which will leave a carbon residue after heating in a closed chamber be so coiled, as much as two thousand ohms resistance may be obtained without presenting a radiating-surface greater than three-sixteenths of an inch; that if such fibrous material be rubbed with a plastic composed of lamp-black and tar, its resistance may be made high or low, according to the amount of lamp-black placed upon it; that carbon filaments may be made by a combination of tar and lamp-black, the latter being previously ignited in a closed crucible for several hours and afterward moistened and kneaded until it assumes the consistency of thick putty. Small pieces of this material may be rolled out in the form of wire as small as seven-one-thousandths of an inch in diameter and over a foot in length, and the same may be coated with a non-conducting non-carbonizing substance and wound on a bobbin, or as a spiral, and the tar carbonized in a closed chamber by subjecting it to high heat, the spiral after carbonization retaining its form.

All these forms are fragile and cannot be clamped to the leading-wires with sufficient force to insure good contact and prevent heating. I have discovered that if platinum wires are used and the plastic lamp-black and tar material be molded around it in
4112 the act of carbonization there is an intimate union by combination and by pressure between the carbon and platina, and nearly perfect contact is obtained without the necessity of clamps; hence the burner and the leading-wires are connected to the carbon ready to be placed in the vacuum-bulb.

When fibrous material is used the plastic lamp-black and tar are used to secure it to the platina before carbonizing.

By using the carbon wire of such high resistance I am enabled to use fine platinum wires for leading-wires, as they will have a small resistance compared to the burner, and hence will not heat and crack the sealed vacuum-bulb. Platina can only be used, as its expansion is nearly the same as that of glass.

By using a considerable length of carbon wire and coiling it the exterior, which is only a small portion of its entire surface, will form the principal radiating-surface; hence I am able to raise the specific heat of the whole of the carbon, and thus prevent the rapid reception and disappearance of the light, which on a plain wire is prejudicial, as it shows the least unsteadiness of the current by the flickering of the light; but if the current is steady the defect does not show.

I have carbonized and used cotton and linen thread, wood splints,

T. A. EDISON.
Electric-Lamp.

No. 223,898. **Patented Jan. 27, 1880.**

No. 286.
C. E. Light Co.
v.
McK. Light Co.
p. 4110

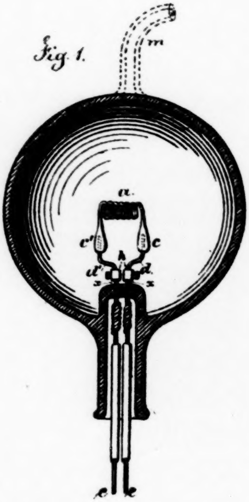
Fig. 1.
m
a
c'
c
h
d'
d
x
x
e
e

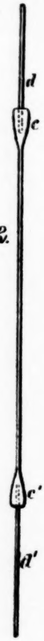
Fig. 2.

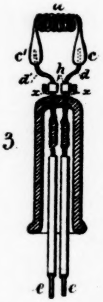
Fig. 3.
a
c'
c
h
d'
d
x
x
e
c

Witnesses
Chas H. Smith
Geo. T. Pinckney

Inventor
Thomas A. Edison
per Lemuel W. Serrell
atty

papers coiled in various ways, also lamp-black, plumbago, and carbon in various forms, mixed with tar and kneaded so that the same may be rolled out into wires of various lengths and diameters. Each wire, however, is to be uniform in size throughout.

If the carbon thread is liable to be distorted during carbonization it is to be coiled between a helix of copper wire. The ends of the carbon or filament are secured to the platina leading-wires by plastic carbonizable material, and the whole placed in the carbonizing-chamber. The copper, which has served to prevent distortion of the carbon thread, is afterward eaten away by nitric acid, and the spiral soaked in water, and then dried and placed on the glass holder, and a glass bulb blown over the whole, with a leading-tube for exhaustion by a mercury-pump. This tube, when a high vacuum has been reached, is hermetically sealed.

With substances which are not greatly distorted in carbonizing, they may be coated with a non-conducting non-carbonizable substance, which allows one coil or turn of the carbon to rest upon and be supported by the other.

(Here follows diagram marked p. 4110.)

In the drawings, figure 1 shows the lamp sectionally. *a* is the carbon spiral or thread. *c c'* are the thickened ends of the spiral, formed of the plastic compound of lamp-black and tar. *d d'* are the platina wires. *h h* are the clamps, which serve to connect the platina wires, cemented in the carbon, with the leading-wires *x x*, sealed in the glass vacuum-bulb. *e e* are copper wires, connected just outside the bulb to the wires *x x*. *m* is the tube (shown by dotted lines) leading to the vacuum-pump, which, after exhaustion, is hermetically sealed and the surplus removed.

Fig. 2 represents the plastic material before being wound into a spiral.

Fig. 3 shows the spiral after carbonization, ready to have a bulb blown over it.

I claim as my invention—

1. An electric lamp for giving light by incandescence, consisting of a filament of carbon of high resistance, made as described, and secured to metallic wires, as set forth.

2. The combination of carbon filaments with a receiver made entirely of glass and conductors passing through the glass, and from which receiver the air is exhausted, for the purposes set forth.

3. A carbon filament or strip coiled and connected to electric conductors so that only a portion of the surface of such carbon conductors shall be exposed for radiating light, as set forth.

4. The method herein described of securing the platina contact-wires to the carbon filament and carbonizing of the whole in a closed chamber, substantially as set forth.

Signed by me this 1st day of November, A. D. 1879.

THOMAS A. EDISON.

Witnesses:
S. L. GRIFFIN.
JOHN F. RANDOLPH.

Correction in Letters Patent No. 223,898.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *December* 18, 1883.

In compliance with the request of the party in interest, letters patent No. 223,898, granted January 27, 1880, to Thomas A. Edison, of Menlo Park, New Jersey, for an improvement in " electric lamps," is hereby limited so as to expire at the same time with the patent of the following named, having the shortest time to run, viz: British patent dated November 10, 1879, No. 4576; Canadian patent dated November 17, 1879, No. 10654; Belgian patent dated November 29, 1879, No. 49884; Italian patent dated December 6, 1879, and French patent dated January 20, 1880, No. 133,756.

It is hereby certified that the proper entries and corrections have been made in the files and records of the Patent Office.

This amendment is made that the United States patent may conform to the provisions of section 4887 of the Revised Statutes.

BENJ. BUTTERWORTH,
Commissioner of Patents.

Approved:

M. L. JOSLYN,
Acting Secretary of the Interior.

4115

UNITED STATES PATENT OFFICE.

ALBON MAN, of Brooklyn, New York.

Electric Lamp.

Specification forming part of Letters Patent No. 227,118, dated May 4, 1880. Application filed March 31, 1880. (No model.)

To all whom it may concern:

Be it known that I, Albon Man, of Brooklyn, in the county of Kings and State of New York, have invented certain new and useful improvements in electric lamps, of which the following is a description in such full, clear, exact, and concise terms as to enable any one skilled in the arts or sciences to which it appertains or with which it is most nearly connected to make and use the same, reference being had to the annexed drawings, making part of this specification, and to the figures and letters of reference marked thereon.

In incandescent electrical lights positive electrical connection equal to or greater than the conducting power of the incandescent pencil must be made with the pencil in order to prevent the occurrence of an electrical arc, which immediately destroys the pencil itself. Tension, torsion, or compression upon the pencil acts in the end, by continual repetition, to destroy it.

Expansion and contraction of the electrical supporters or connections of the pencil, causing or tending to cause motion of the pencil in any direction other than that in which it can freely move, puts tension upon it, and sooner or later destroys it. The more yielding the parts sustaining the pencil (while at the same time making electrical connections) can be made the smaller the pencil or light-giving portion may be made, and the smaller the pencil the greater the amount of light that may be obtained by passing a given current of electricity through it.

It is evident that one end of the pencil may be rigidly held if the other is flexibly connected; but at the same time such other end must be sustained laterally and prevented from vibrating or moving in any direction other than in the line of its axis.

I prefer to place the pencil in an upright position, as in this position it is less likely to give way under the high heat to which it is subjected, and it can be more readily attached to its supports, and such supports in this position do not so much interfere with the radiation of its light.

It is to accomplish these results and purpose that I have devised the following method of making and supplying the incandescent portion of an electric lamp, that the expansion and contraction of the two parts caused by the heat of electricity shall be equal, the expansion of one part neutralizing the expansion of the other and the contracting of one part neutralizing the contraction of the other in all directions, except in the direction of the axis of the pencil or light-giving portion of the circuit supported by these parts.

My invention appertains to sealed incandescent electric lamps; and it consists, first, of hermetically joining and sealing, with a tight metal joint, the globe of the lamp, made of glass, porcelain, or other similar material, through which the light is radiated, to its base, bottom, stopper, and all the other parts or fittings appertaining to it, by which it is made a completely hermetically-sealed lamp, while providing at the same time for free flow of the electric current or circuit through the lamp, and also for exhausting the atmosphere and charging the lamp with a carbon-preservative gas or atmosphere; second, of a symmetrical suspending electrical connection to the top part of the incandescent carbon pencil, consisting of a divided metallic conductor arranged to embrace, hold, and support the pencil, and to equally divide the current going to and from it, so that the expansion and contraction of the supporting parts shall be equal, the expansion occasioned by the passage of the electric current through one part of the supporting-conductor being equalized by the passage of an equal amount through the other part, the object being to maintain all the supporting parts of the pencil in their normal relative position—that is, not affected in their relative position by the heat of the current through them, or by the heat of the incandescent portion of the lamp; third, of an electrical connection and support to the lower portion of the pencil, consisting of a divided conductor, whose expansion and contraction, occasioned by the passage of the current, will equalize each other, and thus prevent any lateral motion of the pencil, while at the same time it is left free to expand and contract in the line of its axis; fourth, of an electrical suspending-
4116 support for the carbon pencil of an incandescent electric
lamp, consisting, substantially, of a yoke constructed and arranged symmetrically with reference to the pencil, as a conductor of heat and electricity, that the only motion given to the pencil by expansion and contraction through its support shall be in the line of its axis; fifth, of an electrical connection with the opposite end of a suspended carbon pencil, consisting of two semi-cylindrical grooved pieces of carbon united upon the pencil by wires or a clamping-ring, and in the embrace of yielding metallic connection, equally divided and disposed around it in such relation and manner that the expansion and contraction on all sides and in all parts shall be equal, in so far as there may be any tendency to throw the pencil out of its normal position laterally; sixth, of an electrical connection to the top and bottom end of the carbon pencil of an incandescent electric lamp, consisting of equally-divided metal electric conductors, united to the pencil at top and bottom by dividing and intervening pieces of carbon, the bottom conductor being not only equally divided, but also made yielding to avoid weight, pressure, and tension upon the pencil; seventh, of an electrical connection to the lower end of the carbon pencil, consisting of a yielding conductor divided equally around it, and arranged to allow it freedom of motion in the line of its axis and at the same time avoid all lateral or torsionate strain upon it.

(No Model.) 2 Sheets—Sheet 1.

A. MAN.

Electric Lamp.

No. 227,118. **Patented May 4, 1880.**

No. 286.
C. E. light Co.
v.
McK. light Co.
} p. 4113

FIG. 1.

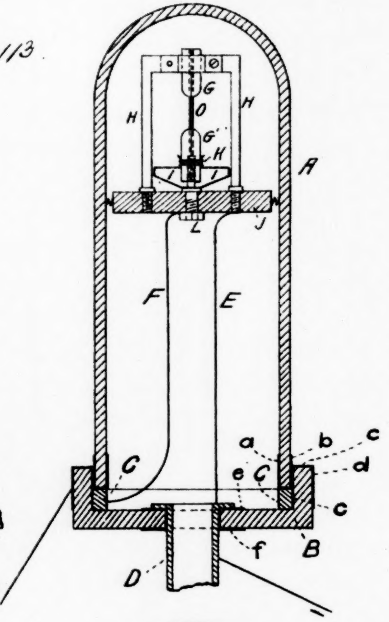
G
O
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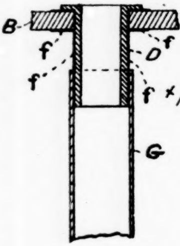
FIG. 3.



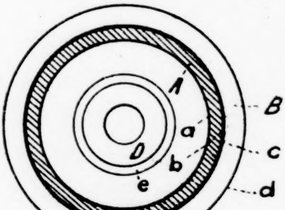


FIG. 2.

WITNESSES.

Chas. C. Bull
Wm. H. Broadnax

INVENTOR.

Albon Man
By Amos Broadnax Atty.

No. 286.
C. E. Light Co.
v.
McK. Light Co } p. 4114

(No Model.) 2 Sheets—Sheet 2.

A. MAN.
Electric Lamp.

No. 227,118. **Patented May 4, 1880.**

FIG. 4.

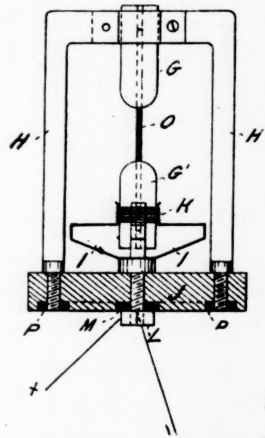

H
G
O
H
H
G'
K
I
I
J
P
M
L
P
+
-

FIG. 7.

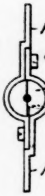


FIG. 5.

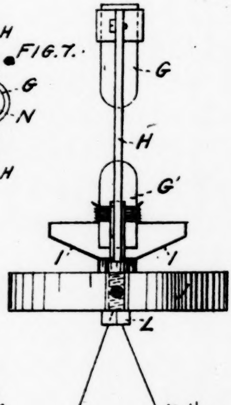


FIG. 6.

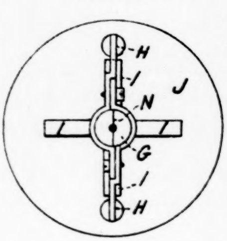


FIG. 9.

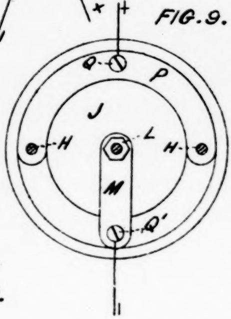


FIG. 8.

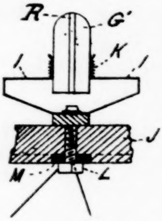
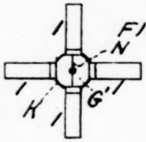


FIG. 10.



WITNESSES.

Wm. A. Shaw
Wm. H. Broadnax

INVENTOR.

Albon Man. By his Atty
Amos Broadnax

A detail description of the first part of my invention is as follows:

(Here follow diagrams marked pp. 4113 and 4114.)

In the drawings the globe of the lamp is shown by A. It is made of glass, porcelain, or any similar material suitable for the radiation of light. The base or stopper of the lamp is shown by B. It may be made of any of the materials aforesaid, or it may be made wholly of metal; but if made of metal proper provisions must be made for insulating the conducting-wires through it in and out of the lamp.

Assuming, now, the base or stopper of the lamp to be made of glass, the joint between it and the globe is made and sealed as follows:

The surface of the globe at *a* and *b* and the surface of the stopper or base at *c d* and *e f* are first metallized—that is, covered or filled with metal—either by fire-gilding, silvering, or platinizing in the ordinary method of fire-gilding, silvering, platinizing, or otherwise metallizing the surface of glass, porcelain, crockery, stoneware, and other similar material. These parts, having been thus metallized, are put into an electroplating bath or solution and electroplated by the ordinary process of electroplating. In the base of the lamp a narrow metal ring, *c*, is fitted, upon which the bottom end of the globe sets. The parts, being thus prepared, are brought together and are united, joined, and sealed with solder applied to the electroplated parts of the base and globe of the lamp.

Instead of first electroplating the several parts and afterward uniting them with solder, as above described, I can secure them together after metallizing them, and put them thus united in the electroplating-bath and electroplate directly upon the metallized surface and over the joints or parts of contact, thus making a solid metal joint by electroplating instead of soldering.

The drawings show a tube, D, which may be of glass or metal, and which is joined with a tight joint to the base or stopper of the lamp, in the same way the globe is joined to the base. The object of this tube is to furnish means to charge the lamp with the carbon-preservative atmosphere, or to exhaust the air out of it.

In case the tube be made of glass or porcelain, it must be thoroughly metallized and electroplated in the joint to make it a conductor of electricity, and means (connecting-post) must be supplied to connect the wires; but there is no objection to making the tube of metal and joining it to the base or stopper, as above described, the wire E being connected to the upper end of the tube and the wire F to the metallic ring *c* in contact with the electroplating and solder of the joint, the positive and negative poles being applied as shown, the connection being made by any of the well-known means.

My intention is to make the tube D of lead or other soft metal and use it as part of the conducting-circuit, and as means of finally sealing the lamp after it has been exhausted of air and charged with a carbon-preservative gas or atmosphere, the conducting-wire to be connected to the outer and inner end of the tube, or carried through the tube or its wall into the globe of the lamp, the sealing being accomplished by forcing the walls of the tube together and sealing it with a blow-pipe or with solder.

The second part of my invention is shown in the drawings, more especially by Figs. 4, 5, and 7. It consists of a divided conductor, the two parts of which are shown by H H. These conductors are made of metal, of equal size and of equal conducting power. Their upper ends are formed in the shape of a yoke, the two parts of which are made exactly symmetrical with reference to each other, and are clamped by means of screws upon two grooved semicircular pieces of carbon, G, in which the illuminating-pencil *o* is held. These pieces of semi-cylindrical grooved carbon are to be made exactly of the same size, divided in the center longitudinally, the dividing-joint N to be arranged upon the line of the joint of the yoke, as shown by Figs. 6 and 7.

Upon the bottom ends of the divided conductors H H a screw-shank is made, that passes through holes in the soapstone diaphragm-plate J and screws into the respective ends of a semicircular
4117 metal conductor, P, set in the bottom side of the diaphragm-plate J, as shown by Figs. 4 and 9 of the drawings.

The points of contact between the lower ends, H, of the divided conductor with the plate P are exactly equidistant from the +-point Q, the two ends of the plate from that point being made of exactly the same volume and conducting power. By these means the current entering at Q is made to divide equally and enter the illuminating-pencil *o* from both sides with equal intensity, equally heating and expanding the two branches of the conductor, from the top of which the carbon pencil is suspended, thus avoiding all lateral or torsionate strain upon the illuminating-pencil, while at the same time it is left free to expand and contract upon the line of its longitudinal axis, the dividing conductor acting as a divided electrical support of equal expanding capacity, between which the carbon pencil is suspended, and by which all lateral or torsionate strain upon it is avoided.

The third point of my invention is more especially illustrated by Figs. 8 and 10 of the drawings, though its connection with the other parts of the invention is especially shown by Figs. 4 and 5, and incidentally by the other figures of the drawings. It consists of a divided metal conductor composed of strips of thin metal, forged and arranged substantially in the form of two elliptical springs set across each other, as shown by I, Figs. 8 and 10, for the support of the lower end of the carbon pencil. These elliptical springs or strips of metal are all of equal length, size, volume, and conductivity electrically. They are set across each other equidistant apart, and are held to the diaphragm-disk J by means of a screw, L, reaching down and making contact with the piece U, to which the —-pole is connected at Q′.

The top ends of the elliptics are turned up, as at *k*, forming together an open slotted socket of the ends of the several strips of metal, into which is inserted a cylindrical piece of carbon, G′, divided longitudinally in the center, and grooved, as shown by R, to receive the lower part of the carbon pencil. The carbon-support G′ is secured in the divided elliptical conductors and the pencil in the carbon-support by means of wire wrapped around the slotted socket, or by means of a clamping-ring upon the socket, as may be most convenient. By these means the lower part of the carbon pencil is supported upon a divided electric conductor yielding and equal on all sides, and the carbon pencil is allowed to expand and contract in the line of its axis, while at the same time all tensile, torsionate, or lateral strain upon it is avoided.

The shape and size of the elliptical or divided conductors must be substantially alike on all sides, that the expansion, contraction, and electrical conducting power may be alike on all sides and the normal position of the carbon pencil with reference to its connections and supports be equally maintained.

The fourth, fifth, sixth, and seventh parts of my invention are fully described in the description given above of the second and third parts of it. A description of these two parts includes a description of the above-mentioned four.

Having described my invention, I claim and desire to secure by letters patent—

1. Hermetically sealing and joining the globe and stopper of an electric lamp by electroplating and solder, or by electroplating alone, applied to the metallized surfaces of the parts joined, preserving at the same time the insulation of the electric circuit through the lamp, substantially as described.

2. A soft-metal tube hermetically joined with a metal joint to the glass bottom or stopper, as part of the electric circuit in the lamp, and for the purpose of filling, exhausting, and finally sealing it, substantially as described.

3. A symmetrical suspending electrical connection to the top part of the incandescent carbon pencil, consisting of a divided metallic conductor arranged to embrace, hold, and support the pencil, and to equally divide the current going to and from it, so that the expansion and contraction of the supporting parts shall be equal, substantially as described.

4. An electrical connection and support to the lower portion of the pencil, consisting of a divided conductor whose expansion and contraction, occasioned by the passage of the current, will equalize each other, and thus prevent any lateral motion of the lower portion of the pencil, while at the same time it is left free to expand and contract in the line of its axis, substantially as described.

5. An electrical suspending support for the carbon pencil of an incandescent electric lamp, consisting, substantially, of a yoke constructed and arranged symmetrically with reference to the pencil, as a conductor of heat and electricity, that the only motion given to the pencil by expansion and contraction through its support shall be in the line of its axis.

6. An electrical connection with the opposite ends of a suspended carbon pencil, consisting of two semi-cylindrical grooved pieces of carbon united upon the pencil by wire or a clamping-ring, and in the embrace of yielding metallic connection, equally divided and

disposed around it in such relation and manner that the expansion and contraction on all sides and in all parts shall be equal, in so far as there may be any tendency to throw the pencil out of its normal position laterally.

7. An electrical connection to the top and bottom end of the carbon pencil of an incandescent electric lamp, consisting of equally-divided metal electric conductors united to the pencil at top and bottom by divided and intervening pieces of carbon, the bottom conductor being not only equally divided, but also made yielding to avoid weight, pressure, and tension upon the pencil. 4118

8. An electrical connection to the lower end of a yielding conductor, divided equally around it, and arranged to allow it freedom of motion in the line of its axis and at the same time avoid all lateral or torsionate strain upon it.

ALBON MAN.

Witnesses:
WM. H. ALLEE.
ROBERT M. STRATTON.

4119

UNITED STATES PATENT OFFICE.

WILLIAM E. SAWYER, of New York, and ALBON MAN, of Brooklyn, N. Y., assignors to Electro-Dynamic Light Company.

Carbon for Electric Lights.

Specification forming part of Letters Patent No. 229,335, dated June 29, 1880. Application filed November 22, 1878.

To all whom it may concern:

Be it known that we, William Edward Sawyer, of the city, county, and State of New York, and Albon Man, of Brooklyn, county of Kings, and State aforesaid, have jointly invented certain improvements in carbons for electric lights; and we do hereby declare the following to be a description of the same, and of the manner and process of making, constructing, and using them, in such full, clear, concise, and exact terms as will enable any person skilled in the art or science to which it appertains, or with which it is most nearly connected, to make, construct, and use the same, reference being had to certain letters patent of the United States heretofore granted to us for certain inventions hereunto appertaining, and to which especial reference will hereinafter be made.

Our invention consists of a new article of manufacture, consisting of an improved illuminating conductor for electric lamps, composed of consolidated carbon created by electric action.

In letters patent of the United States No. 205,144, granted to us, we have shown and described an electric lamp, in which a pencil of carbon is heated to in candescence in a nitrogen or other carbon-preservative atmosphere.

One of the principal obstacles to successful electric lighting by incandescence is the dissociated character of nearly all obtainable carbon. In most of such carbon there is danger of fracture as well as of the establishment of the voltaic arc; and, furthermore, the carbon, unless specially prepared by our process, naturally occludes sufficient air or oxygen to render its consumption a mere question of time, since, as fully set forth in the letters patent referred to, the least quantity of oxygen in a sealed lamp is sufficient to combust an indefinite quantity of carbon.

As is well known, carbon suitable for electric lighting by the voltaic arc is naturally produced in gas retorts; but generally the rods of carbons used in the "regulator lamps," so-called, are molded from the powdered material. Neither the one nor the other quality of carbon is suitable for electric lighting by incandescence. In both there is a lack of homogeneity. The pencil is not sufficiently hard and dense, because, in the first place, the heat required to produce the proper character of carbon is as high as 7,000° Fahrenheit, and such a temperature is not obtainable in the retort; and in the second place the mechanical subdivisions of the material and the pressure necessary to produce the perfect article are practically unattainable. Carbon of the ordinary sort, when heated by the electric current, exhibits points and lines of unequal brilliancy. Carbon prepared by our process, when so heated, glows with a uniform brilliancy throughout.

We have found that a pencil of carbon immersed in a hydrocarbon gas or liquid and heated to an extremely high temperature by the voltaic current is not itself attacked, but decomposes the surrounding matter, the carbon of which enters and fills up its pores to an extent impossible except with matter in a very attenuated state, and deposits a perfectly homogeneous layer, generally of a bright gray color, upon the exterior surface. As the carbon increases in size more current is required to maintain its temperature, and if the current is gradually increased in accordance with the demand for it there is appearingly no limit to the increase in mass of the homogeneous exterior deposit. Carbon pencils may be cut from this deposit, or the original pencil with its coating may be used in the lamps.

In this process it would seem that the carbon is never in contact with the liquid in which it is immersed, but surrounded by a carbon gas of a very high temperature. Naphtha, turpentine, beeswax, balsam, and most oils, if pure, operate satisfactorily. Almost any hydrocarbon, in fact, will answer.

We do not confine ourselves to the treatment of carbon alone, since it is obvious that many infusible substances, non-conductors of electricity, may be heated in hydrocarbon liquids or gases, so as to render them conductors of electricity—as, for instance, a tube of lime inclosing a pencil of carbon, through which the electric current is caused to circulate.

4120 In the letters patent hereinbefore referred to we have described a method of charging a sealed globe with pure nitrogen gas. We will suppose that the pencil of carbon, held between two carbon pieces of greater mass than that of the pencil, as shown in the said letters patent, is immersed in the hydrocarbon liquid and heated in the manner already described. Being then cleansed in alcohol, the pencil and its holders, without having been disturbed, are placed in the globe, in which they are to be hermetically sealed. The globe is charged with pure nitrogen, and then, while still allowing pure nitrogen to flow into and out of the globe, we heat the carbon to incandescence, thus driving out all impurities and occluded gases, which are carried out of the lamp by the current of nitrogen.

With this operation the preparation of the carbon is completed, and the lamp, now being hermetically sealed, as described in the letters patent referred to, is ready for use.

Having thus described our invention, we claim and desire to secure by letters patent—

Carbon consolidated and purified by electrically treating it, in combination with a carbonaceous substance, for the production of electric burners.

WILLIAM EDWARD SAWYER.
ALBON MAN.

Witnesses:

AMOS BROADNAX.
THOS. CROCKER.

2 Sheets—Sheet 1.

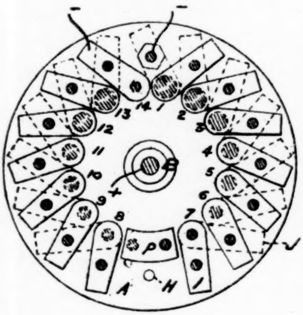
W. E. SAWYER & A. MAN.

Electric Switch.

No. 229,476.

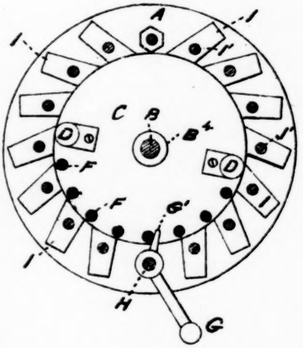
Patented June 29, 1880.

FIG. 1.



−
−
14
1
2
3
4
5
6
7
8
9
10
11
12
13
B
x
p
J
A
H
1

FIG. 2.



A
1
1'
1
C
B
B⁴
D
D
F
F
J'
G'
1
1'
H
G

FIG. 3.

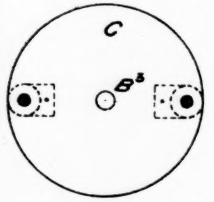
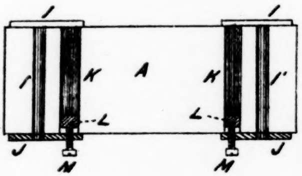
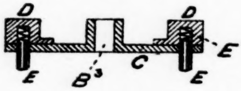


FIG. 4.



1
1
1
K
A
K
1'
L
L
J
M
M
J

FIG. 5.



No. 286.
C. E. Light Co.
v.
McK. Light Co.
} p. 4121

WITNESSES.

F. S. Miller Jr
Wm. H. Broadnax

INVENTORS.

William E. Sawyer
Albon Man By
Amos Broadnax
Atty

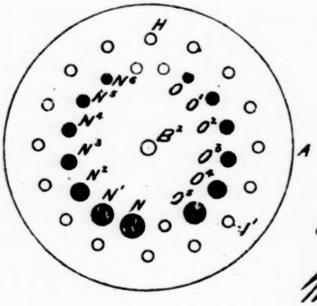
2 Sheets—Sheet 2.

W. E SAWYER & A. MAN.

Electric Switch.

No. 229,476. Patented June 29, 1880.

FIG. 6.


H
N⁶
N⁵
N⁴
N³
N²
N¹
N
O
O¹
O²
O³
O⁴
O⁵
B²
A
I'

No. 286.
C. E. Light Co.
v.
McK. Light Co.
} p 4132

FIG. 7.

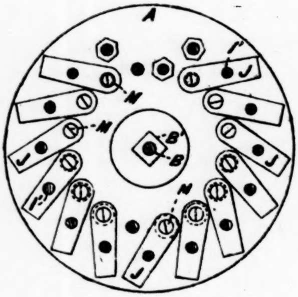
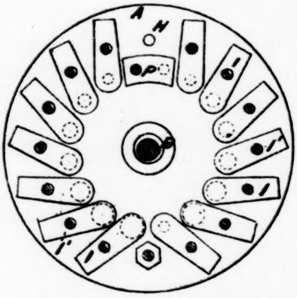

A
I'
J
N
M
B'
B
J
J
I'
N
J

FIG. 8.



WITNESSES.

J. S. Miller Jr
William H. Broadnax

INVENTORS.

William E. Sawyer
Albon Man By
Amos Broadnax Atty

4123

UNITED STATES PATENT OFFICE.

WILLIAM E. SAWYER, of New York, and ALBON MAN, of Brooklyn, N. Y., assignors to Electro Dynamic Light Company.

Electric Switch.

Specification forming part of Letters Patent No. 229,476, dated June 29, 1880. Application filed December 5, 1878.

To all whom it may concern:

Be it known that we, William Edward Sawyer, of the city, county, and State of New York, and Albon Man, of Brooklyn, county of Kings, and State aforesaid, have jointly invented certain new and useful improvements in electric switches for dividing and regulating the application of electric currents to electric lamps; and we do hereby declare the following to be a description of our invention, and of the manner and process of making, constructing, and using the same, in such full, clear, concise, and exact terms as to enable any person skilled in the art or science to which it appertains, or with which it is most nearly connected, to make, construct, and use the same, reference being had to the accompanying drawings, making part of this specification, and to the figures and letters of reference marked thereon, and also to letters patent allowed to us for switches for electric lights, November 15, 1878.

In this switch the mode of operation in its relation to the lamp is substantially the same as that of the letters patent allowed to us as aforesaid; but this switch differs from that in its mechanical construction and in the material of which it is constructed, by which all danger or inconvenience arising from the heat of the current is avoided.

The frame of this switch is composed of soapstone or other non-conductor of heat that can be readily worked in the desired form, and instead of resistances formed of metallic conductors, as in the patent above referred to, we employ either broken or powdered carbon or carbon rods packed in tubes formed or set in the frame of the switch.

(Here follow diagrams marked pp. 4121 & 4122.)

Reference being had to the drawings, A is a disk of plaster of paris, soapstone, or other heat-resisting material, perforated, as shown in Fig. 6, the black circles being those which are filled with carbon, the others being for the rods and connections by which the several parts are clamped together.

On the top side of the disk are set fourteen metallic pieces, I, and on the bottom side thirteen similar pieces, J. These pieces are arranged as shown, and drawn firmly together and down upon the disk A by screw-rods I′, the position they hold with respect to each other being clearly shown in Fig 1, wherein the full lines represent the pieces I upon the top of the disk and the dotted lines the pieces J upon the under side of the disk. The enlarged ends of the pieces I J cover the holes N O through the disk, the pieces I acting as a stopper to the upper end of the hole. The hole being packed with carbon K, Fig. 4, the plunger L is put into the lower end, and by means of screw M in pieces J the plunger L is caused to exert any required pressure upon the carbon, thus making perfect connection with the carbon and enabling its resistance to be changed, if desired.

Through hole B^2 passes a stud, B, drawn down upon the disk A by nut B′ on the under side of the disk, and turning upon this stud is a metallic disk, C, Figs. 2 and 3, through the hole B^3 of which the stud passes, the disk C being secured in place by nut B^4, Fig. 2, on the upper end of stud B.

On the disk C are two brackets, D D, drilled partly through from the under side of the disk. In the circular cavities thus made, actuated by spiral springs E′, work the two plungers E, which, as the disk is turned, make connection with the faces of the pieces I. The disk is further provided with eight pins, F, in which the pin G′ of crank-key G, working on stud H, engages, precisely the same as in the letters patent referred to. Referring to those letters patent, the current, as shown in Fig. 1, enters from the + side at the stud B, and thence through disk C and its plunger E, and when the lamp is not in circuit it passes outward by way of piece I (numbered 1) and the carbon resistance N, which has the same resistance as that of the lamp. When the lamp is fully lighted the current passes outward by way of piece I, (numbered 14,) and through the lamp.

The object of the piece P is merely to keep the plungers E from dropping out of place. Supposing the resistance of the lamp is .95 ohm, the resistance N, Fig. 6, corresponding to piece I, No. 1, of Fig. 1, is .95 ohm. When the lamp is completely out of the circuit one of the studs E is bearing upon piece I, No. 1, and the other stud E is bearing upon the blank piece P, with which there is no connection. 4124 A single turn of the crank brings the studs upon pieces I, Nos. 2 and 8, and the current divides, three-fourths of it flowing, by way of pieces 2, carbon resistance N′, of $.31\frac{2}{3}$ ohm, piece J, and bolt I′, to piece I, No. 1, and resistance N, of .95 ohm, outward, and one-fourth of it flowing, by way of piece 8, carbon resistance O, of 1.9 ohm, and thence by piece J and bolt I′ to piece 9; thence through carbon resistance O′, of .38 ohm, and so on through carbon resistances O^2, of $.25\frac{1}{3}$ ohm, O^3, of $.18\frac{2}{21}$ ohm, O^4, of $.07\frac{5}{21}$ ohm, and O^5, of $.06\frac{1}{3}$ ohm, and thence, through piece J and bolt I′, to piece 14 and the lamp. The total resistance of the first or shunt circuit is therefore $1.26\frac{2}{3}$ ohm, and that of the lamp circuit, including the lamp, is 3.8 ohms, making the joint resistance .95 ohm. The resistance of N^2 is $.63\frac{1}{3}$ ohm, N^3 $.63\frac{1}{3}$ ohm, N^4 $1.26\frac{2}{3}$ ohm, N^5 3.8 ohms, and N^6 7.6 ohms, making a sum total of resistances on the shunt side of 15.2 ohms.

Without following out the various changes, which are fully set forth in the letters patent referred to, suffice it to say that when one plunger E is bearing upon piece I, No. 1, the other plunger is bearing upon blank piece P, and that the plungers thereafter take position as follows: upon 2 and 8, 3 and 9, 4 and 10, 5 and 11, 6 and 12, 7 and 13, and lastly blank piece P and 14, when the entire current is directed through the lamp.

Having thus fully described our invention, we claim and desire to secure by letters patent—

1. An electric switch consisting of a frame composed of soapstone or plaster, or other insulating material, also suitable to resist the transmission of heat, fitted with carbon resistances and combined with metal contact-joints and conductors arranged in relation to each other to regulate the application and division of the current to the lamp, as set forth, and at the same time avoid danger or inconvenience from the heat of the current.

2. A circular disk, A, fitted with packed carbon resistances, as set forth.

3. A disk, A, fitted with pieces I and J, clamped to the disk, as set forth.

WILLIAM EDWARD SAWYER.
ALBON MAN.

Witnesses:
THOS. CROCKER.
GEO. W. SAWYER.

4127

UNITED STATES PATENT OFFICE

JOSEPH W. SWAN, of Newcastle-upon-Tyne, England.

Electric Lamp.

Specification forming part of Letters Patent No. 233,445, dated October 19, 1880. Application filed April 12, 1880. (No model.)

To all whom it may concern:

Be it known that I, Joseph Wilson Swan, chemist, of Newcastle-upon-Tyne, England, have invented an improvement in electric lamps, of which the following is a specification.

My invention relates to that kind of electric lamp in which light is produced by the incandescence of a continuous conductor of carbon inclosed in an exhausted glass bulb, and provides means for increasing the durability of the said kind of lamp.

The first part of my invention has for its object to prevent the cracking and leakage of the glass bulb or inclosing vessel in consequence of the heating and cooling of the conducting-wires, which, when simply sealed into the glass globe, cause it to crack and leak at or near the junction of the wires and glass.

The devices employed for obtaining the object described are caps *a*, of platinum, attached to the bulb at the places where the conducting-wires enter it. Each cap is attached to the bulb by means of the fusion of the glass around the rim of the cap. The conducting-wires pass through or into the caps, and the junction of the wires and caps is secured air-tight by soldering, or, where the wire does not pass through the cap, but into it, soldering is not essential. A firm contact of the conducting-wires with the interior of the caps is in that case sufficient. The forms of cap I prefer to use are shown in the annexed drawings, figures 1 and 2.

(Here follow diagrams marked pp. 4125 & 4126.)

Fig. 1 shows a section, through its axis, of the kind of cap, *a*, I use when the wire passes through it, and is soldered into it. Fig. 2 shows a section, through its axis, of the kind of cap, *a*, I use when the wire only enters the inside of the cap, but does not pass through it.

The size and figure of the cap *a* may be varied to some extent without detriment to the object in view, and I therefore do not limit myself strictly to the exact size and form indicated by the drawings.

The second part of my invention has for its object to prevent the rupture of the carbon within the exhausted glass bulb, as the results of its unequal contraction.

I have found that when the carbon employed within the lamp is formed of a horseshoe-shaped plate, produced by cutting out the horseshoe-shaped piece from a sheet of card-board, and afterward

(No Model.) 2 Sheets—Sheet 1.

J. W. SWAN.

Electric Lamp.

No. 233,445. Patented Oct. 19, 1880.

No. 286
C. E. Light Co.
v
McK. Light Co. } p4125

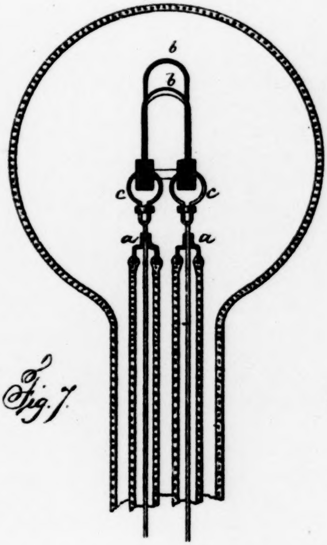


Fig. 7.

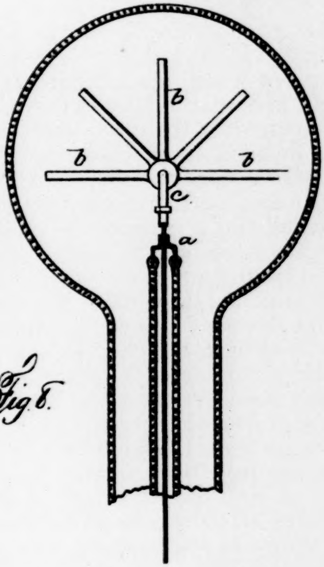


Fig. 6.

Fig. 3.

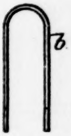


Fig. 4.

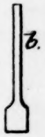


Fig. 1.

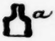
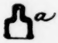


Fig. 2.



Witnesses
Harold Serrell
Chas. H. Smith

Inventor
Joseph Wilson Swan
per Lemuel W. Serrell
atty.

(No Model.) 2 Sheets—Sheet 2.

J. W. SWAN.

Electric Lamp.

No. 233,445. **Patented Oct. 19, 1880.**

No. 286
C.E. Light Co. v. McK Light Co. } p 4126

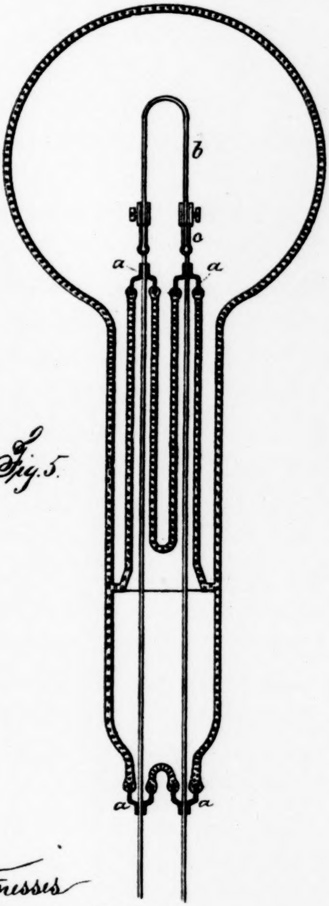


Fig. 5.

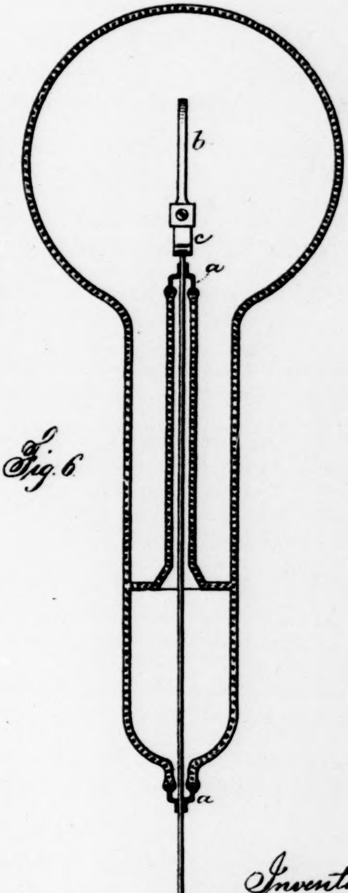


Fig. 6

Witnesses
Harold Serrell
Chas H. Smith

Inventor
Joseph Wilson Swan
per Lemuel W. Serrell
atty

carbonizing it by heat, the horseshoe-shaped carbon-plate so produced is liable to become distorted and ultimately to break in consequence of the unequal contraction caused by the unequal heating of the inner and outer portions of the arch during the use of the lamp.

The defect above described I remedy by forming the carbon to be made incandescent of a strip of card-board, paper, or parchment-paper, *b*, bent into the form of an arch, hoop, or loop, the front view, Fig. 3, of such an arch, hoop, or loop showing its section or thickness, and the side view, Fig. 4, its width.

Where the paper is cut out in the shape of a horseshoe or an arch the measurement at the inner side of the arch is less than that around the outer side of the arch; hence the inner portion offers less resistance to the current than the outside, and becomes the most highly heated.

In my improvement the straight strip offers a uniform resistance to the current, and this resistance is the same and the temperature uniform when the strip of paper is bent to the required form. The strip of card-board, paper, or parchment-paper *b*, bent as aforesaid, I subject to a white heat in a closed vessel of a suitable material, such as fire-clay containing powdered charcoal or other suitable air-excluding powder. I mount one or more of the curved carbon strips, formed as above described, within a glass bulb by clipping the ends of the said curved carbon strips between forceps *c*, of platinum, or an alloy of platinum and iridium, attached to the conducting-wires, which pass through or into the caps, as before described.

The carbon arch and the caps are shown in position in a lamp in Figs. 5 and 6, in which Fig. 5 is a front view, and Fig. 6 a side view, of the carbon, the glass bulb being shown in section.

I guard against the destruction of a lamp in consequence of the accidental rupture of the carbon within it by employing two or more pieces of carbon, *b*, in each lamp.

The multiple carbon arches I clip together by their ends
4128 by means of platinum forceps *c*, before mentioned. I spread
out the arches in the manner indicated in Figs. 7 and 8, in which Fig. 7 is a front view, and Fig. 8 a side view, of the carbons as arranged in a lamp, the glass bulb being shown in section.

The third part of my invention has for its object the prevention of the evolution of gas occluded by the conducting-wires within the lamps and the prevention of leakage through the platinum caps; and these objects I accomplish by coating the conducting-wires and caps with glass or enamel.

The parchment-paper, which I prefer to use, produces a much stronger and more elastic carbon than the paper or bristol-board heretofore employed, and offers a more uniform resistance to the current.

I claim as my invention—

1. The combination, with an electric lamp, of platinum caps in the glass where the conductors are applied, substantially as specified.

2. In an incandescent electric lamp, a carbon formed from a straight strip of card-board, paper, or parchment-paper, and bent to the form of an arch, hoop, or loop, and carbonized by heat while in a bent condition, substantially as set forth.

3. A carbon for an electric lamp made of the carbonized parchment-paper.

4. In an electric lamp, the internal wires and caps coated with glass or enamel.

Signed by me this 15th day of March, A. D. 1880.

JOSEPH WILSON SWAN.

Witnesses:

EVAN R. JONES,
ROBERT ROWELL,
Both of No. 6 Grey Street.

4130 UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, of Menlo Park, New Jersey, assignor to the Edison Electric Light Company, of New York, N. Y.

Carbon for Electric Lamps.

Specification forming part of Letters Patent No. 251,540, dated December 27, 1881. Application filed August 6, 1880. (No model.)

To all whom it may concern:

Be it known that I, Thomas A. Edison, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful improvement in carbons for electric lamps; and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon:

In incandescent electric lighting I prefer to use for the incandescing conductor a small slip or filament of carbon bent into a curve, now generally designated the "horseshoe" carbon. Great success has attended the use of such carbons made from a naturally fibrous material capable of carbonization—for instance, wood formed into proper shape and then carbonized. I have found, however, that the best results are attained with the use of those materials which are fibrous, and wherein the fibers making up the mass of material lie naturally parallel, so that the individual fibers extend from end to end, increasing its strength and obviating danger of breakage from cross or oblique grain.

To produce the best results in giving light it is essential that the carbons should be of uniform size throughout the portion that is rendered incandescent, in order that radiating surface and resistance be regular and uniform, insuring even heating and incandescence.

The object of this invention, therefore, is to produce a small slip or filament for the carbon having parallel fibers and of uniform size; and to this end it consists in a carbon made of the materials and in the way more particularly hereinafter described and claimed.

I have found that for the purposes of the carbon filament cane bamboo is eminently suited, it having long parallel fibers, and with a minimum of cementing or other foreign matters. The cane bamboo is cut into strips, from which the hard glossy or silicious exterior and the pithy interior have been before removed, or from which they are now removed. Each strip is then cut or shaved by proper devices or machinery until its body, or part intended for light-giving, is reduced to the desired form and size, the ends being formed into enlargements, affording a good bearing or surface for uniting the finished carbons to metallic conductors. It is preferable that these enlargements of the ends be formed entirely upon side of the finished slip which forms the blank for carbonization, instead of upon both sides. This construction enables the blank, when placed on edge in the carbonizer, to more readily move therein as it is contracted in the process of carbonization. As the material shrinks in the process of carbonization, the finished carbon being smaller than the blank, allowance is to be made therefor in preparing the blanks, and they should be made proportionately larger than the size desired for the finished carbon. One or a number of blanks thus prepared are then placed in a suitable carbonizing oven or flask and thoroughly carbonized.

(Here follows diagram marked p. 4129.)

In the drawings, figure 1 represents a blank made from cane bamboo, ready for carbonization, having enlarged or clamping ends *s s* formed on one edge only, while in these enlarged or clamping ends are the slots *i i*, by which the slips may be secured in the carbonizer, and which also may form the holes through which pass the screws or clamps, if clamps be used for securing the finished carbon to leading-in wires. Fig. 2 shows in perspective a finished carbon made from the blank shown in Fig. 1.

What I claim is—

1. A slip or filament for forming on carbonization the incandescing conductor of an electric light, made of bamboo or similar fiber, substantially as set forth.

2. An incandescing carbon conductor for electric lights, made from cane bamboo or similar fiber, substantially as set forth.

This specification signed and witnessed this 28th day of July, 1880.

THOS. E. EDISON.

Witnesses:
CHAS. BATCHELOR.
G. E. GOURAND.

(No Model.)

T. A. EDISON.

CARBON FOR ELECTRIC LAMPS.

No. 251,540. Patented Dec. 27, 1881.

Fig. 1.

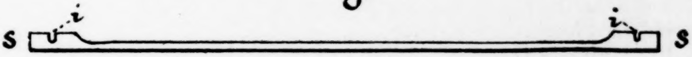
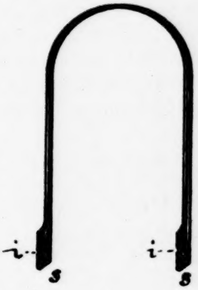


Fig. 2.



No. 286.
C. E. Light Co.
McK. Light Co.
p. 4129

WITNESSES:

O. D. Mott
M. J. Clagett

INVENTOR:

T. A. Edison

BY Dyer & Wilber

ATTORNEYS.

4134 UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, of Menlo Park, New Jersey, assignor to the Edison Electric Light Company, of New York, N. Y.

Electric Distribution and Translation System.

Specification forming part of Letters Patent No. 264,642, dated September 19, 1882.

Application filed August 9, 1880. (No model.) Patented in England September 24, 1880, No. 3880; in Canada November 15, 1880, No. 11997; in Italy November 19, 1880; in Belgium November 30, 1880, No. 53018; in France January 3, 1881, No. 139,588; in Victoria January 4, 1881, No. 2944; in Austria February 3, 1881; in New South Wales March 7, 1881; in New Zealand March 7, 1881, No. 512; in Queensland March 9, 1881; in Spain April 2, 1881, and in India July 20, 1881, No. 528.

To all whom it may concern:

Be it known that I, Thomas A. Edison, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful electric distribution and translation system, (case No. 236;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

This invention relates to a method of equalizing the tension or "pressure" of the current through an entire system of electric lighting or other translation of electric force, preventing what is ordinarily known as a "drop" in those portions of the system the more remote from the central station, and also to other features in systems for the utilization of electricity, as hereinafter explained.

As is well known from patents already granted me and prior applications pending, I use in my system an electric light formed of a continuous incandescing conductor, large numbers of which are grouped into one system, supplied and regulated from a central station, main conductors leading from and to the central station, each lamp or translating device being in a derived circuit to the main conductors, the entire system being what is known as a "multiple-arc" system. From a central station the main conductors may proceed, and it is intended that they should, to a great distance and supply a large number of translating devices. In such cases there is inevitably a difference in tension between various parts of the circuit, due to the resistance of the main conductors. This may be partially remedied by making the conductors very large near or at the station, gradually decreasing their size or conducting capacity; but such plan only lessens slightly the ratio of fall. To obviate the difficulty I provide feeding-conductors, which extend from the generator or generators to the main conductors of the lamp or consumption circuit or circuits, such feeding-conductors not having any translating devices connected therewith, and being connected with the main conductors of the consumption circuit or circuits at the center, ends, or other points on such main conductors. From a central station several sets of such feeding-conductors may run, each set feeding into its own lamp or consumption-circuit or all the sets feeding into a connected system of lamp or consumption circuits. It will be seen that the drop upon the feeding-conductors has no effect upon the relative candle-power of the lamps of the system, the relative candle-power of the lamps being affected only by the drop upon the main conductors of the consumption circuit or circuits between the end of a set of feeding-conductors and points most distant from any feeding-conductors. In order to maintain practically the same candle-power throughout the system, the main conductors of the consumption circuit or circuits should be so proportioned that the drop in tension upon them shall not exceed a definite small limit—for example, five per cent. This drop will make a difference of less than a candle-power in all the sixteen-candle-power lamps of the system, which difference is not perceptible to the eye. Upon the feeding-conductors, however, any loss can be made. This loss will be varied according to localities and the relative cost of copper for conducting purposes and horse-power for generation. This loss upon the feeding-conductors in large and extended systems will generally be greater than upon the main conductors of the consumption circuit or circuits. It may be, for example, about fifteen per cent.; but circumstances might make it desirable to diminish the loss upon the feeding-conductors down even as low as that upon the main conductors of the consumption circuit or circuits, or to increase the loss upon the feeders to more than fifteen per cent.

In this connection I wish to state that I am aware of the French patent of Khotinsky, No. 107,307, granted March 19, 1875.

When it is desired to use a few lamps near the central station they may be placed upon a direct circuit therefrom, with resistance at the commencement or home end of the circuit sufficient to then reduce the tension of the current in such circuit so that it shall
4135 only be equal to that in the more distant circuits, and one
or more of such circuits may be combined with the circuits before described. When large buildings or blocks of buildings using many lamps are to be supplied, it may be desirable to lay therefor separate feeders insulated from each other.

Where several central stations are used in a city, each having feeding-conductors leading to lamp-circuit conductors of the description before noted, it may be advisable to connect the feeding-circuits of all the stations, equalizing the tension or pressure throughout the entire system of the place where the central stations are located.

In the drawings are given diagrammatic representations of circuits, which will be more fully hereinafter described.

(Here follow diagrams marked pp. 4131, 4132, & 4133.)

No. 286.
C. E. Light Co } p. 4131
McK. Light Co

(No Model.) 3 Sheets—Sheet 1.

T. A. EDISON.

ELECTRIC DISTRIBUTION AND TRANSLATION SYSTEM.

No. 264,642. Patented Sept. 19, 1882.

Fig. 1.

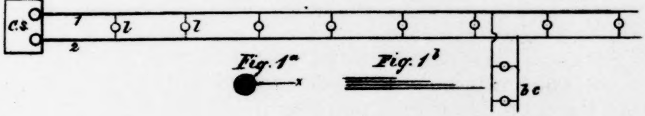
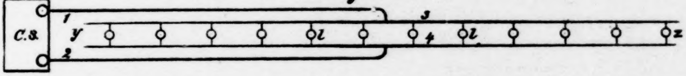

C.S.
1
2
l
l
Fig. 1a
x
Fig. 1b
3c

Fig. 2.


C.S.
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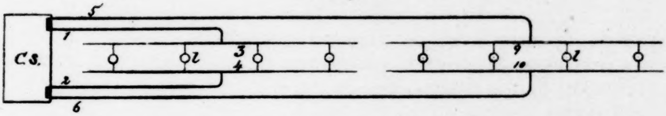
y
3
4
l
l
z

Fig. 3.


C.S.
5
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l
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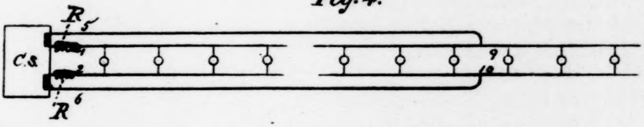
10
l

Fig. 4.


C.S.
R
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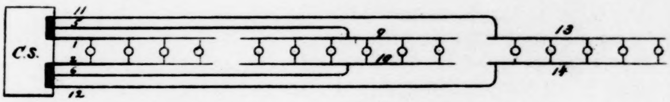
1
2
R
6
9
10

Fig. 5.


C.S.
11
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1
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12
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13
14

Witnesses:

J. W. Howard
James A. Payne

Inventor.

T. A. Edison
per Dyer & Wilber
Attorneys

No. 286.
C. E. Light Co
v
McK Light Co
} p. 4132

(No Model.) 3 Sheets—Sheet 2.

T. A. EDISON.

ELECTRIC DISTRIBUTION AND TRANSLATION SYSTEM.

No. 264,642. Patented Sept. 19, 1882.

Fig. 6.

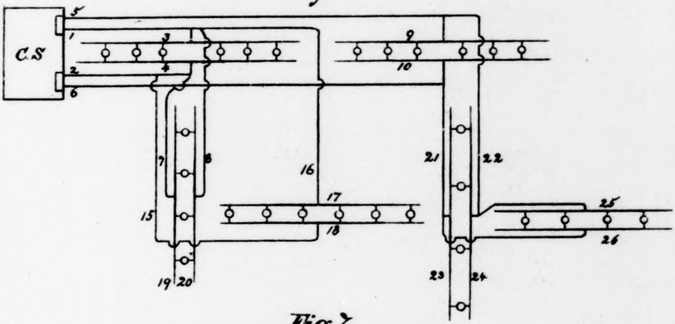
C.S
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Fig. 7.

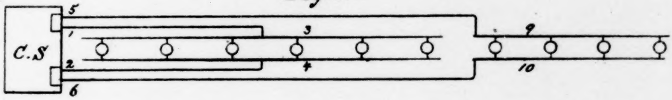
C.S
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Fig. 8.

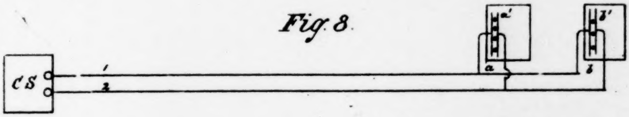


Fig. 9.

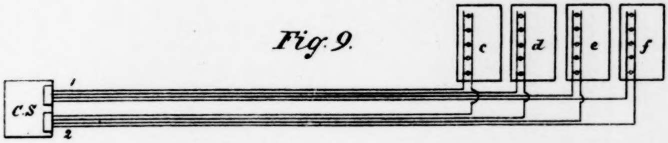
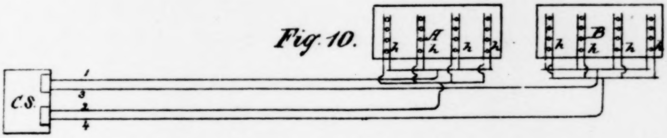


Fig. 10.


A
h
h
h
h
B
h
h
h
h
C.S.
1
3
2
4

Witnesses:

F. W. Howard
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Attorneys.

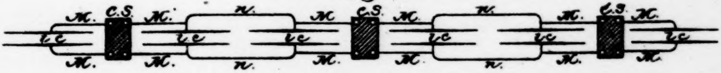
(No Model.) 3 Sheets—Sheet 3

T. A. EDISON.

ELECTRIC DISTRIBUTION AND TRANSLATION SYSTEM.

No. 264,642. Patented Sept. 19, 1882.

Fig. 11.


M.
C.S.
M.
N.
M
C.S.
M.
N.
M.
C.S.
M.
L.C
L.C
L.C
L.C
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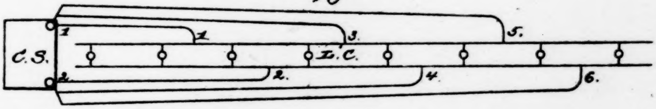
L.C
M.
M.
N.
M.
C.S.
M.
N.
M.
M.

Fig. 12.


C.S.
1
2
1
3
5
L.C.
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No. 286.
E. Light Co.
v.
McK. Light Co. } p. 4133

Witnesses:
J. E. Clark.
N. A. Clark.

Inventor;
Thomas A. Edison,
By Richd. N. Dyer.
Attorney.

Figure 1 illustrates a plan wherein the conductors are made larger at their home ends, gradually tapering to the outer end of the system. Where such plan is used it is preferable to make the conductor a compound one, composed of several single wires of different lengths, one or two of which extend the whole length of the conductor, others ending at various points, as shown in Fig. 1^b. These wires are not insulated, but merely grouped in a bunch, which have transverse fastenings at intervals, or which may be fastened together by branch conductors passing around where connections are formed, as shown in Fig, 1^a. It is preferable to form all conductors which vary in size, decreasing from some point in this manner, and it is to be understood in subsequent descriptions that all such conductors are so made.

In Fig. 2 feeding-conductors 1 2 lead from central station C S, connecting with the lamp-circuit 3 4 at about its center, the conductors of the lamp-circuit being largest at that point, and also of slightly larger capacity at that point than the feeding-conductors. By this arrangement most of the fall of pressure or drop in tension takes place in the feeding-circuit, so that it cannot affect any lamps, while the drop in the lamp-circuit is reduced very low, as before explained, the drop from the center of the lamp-circuit to either terminal being only about one-fourth what the drop would be from *y* to *z* if either end were connected directly to the central station. Any desired number of lamp-circuits may be so arranged, each having its proper feeding-conductors, two so arranged being shown in Fig. 3.

In some instances where it is desired to use a few lamps near the station they may be placed directly upon main conductors, and combined with the circuits shown in Figs. 2 and 3, as shown in Fig. 4, where feeders 5 6 connect with lamp-circuit 9 10, arranged as in Figs. 2 and 3, while circuit 1 2, connected directly to C S, has a few lamps upon it, in which case resistances R R should be used therein to lessen the tension of the current in 1 2 to the same extent as it is lessened by the larger conductors 5 6. With such arrangement may also be combined an ordinary terminal circuit containing a few lamps, such as the circuit 13 14 in Fig. 5.

In Fig. 6 is shown direct or main feeding circuits 1 2 and 5 6 with lamp-circuits 3 4 and 9 10 with branch feeders 7 8, 15 16, and 21 22 leading into side streets, supplying lamp-circuits 17 18, 19 20, 23 24, and 25 26, the branch feeders being derived circuits from the main feeders, all constituting a multiple-arc system.

In Fig. 7 feeding-mains 1 2 connect to the center of the lamp-circuit 3 4, while feeders 5 6, leading to a greater distance and to a circuit when comparatively few lamps are required, connects to the end of lamp-circuit 9 10, whose conductors gradually taper from the point of connection. This arrangement is sometimes desirable in sparsely-settled localities, as involving economy in the laying of conductors.

In Fig. 8 is shown feeding-conductors 1 2, from which lead house-feeders *a b*, which connect to lamp-circuits *a′ b′*, which are of same description as circuit 3 4, Fig. 2.

Fig. 9 shows a series of houses or buildings, *c d e f*, to each of which leads a feeding-circuit of insulated conductor, the lamp-circuit of each house being thereby put in direct connection with the central station C S, the tension of the current in any one lamp-circuit not being effected by the others.

In Fig. 10 are two blocks of buildings, A and B, composed each of several houses, *h h h*, separate feeding-circuits 1 2 and 3 4 leading to branch feeding circuits, from which lamp-circuits lead into each house, each house or lamp-circuit being provided with its own connection and meter.

In the arrangements shown in Figs. 8, 9, and 10 the greatest portion of the fall or drop occurs in the conductors leading to the house or block lamp-circuits, the tension or pressure in the branches leading into the houses being maintained practically uniform thereby in each lamp-circuit.

Fig. 11 shows a series of central stations, C S, from each of which lead main feeding-circuits M, which may be of any desired number, each connecting to and feeding into a lamp-circuit, *l c*. The mains of all the stations are connected by conductors *n n n*, so that all the stations are electrically connected into one general system, whereby the pressure throughout the entire system is equalized.

In Fig. 12 the lamp-circuit L C is fed by a number of feeding-circuits, connecting thereto on opposite sides, alternately 1 2, 3 4, and 5 6, forming three feeding-circuits, by which arrangement a comparatively uniform force or pressure may be maintained throughout the entire system.

I do not claim broadly a conductor tapering from the source of energy, as such, *per se*, is old; but I do claim, as hereinafter set forth, my particular way of forming such a conductor.

What I claim is—

4136 1. A consumption-circuit, in the main conductors of which the drop in tension is not sufficient to vary practically the candle-power of the lamps connected therewith, in combination with feeding-conductors connecting the consumption-circuit with the source of electrical energy, and having no translating devices connected therewith, the drop in tension upon such feeding-conductors not affecting the relative candle-power of the lamps of the consumption-circuit, substantially as set forth.

2. A consumption-circuit in the main conductors of which there is a definite small drop in tension not sufficient to vary practically the candle-power of the lamps connected therewith, in combination with feeding-conductors connecting the consumption-circuit with the source of electrical energy, and having no translating devices connected therewith, the loss upon such feeding-conductors being greater than upon the main conductors of the consumption-circuit, substantially as set forth.

3. The combination of a consumption-circuit, in the main conductors of which the drop in tension is not sufficient to vary practically the candle-power of the lamps connected therewith, with a feeding-circuit having no translating devices, and extending from

the source of electrical energy to the center of the consumption-circuit, substantially as set forth.

4. The combination of two or more central stations having feeding-conductors, and consumption circuits supplied by such feeding-conductors, as described, of connections between the conductors of the central stations, substantially as and for the purposes set forth.

5. The combination, in one system, of a main circuit connected directly to a source of energy, and containing translating devices, and provided with resistances for lessening the tension or pressure of the current to that of the average of the system, a circuit not directly connected to the source of energy containing translating devices, and a feeding-circuit connecting the latter circuit with the source of energy, substantially as set forth.

6. The combination of a number of uninsulated wires of different lengths grouped together and fastened at intervals, forming a gradually-tapering conductor, substantially as set forth.

This specification signed and witnessed this 4th day of August 1880.

THOS. A. EDISON.

Witnesses:

WM. CARMAN.
OTTO A. MOSES.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, of Menlo Park, New Jersey, assignor to the Edison Electric Light Company, of New York, N. Y.

Electric Distribution System.

Specification forming part of Letters Patent No. 266,793, dated October 31, 1882. Application filed December 9, 1881. (No model.)

To all whom it may concern:

Be it known that I, Thomas A. Edison, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful improvement in electrical distribution systems, (case No. 361;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

In a system of electric lighting in which a town or village or a portion thereof is supplied from one central station it may sometimes occur that the district supplied is irregular in shape, and that in some parts of the district more lights may be used, and consequently more electricity required, than in others.

The object of this invention is to so arrange the system of conductors supplying the district that the supply in the various localities of the district will be proportioned to the demand.

In a prior application I have set forth the manner in which I usually prefer to arrange my conductors in cases where about the same supply is required all over the district, viz: Along each face of each block in the district are laid two conductors—one "positive," the other "negative"—and at every street-corner where the conductors intersect each other all the positive conductors are connected together and all the negative—that is, wherever two conductors of the same name cross each other they are connected together—and feeding-conductors connect with these street-mains at certain definite and regularly-arranged points, so that a constant amount of electricity is supplied in all parts of the district in a uniform manner; but where, as explained above, the district is irregular in shape and some parts of it require more current than others this arrangement is modified as follows: By estimating the number of lamps or other translating devices used in the entire district and the proportion used in various parts thereof, I am enabled to discover what may be termed the "centers of consumption"—that is, the points in the neighborhood of which or around which a certain amount of electricity is consumed.

In parts of the district which are thickly settled and contain a good many consumers of electricity the center of consumption would be the center of a very small space, while in sparsely-inhabited localities, where few lamps are used, the space surrounding the center of consumption would be larger. The district might thus be considered as divided into irregularly-

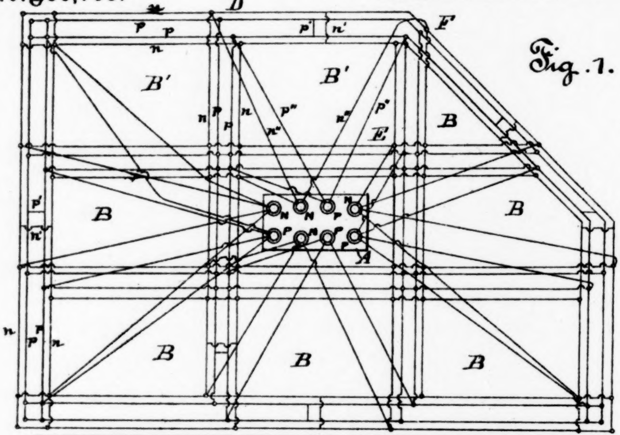
No. 286.
C. E. Light Co
v.
McK. Light Co
} p. 4137

(No Model.)

T. A. EDISON.

ELECTRIC DISTRIBUTION SYSTEM.

No. 266,793. Patented Oct. 31, 1882.


D
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n'' p'
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B
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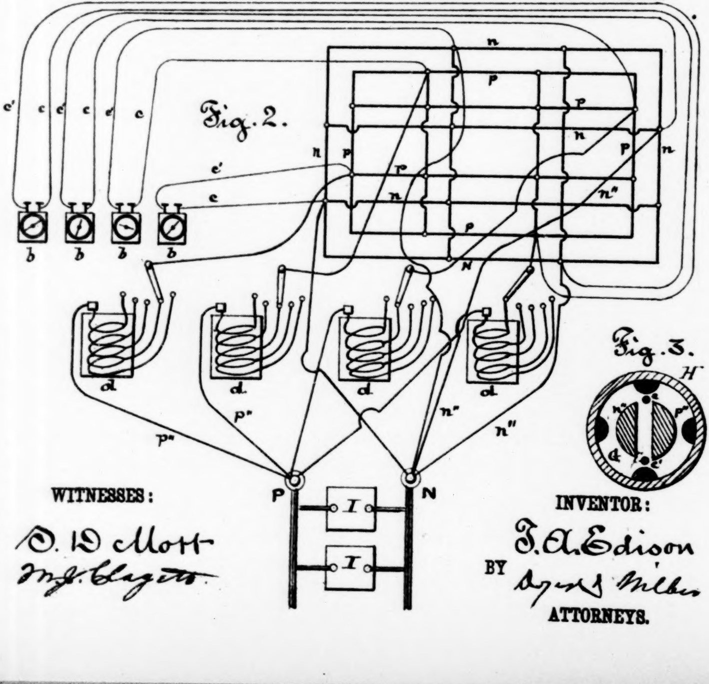
B
B
B

Fig. 1.


c' c c' c c' c
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n p
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N
b b b b
d d d d
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n''
n''
P
N
I
I

Fig. 2.

H
n''
p''
c
c'

Fig. 3.

WITNESSES:

D. W. Mott
Wm. J. Clagett

INVENTOR:

T. A. Edison

BY Dyer & Wilber

ATTORNEYS.

shaped sub-districts, each containing about the same number of lamps, and each consuming approximately the same amount of energy. To each of these centers of consumption is run from the central station a "feeding-circuit," consisting of a positive and a negative conductor, each of which is connected at the proper point to a similar conductor of the main system. As stated above, all the positive and all the negative main conductors are connected together wherever they intersect. I sometimes find it desirable to connect them also at other points by running cross-connections across the street at various places along the faces of the blocks.

The feeding-conductors are preferably of the form set forth in my prior application, (serial No. 31825,) with the exception that small additional wires are laid in the tubes, which form additional circuits, each of which runs from a center of consumption back to the central station, where it passes through an electro-dynamometer or other suitable device for indicating electric pressure, and thence returns again to the center of consumption, so that the amount of energy used in each feeding-circuit or the electrical potential at center of consumption is indicated, and adjustable resistances are placed in each feeding-circuit, so that according to the indications of the electro-dynamometer more or less current may be supplied to the circuit. The main conductors of the consumption-circuit are made of such size that the drop in electro-motive force upon them will not be sufficient to vary practically the candle-power of the lamps, while upon the feeding-conductors any drop may be provided for without affecting the relative candle-power of the lamps of the consumption-circuit, such feeding-conductors having no translating devices connected therewith. The loss upon the feeding-conductors 4139 is preferably greater than that upon the main conductors of the consumption-circuit, but will be varied in different localities according to the relative cost of copper for conducting purposes and horse-power for generation. The electro-dynamometer used is preferably that of Weber, a large resistance—say 10,000 ohms—being placed in circuit with the instrument, as is well understood, so that the instrument will vary with the variations in tension, and will practically indicate the electro-motive force of the current.

(Here follows diagram marked p. 4137.)

In the accompanying drawings, figure 1 is a diagram of a district, showing the system of mains and feeding-circuits; Fig. 2, a diagram showing a part of the district, with a portion of the apparatus used at the central station; and Fig. 3 is a cross-section of one of the underground tubes containing the conductors of a feeding-circuit.

A, Fig. 1, represents a central station; N and P, respectively, the negative and positive poles of batteries of electric generators situated in the station. B B′ B″ are blocks which compose the district or part of it. The blocks B′ B″ may be taken as types of all the others. In each of the streets surrounding these blocks are laid the main conductors *p n*, *p* representing positive and *n* negative conductors.

Wherever conductors of the same name cross each other they are run into a junction-box and connected, and additional connections may also be made between them by cross-conductors *n' p'*, placed across the street at various points along the faces of the blocks.

The centers of consumption are, as before explained, various irregularly-located points at different distances from the source of supply, A, such as the points C D E F. To these points are run the feeding-circuits, each consisting of a positive conductor, *p''*, and a negative conductor, *n''*. The conductors *p''* all run from positive poles P of the generators and the conductors *n''* from negative poles N. By these feeding-circuits electricity is supplied to the different groups of lamps, each of which surrounds a center of consumption.

In Fig. 3, *n'' p''* are the feeding-conductors, surrounded by insulating-washer G, which separates them from an inclosing metal tube H. *c c'* are small wires, which also pass through the tube H.

Fig. 2 illustrates the manner in which the conductors surrounding any block B of the district are arranged.

I I represent a battery of electric generators, N P being respectively its negative and positive poles, from which run the feeding-conductors *n'' p''* to the centers of consumption of the block, where they are connected to the street conductors *n p* by means of the junction-boxes described in a prior application.

For convenience in the drawings, the wires *c c'*, which are inclosed in the same tube with the conductors *n'' p''*, are shown separated from these conductors in Fig. 2. These wires *c c'* form an auxiliary circuit to each feeding-circuit, passing through electro-dynamometers *b b* or other suitable devices for indicating electric pressure at the central station, which by this means indicates the electrical potential at the centers of consumption.

d d are adjustable resistances, placed in the feeding-circuits, by means of which more or less current may be made to pass through such circuits, according to the indications of the electro-dynamometers.

What I claim as my invention is—

1. In a system of electrical distribution, the intersecting and connected positive conductors and the intersecting and connected negative conductors, forming the main conductors of the consumption-circuit, upon which the drop in electro-motive force is not sufficient to vary practically the candle-power of the lamps, in combination with a central station and feeding-conductors having no translating devices connected therewith, and extending from the source of electrical energy at the central station to the main conductors of the consumption-circuit, said feeding-conductors being connected with such main conductors of the consumption-circuit at or near centers of consumption, substantially as set forth.

2. The combination, with a feeding-circuit of an electrical distribution system, of an auxiliary circuit composed of smaller con-

ductors connected at its terminals with the terminals of the feeding-circuit, and containing a suitable device for indicating electric tension, so that the electro-motive force of the current in the main circuit is indicated, substantially as set forth.

3. The combination of the conductors forming a circuit of an electrical distribution system, placed in an enclosing tube, of smaller conductors in the same tube, having their terminals connected with those of the main conductors, and forming a circuit in which is placed a suitable device for indicating electric tension, substantially as and for the purpose set forth.

4. In a system of electrical distribution, the combination of the intersecting and connected positive conductors and the intersecting and connected negative conductors, forming the main conductors of the consumption-circuit, with cross-connections connecting the conductors of the same polarity together between the points of intersection, a central station, and feeding conductors having no translating devices connected therewith, and extending from the source of electrical energy at the central station to the main conductors of the consumption circuit at or near centers of consumption, substantially as set forth.

5. In a system of electrical distribution, the intersecting and connected positive conductors and the intersecting and connected negative conductors, forming the main conductors of the consumption-circuit, in combination with a central station, feeding-conductors 4140 extending from the central station to the consumption circuit, and having no translating devices connected therewith, and means located in each feeding-circuit for regulating the tension of the current supplied thereby to the consumption-circuit, substantially as set forth.

6. In a system of electrical distribution, the intersecting and connected positive conductors and the intersecting and connected negative conductors, forming the main conductors of the consumption-circuit, in combination with a central station, feeding-conductors extending from the central station to the consumption-circuit, and having no translating devices connected therewith, an auxiliary circuit extending to the outer end of each feeding-circuit and containing a device for indicating electro-motive force, and an adjustable resistance in each feeding-circuit, substantially as set forth.

This specification signed and witnessed this 25th day of October, 1881.

THOS. A. EDISON.

Witnesses:
H. W. SEELY.
RICH'D N. DYER.

4145 UNITED STATES PATENT OFFICE.

Thomas A. Edison, of Menlo Park, New Jersey, assignor, by mesne assignments, to the Edison Electric Light Company of New York, N. Y.

System of Electrical Distribution.

Specification forming part of Letters Patent No. 369,280, dated August 30, 1887.

Application filed February 5, 1880. Serial No. 2282. Patented in England February 11, 1880, No. 602; in Italy May 10, 1880, No. 11809; in Belgium May 15, 1880, No. 51329; in France July 5, 1880, No. 136,399; in Canada July 21, 1880, No. 11527, and in Austria-Hungary October 5, 1880, No. 30–1837.

To all whom it may concern:

Be it known that I, Thomas A. Edison, of Menlo Park, in the State of New Jersey, United States of America, have made certain new and useful improvements in furnishing light and power from electricity, of which the following is a specification.

The object of this invention is to arrange a system for the generation, supply, and consumption, for either light or power, or both, of electricity, that all the operations connected therewith requiring special care, attention, or knowledge of the art shall be performed for many consumers at central stations, leaving the consumers only the work of turning off or on the supply, as may be desired—in other words, to so contrive means and methods that electricity may be supplied for consumption in a manner analogous to the systems for the supply of gas and water without requiring any greater care or technical knowledge on the part of the consumer than does the use of gas or water, in order that economy, reliability, and safety may be insured.

In carrying the invention into effect, a city, town, village, or locality may form one district, or, if the extent of territory makes it desirable, may be divided into several districts. In each district I provide a central station, at which are grouped a suitable prime motor or several motors, dependent upon the amount to be supplied, generators or means for converting the prime motive force into electricity, and means for determining and regulating the amount of electricity generated and supplied, in order that a constant pressure of electricity (so to speak) may be kept up. The prime motors are any suitable engines, steam or water, and one or a series of two or more is provided, as may be necessary, each of which is provided with its own system of shafting and belting, driving a number of magneto-electric machines, the number actuated by one prime motor being hereinafter termed a "battery."

It is to be noted, as is also shown in previous applications for patents made by me, that I make my field-of-force magnets exceedingly long and of an extremely large mass of metal in proportion to the mass of metal in the revolving armature carrying the generating-coils. The effect of this is to give to the generators field-magnets of great strength, so that currents of the desired high electromotive force can be generated in armatures of low resistance, and the waste of energy in the form of heat in such armatures will be reduced to the minimum. I desire to avoid also the use of generators having the coils of their field-magnets in series with their generating-coils, since this, besides being a defective arrangement with respect to regulation, also increases the internal resistance of the machines, and results in an objectionable waste of energy; hence I prefer to keep the coils of the field-of-force magnets and the generating-coils separate, and that one machine in each battery (which machine may be termed the "battery field-of-force generator") be used to supply the requisite energy to the field-of-force magnets of the other machines in such battery, (which may be termed the "supply-generators.") The coils of the field-of-force magnets are connected as a series or in a multiple arc in one circuit, while the generating-coils of the supply-generators of each battery are all connected in a multiple arc to the main conductors. This arrangement, it is seen, gives great economy, as the per cent. of the entire current generated in each battery absorbed in keeping up the magnetic maximum in the field-of-force magnets when it is furnished by one special machine of the battery, the number given it to feed being properly calculated, being less than when a portion of the current generated in each machine is absorbed in its own field-of-force magnets.

Where a single battery of machines is used, it is preferable, in view of what has been hereinbefore stated, that the current for the coils of the field-of-force magnets of the field-of-force generator of the battery be supplied by a small galvanic battery; but if more than 4146 one battery of machines be used the field-of-force generators of all the batteries are fed from one or more prime field-of-force generators connected in a multiple arc or in a series, the field-of-force magnets of the prime field-of-force generator or generators used being kept magnetically saturated by a weak galvanic-battery current, as before set forth. For instance, a weak galvanic current supplies the field-current necessary for one prime field-of-force generator, which in turn feeds the field-of-force magnets of the field-of-force generators of the batteries of twenty or thirty machines, the ultimate effect in the generation of current depending upon (as one important factor) the tension of the galvanic current sent through the field-of-force coils of the prime field-of-force generator. This prime field-of-force generator may, however, be a dynamo-electric machine instead of a magneto-machine, its field of force being kept up by the current generated in the machine instead of by a galvanic current.

At the central station all the supply-generating coils or batteries thereof are connected to conductors on the multiple-arc system, and from these conductors at the station main conductors (which for conveience may be called simply the "mains") connected thereto, also on the multiple-arc system, lead in any and all desired directions for conveying the energy to the points where work, either by translation into light or motive power, is to be done. All of such conductors from the generators at the station to the lamps are made in pairs—one from the outgoing current and the other for the returning current of electricity, the circuits throughout the system being complete or round metallic circuits, the conductors of which are well insulated from each other and from the earth. The use of the earth for one-half of the circuit would largely increase the difficulties arising from the grounding of the conductors or the crossing of the conductors among themselves or with the conductors of other circuits to such an extent that a system so constructed would be impracticable.

In order to give a better understanding of the method of regulating what, for convenience, may be called the "pressure" of the current through the entire system, I will here state that all the devices for translation of electricity into work are arranged on the multiple-arc system, each device being in its own derived circuit, the effect being, in substance, to give each a circuit from the generating source independent of the circuit of all the other devices. As a resultant, it follows that the greater the number of translating devices brought into circuit the less the total resistance of the circuit. For instance, I prefer that my lamps should each be of about one hundred ohms resistance. Then, if one lamp only be in circuit, there is a resistance of one hundred ohms. If another lamp be put in circuit, two circuits, each of one hundred ohms, are provided for the current, making the net total resistance to the current fifty ohms, although the resistance in each derived circuit remains unchanged. This effect is ordinarily opposite to the effect produced by the addition of lamps when they are connected in an ordinary straight circuit, each one then adding to the resistance of the circuit.

The bringing into operation successively of numbers of the devices, and thereby making more paths or circuits for the currents, does not appreciably lessen the pressure or diminish the effect upon the devices in use, the active forces at the central station—viz., prime field-of-force generators and motive power—remaining unchanged until the net resistance of the devices in circuit exterior to the battery of machines is so diminished as to approach in a degree the resistance of the battery and main conductors, it being remembered that as the machines of a battery are connected in multiple arc the net internal resistance of a battery is as many times less than one machine as there are machines in the battery.

To avoid any appreciable variations and insure uniformity, it is essential that any lessening of pressure be immediately indicated, in order that just sufficient energy be generated and sent out to keep up an equal flow through the circuit of each translating device—that is, that the pressure be kept up uniform, whether more or less translating devices be in circuit. This is attained by providing at the central station means for constantly indicating the pressure and for regulating the production if appreciable variation be indicated. At each central station test lights are arranged, so that an approximate visual test of the effect of pressure upon the circuit of any translating devices in use may be shown. From what has been said, it is evident that as more or less translating devices are brought into circuit the total resistance of the circuit, or all the circuits thereof, to the flow of all the current generated varies. To indicate this electro-dynamometers, galvanometers, or electrometers are placed across the main conductor at the central station, or by return-wire at any point in the circuit, with a zero-mark placed to correspond with the deflection consequent upon the maintenance of the proper amount of pressure. It may be advisable (and I have so done) to place at the central station a series of standard Daniell batteries, connected by a switch-circuit to the galvanometors or electro-dynamometers, in order that they may be frequently tested for any inaccuracy occurring from any cause whatever. By these means any error whatever therein is readily detected.

To correct variations in the pressure various means may be employed. Each supply-generator may be connected into the circuit
through a switch, and each series may be likewise so connected
4147 so that the current of one or more of a series, or one or more
entire series, may be cut out or thrown into the circuit, or
each machine may be arranged so as to be disconnected from the prime motor; or when needed, the prime motor of an entire series may be disconnected. The plan I prefer, howerer, is to arrange in connection with the circuit of the battery feeding the field-of-force magnets of the prime field-of-force generator before referred to a series of resistances, so that the energy of the battery-current may be varied, this variation causing in turn a variation in the current induced in the prime field-of-force generator and in all the generators directly or indirectly controlled thereby. Where a dynamo-machine is used these resistances are to be used in the same manner in connection with the circuit, including the coils around the field-magnets. For distribuing the current thus generated and regulated at the central stations I prefer to use conductors within insulated pipes or tubing, made water-tight and buried beneath the earth, provisions being made at suitable intervals for house or side connections, as shown in a prior application of mine. While this plan is preferable for many reasons, it is evident that conductors may be carried in the air or over house-tops.

While only one pair of conductors may be laid on each street, I prefer, especially where streets are wide, to lay a pair of conductors along each side of the street, near the curb. At proper intervals street-lamps may be connected thereto by derived circuits. From main conductors on principal streets subsidiary main conductors are laid through side streets. From the street conductors, wherever desired, derived circuits are led into houses, one of the conductors passing through a suitable meter, preferably one which measures the amount of electricity passing through, as shown in a prior application of mine for a patent.

In the house each translating device is placed in a derived circuit, the entire system of means for generation, conduction, and translation being one great multiple-arc system with complete or round metallic circuits. The translating devices in each house may be either for light or power, or both. For light the electric lamp consisting of an incandescing material hermetically sealed in glass (shown in other applications filed by me) is preferred. This lamp is made of a high resistance in comparison with that of any electric lamps which, to my knowledge, have been proposed.

In lights heretofore proposed the endeavor seems to have been to lessen the resistance of the carbon, none having been suggested of higher resistance than, say, ten ohms; but I have discovered that a very much higher resistance—say one hundred ohms—must be used, in order that a number may be economically and successfully used in a system.

The motors used should be so constructed that each, with a constant flow or pressure of current, will give the exact power required. This requires that each motor should be wound with finer or coarser wire and into more or less convolutions, which determine the maximum effect of the motor. In addition, as the motors may be run with variable loads or amounts of work to perform, and as irregularity of speed would be a consequent thereof, it would be preferable to provide each motor with a governor which an excessive speed would operate to break the circuit of the motor or to otherwise control it. A preferable form of governor therefore will form the subject-matter of an application for a patent to be filed by me.

A system arranged as thus described provides for all the conditions precedent to an economical and reliable utilization of electricity as a lighting or motive-power agent.

As within certain ascertainable limits, the greater the horse-power of an engine the less the proportionate cost per horse-power. By consolidating at one station the prime motive force necessary to the generation of a supply for many consumers a great economy as to production occurs.

As ordinarily proposed, each electric light requires its own regulator, which usually is either thermostatic or magnetic, breaking the circuit or bringing in resistance—in any case making a cumbrous lamp, requiring delicate management and constant attention. By regulating at the central station entirely, I am enabled to use a small separate lamp, which may be used with the exercise of no more than ordinary care or attention. The distribution is so provided for that tampering therewith is guarded against and that connections from the mains to localities of translation are readily made.

The means for measuring insure accurateness in furnishing a basis for equitable charges for the amount used by any particular consumer.

In the drawings accompanying and forming part of this specification an arrangement of means is shown for carrying my invention into effect, although it is to be particularly noted that the invention is not dependent upon the specific means and their arrangement noted and shown, but that they may be varied without departing from the spirit of my invention. The drawings illustrate, however, what I now consider the more preferable means and arrangements.

(Here follow diagrams marked pp. 4141 to 4144, incl.)

No. 286.
C. E. Light Co.
v.
M.C.K. Light Co. } p. 4141.

4 Sheets—Sheet 1.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 369,280. Patented Aug. 30, 1887.

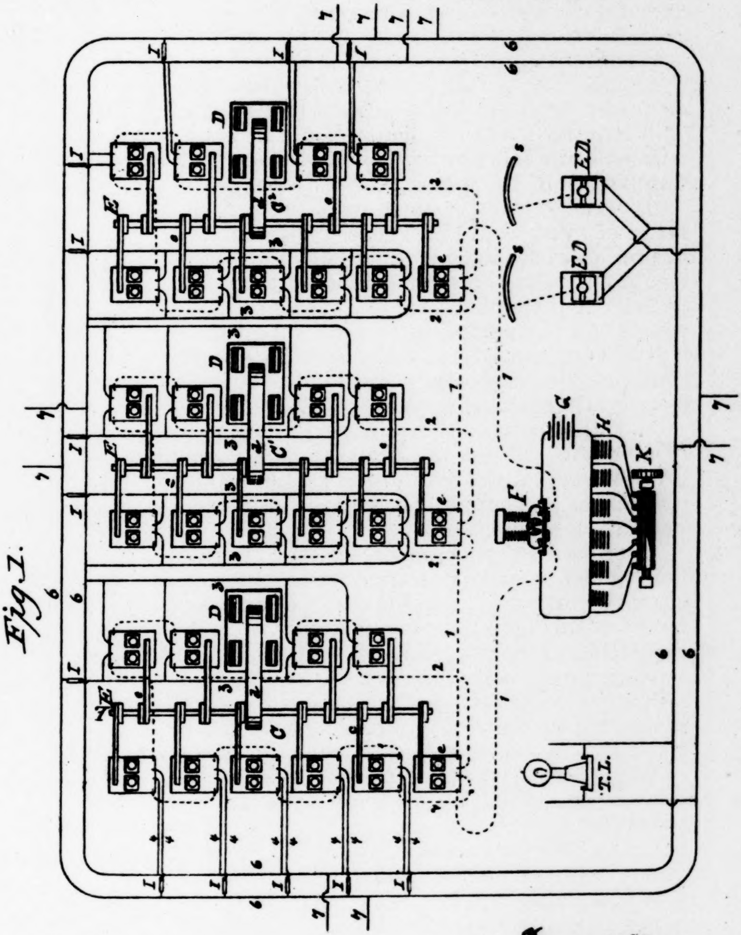

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Fig. I.

Attest:

Sam. D. Mott
Jas. A. Payne.

Inventor:

T. A. Edison
per Dyer & Wilber
his Atty's.

No. 286.
E. Light Co.
v.
McK Light Co. } p. 4142

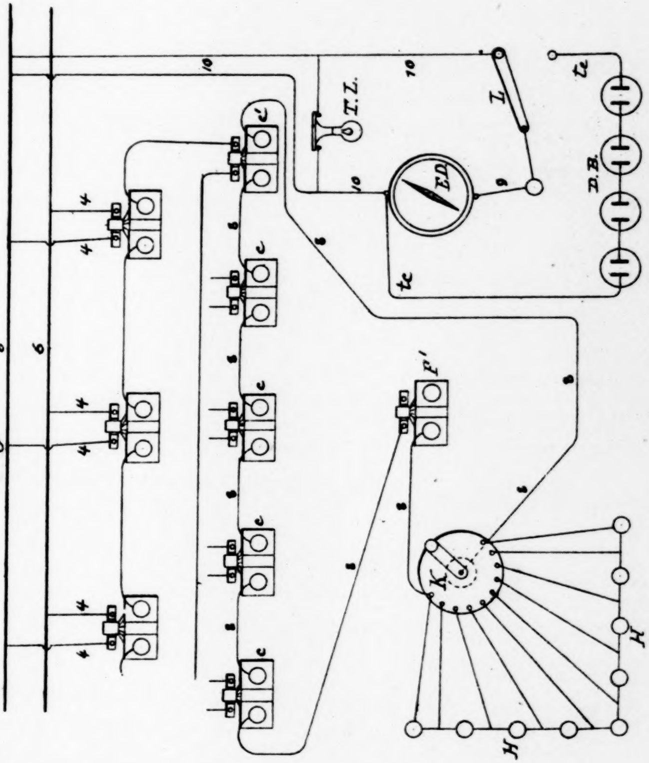
4 Sheets—Sheet 2.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 369,280. **Patented Aug. 30, 1887.**

Fig. 2.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Attest:-

Sam D. Mott.
Jas. A. Payne

Inventor:-

T. A. Edison, per
Dyer & Wilber
his Atty's

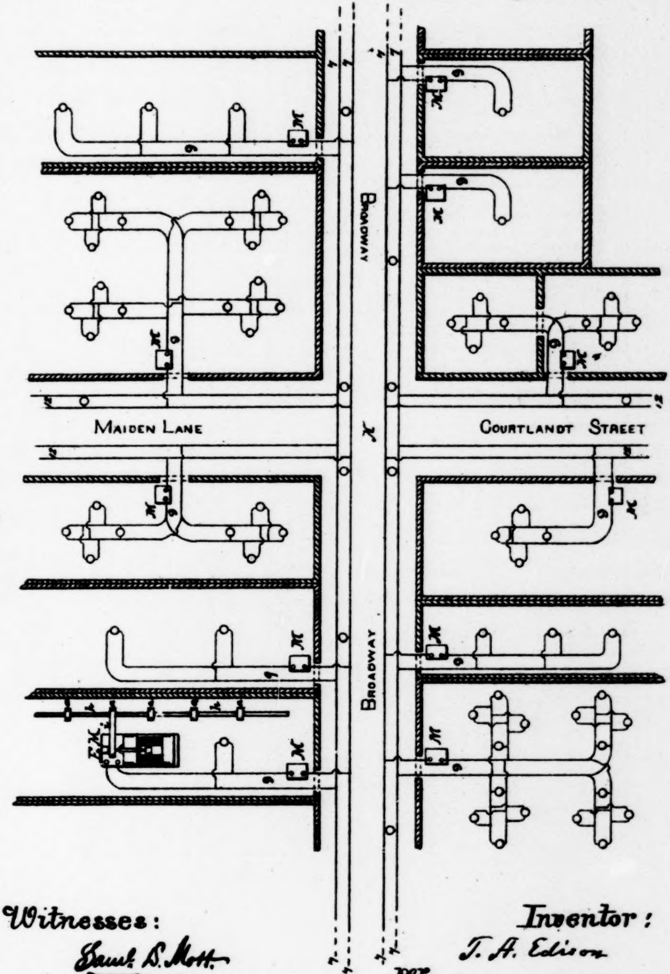
No. 286
E. Light Co.
v.
McK. Light Co. } p. 4143

4 Sheets—Sheet 3.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 369,280. Patented Aug. 30, 1887.



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BROADWAY

Fig. 3.

Witnesses:

Saml. D. Mott.
Jas. A. Payne.

Inventor:

T. A. Edison

per

Dyer & Wilbur
Attorneys

No. 286
E. Light Co
v. McK. Light Co. } p. 4144

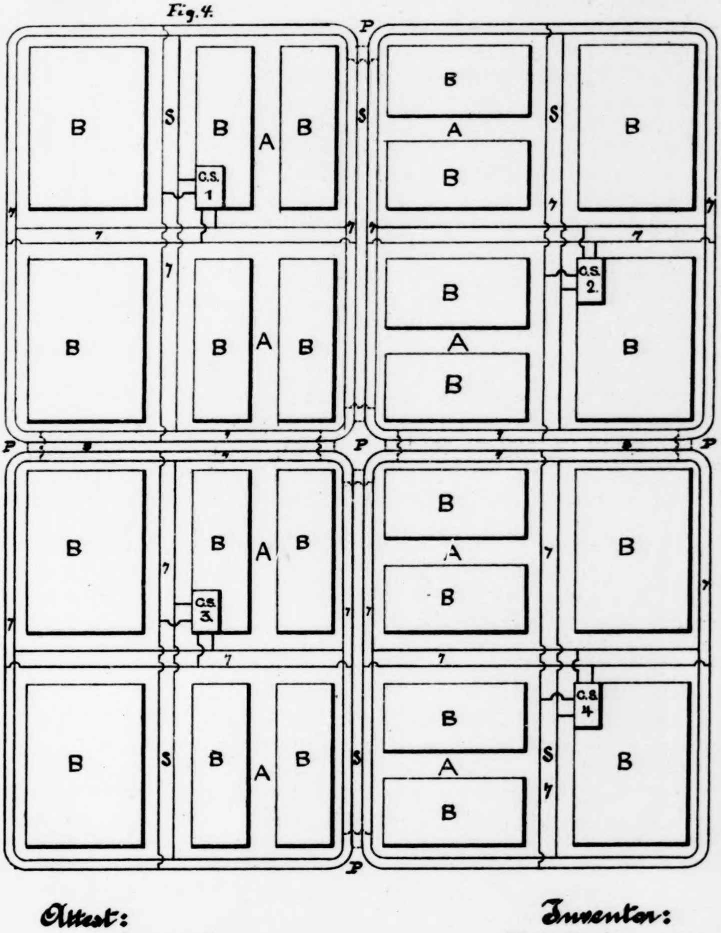
4 Sheets—Sheet 4.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 369,280. Patented Aug. 30, 1887.

Fig. 4.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Attest:

Saml. D. Mott
Jas. A. Payne

Inventor:

T. A. Edison per
Dyer & Wilber
Attys.

In these drawings, figure 1 is a plan view of a central station. Fig. 2 is a modification of Fig. 1. Fig. 3 is a plan view illustrating the street-mains and house-connections with translating devices properly introduced. Fig. 4 is a plan showing a locality divided into four districts.

In Fig. 1 three batteries of generation, C C' C^2, are shown, which number may be increased or diminished, as circumstances may demand. One generator, *c*, of each battery is used to generate the current feeding the field-of-force magnets of the other machines
4148 in its battery, the circuit from such field-generator through
the field-of-force coils in each battery being shown by the broken lines 2 2 2. For actuating the rotating parts an engine, D, is used with each battery, connected by belt *d* to line of shafting E, from which belts *e* pass to the generator. The coils of each battery in which currents are generated are connected, as in C' and C^2, in multiple arc to conductors 3 3 3 3, which in turn are connected in multiple arc to the main conductors 6 6, from which lead in multiple arc the street conductors or mains 7 7, or, as shown in part of battery C, each machine may be directly connected in multiple arc to the station-conductors 6 6. F is the prime field-of-force generator, supplying the battery field-of-force generators *c c c*, its circuit being shown in broken lines 1 1. The field-of-force magnets of F are magnetized by a current from the galvanic battery G, in whose circuit is arranged the series of conductors H, provided with the cut-out K, by which more or less of the resistances are put in or out of the circuit feeding the field of F. This arrangement forms a very effective and simple method of regulating the production of current or the pressure at the central station, for the current generated by F being dependent upon the intensity of the magnetization of its field-of-force magnets, which in turn depends upon the current transmitted around the magnets by the battery G, as the resistance varies such current, it follows that by varying the resistance in the circuit of G the current generated by F varies, which in turn varies the current generated in *c c c*, which in turn varies the current generated in the supply-machines of the batteries, proportionate increase of current and rise of pressure in the latter following increase of current around the magnets of F, and vice versa. One or more test-lamps, T L, are placed at the central station in derived circuits to serve as a photometric test of the pressure in the lines. For more accurately indicating variations in the pressure, one or more electrometers, galvanometers, or electro-dynamometers, E D, are placed in derived circuits, with a scale-mark indicating the pressure determined on as the standard pressure to be maintained. By the proper use of these indicating devices and the regulating devices described, a uniform pressure may be readily and easily maintained through all the mains. It is preferable to connect all circuits from the generating-machines to the main conductors 6 6 through switches I I I, so that an entire battery or any portion thereof may be thrown in or out of circuit, as the draft upon the station may indicate. It is to be noted, also, that the belt and pulleys of each machine are to be arranged by any of the well-known plans, that

it may be disconnected from the motor when desired These means may be used, when desired, as means of regulation, the number of machines in operation being controlled thereby, while the effective force of each machine while in operation is controlled by the resistances. The engines may be of any desired pattern or power, the number of machines in any one battery being limited by the power of the engine.

In Fig. 2, *c c c* are the field-of-force generators of batteries not shown, while *c′* is the field-of-force generator of a battery, of which three supply-generators are shown, connected to station-conductors 6 6, as before explained. The prime field-of-force generator F′ is in this case a dynamo-electric machine instead of a magneto-electric machine, as shown in Fig. 1, all its coils being included in one circuit, 8 8, which passes around the field-of-force magnets of the battery-generators *c c c c c′*. The same principle of regulation is used, however, the resistances H and cut-out K therefor being arranged in connection with the circuit through F′, so as to cause variation in the tension of the current therein, as and with the result before explained. In this figure there is shown what may be used also in connection with the plan shown in Fig. 1—means of testing the electro-dynamometers E D or other indicating instrument used. From a standard Daniell battery, D B, a circuit, *t c*, may be formed around E D by means of the switch L, so that, when desired, the correctness of E D may be ascertained and any inaccuracies which might arise be guarded against.

In Fig. 3 the mains 7 7 are shown, leading from corresponding wires at central station (see Fig. 1) down each side of the street. At side streets conductors 12 12 branch off. The small circles *o* in this figure indicate electric lamps. For street-lighting they are placed, as shown, in derived circuits from the street-mains. From the mains derived circuits 9 9 lead into houses, in which are placed at some suitable spot the meters M, through which one of the house-conductors passes, and by which the amount of electricity supplied to the house is accurately determined. Upon these house-circuits are arranged lamps on the multiple-arc system in such number, position, and grouping as may be desired. In these circuits I also propose to introduce electromotors E M, for furnishing light motive power. From the motor a belt, *i*, leads to a line of shafting, *h*, and pulleys *a a*, for any needed distribution of the power; or the belt *i* may pass directly to a sewing or other machine, a separate motor being used for each power-driven machine. Where motors are desired, each, preferably, should be made of a power proportional to the maximum work to be done. While the electrical tension in each machine is regulated at the central station, yet if the maximum load or work be diminished at any particular motor its speed would necessarily be increased. It also might be desired at times to diminish the normal speed of the motor. In order, therefore, that some determinate speed may be maintained, irrespective of load or work, each motor should be furnished with a governor. For this
4149 purpose I prefer a governor invented by me, and to be the

subject of a separate application, which acts to break the circuit when a certain determinate speed is exceeded.

In Fig. 4 is shown a locality divided into four supply districts. Each is provided with its own central station, marked C. S. 1, C. S. 2, C. S. 3, and C. S. 4. From each proper mains, 77, lead out, as before described. At convenient points, however—say P P—connections between the mains of the systems may be made, the effect then being to merge the entire locality into one large district with four supply stations, the pressure through all being uniform and each station doing its own quota toward maintaining the pressure uniform. The use of four stations and districts in this diagram is arbitrary and for illustration only, as the number actually to be made in any one locality depends upon the needs of the locality.

It is to be noted that all the circuits from the generators to the lamps or other translating devices are complete or round metallic circuits, as before stated.

What I claim is—

1. In a system of electrical distribution, the combination, with a complete or round metallic circuit, of a number of generators connected in multiple arc with such circuit, and consisting each of an armature revolving in a magnetic field, and a number of translating devices, also connected in multiple arc with said circuit, substantially as set forth.

2. In a system of electrical distribution, the combination, with a complete or round metallic circuit, of a number of generators connected in multiple arc with such circuit, and consisting each of an armature of low resistance revolving in a magnetic field of great strength, and a number of translating devices, also connected in multiple arc with said circuit, substantially as set forth.

3. In a system of electrical distribution, the combination, with a complete or round metallic circuit, of a number of generators connected in multiple arc with such circuit, and consisting each of an armature revolving in a magnetic field and having the coils of its field-of-force magnet and its generating-coils separate, (*i. e.*, not connected in series,) and a number of translating devices, also connected in multiple arc with said circuit, substantially as set forth.

4. In a system of electrical distribution, the combination, with a complete or round metallic circuit, of a number of generators connected in multiple arc with such circuit, and consisting each of an armature revolving in a magnetic field, a number of translating devices, also connected in multiple arc with said circuit, and a regulator for regulating the supply of current to such circuit, substantially as set forth.

5. In a system of electrical distribution, the combination, with a complete or round metallic circuit, of means for generating electricity connected with such circuit, and consisting of one or more dynamo or magneto electric machines, translating devices connected in multiple arc with said circuit, an indicator of the electric pressure upon such circuit, and a regulator under control of the operator for regulating the supply of current to such circuit, substantially as set forth.

6. In a system of electrical distribution, the combination, with a complete or round metallic circuit, of a number of generators connected in multiple arc with such circuit, and consisting each of an armature revolving in a magnetic field, translating devices connected in multiple arc with said circuit, an indicator of the electric pressure upon such circuit, and a regulator under control of the operator for regulating the supply of current to such circuit, substantially as set forth.

7. In a system for the generation and distribution of electricity for light or power through cities or towns or districts thereof, a central station whereat are combined a number of generators of electricity connected in multiple arc, and consisting each of an armature revolving in a magnetic field, an indicator of the electric pressure, and a regulator of the current generated, conductors forming complete or round metallic circuits leading from such station to distribute the current throughout the system, and translating devices connected in multiple arc with such conductors, substantially as set forth.

8. In a system for the generation and distribution of electricity for light or power through cities or towns or districts thereof, a central station whereat are combined a number or generators of electricity connected in multiple arc, and consisting each of an armature revolving in a magnetic field, an indicator of electric pressure, and a regulator of the current generated, conductors forming complete or round metallic circuits leading from such station to distribute the current throughout the system, translating devices connecting in multiple arc with such conductors, and meters at the houses for measuring the current supplied to such translating devices, substantially as set forth.

In testimony whereof I have hereunto affixed ny signature this 28th day of January, A. D. 1880.

THOMAS A. EDISON.

Witnesses:
C. P. MOTT.
S. D. MOTT.

4150 A. D. 1840. No. 8644.

Applying Motive Power to the Impulsion of Machinery, &c.

Pinkus' specification.

To all to whom these presents shall come, I, Henry Pinkus, late of Banton square, Coventry street, in the county of Middlesex, but now of No. 36 Maddox street, Regents street, in the said county of Middlesex, Esquire, send greeting:

Whereas her present most Excellent Majesty Queen Victoria, in and by her letters patent under the great seal of Great Britain, bearing date at Westminster, the twenty-fourth day of September, one thousand eight hundred and forty, for herself, her heirs, and successors, did give and grant unto me, the said Henry Pinkus, my

executors, administrators, and assigns, and every of them, by myself and themselves, or by my and their deputy or deputies, servants or agents, or such others as I, the said Henry Pinkus, my executors, administrators, or assigns, should at any time agree with, and no others, from time to time and at all times thereafter during the term of years therein unexpired, should and lawfully might make, use, exercise, and vend within England, Wales, and the town of Berwick-upon-Tweed, and also the colonies and plantations abroad, my invention for "improvements in the methods of applying motive power to the impelling of machinery, applicable, amongst other things, to impelling carriages on railways, on common roads or ways and through fields and vessels afloat, and in the methods of constructing the roads or ways on which carriages may be impelled or propelled," in which said letters patent is contained
4151 a proviso that I, the said Henry Pinkus, shall cause a particular description of the nature of my said invention, and in what manner the same is to be performed, to be enrolled in her said majesty's high court of chancery in England, with- six calendar months next and immediately after the date of the said in part recited letters patent as in and by the same, reference thereunto had, will more fully and at large appear.

Now know ye that, in compliance with the said proviso, I, the said Henry Pinkus, do hereby declare that my invention of improvements in the method of applying motive power to the impelling of machinery, applicable, amongst other things, to impelling carriages on railways, on common roads or ways and through fields and vessels afloat, and in the methods of constructing the roads or ways on which carriages may be impelled or propelled, consist- particularly in the methods of applying and using several seperate and distinct but well-known sources or means of acquiring motive power or powers, force or forces, some of which were specified and applied in my former patent for England, dated twenty-sixth August, one thousand eight hundred and thirty-nine, whereby and by means herein described I induce, transfer, or transmit, as herein described, the motive forces which I cause to be generated and which I apply to the different circumstances, things, and uses herein described, consisting partly in varying the methods or applications described in my said former specification, the variations and additions being—

First. The motive forces, or any or them, to effect propulsion on railways. I vary one of the said motive forces, to wit, what I term gaso-pneumatic in the following manner: That is to say, on a line of railway of the ordinary construction or any modification thereof I lay and continue along the whole length of such railway as series of common gas mains or pipes, 2 of any convenient diameter, say about five or six inches in diameter. These are laid, if on a double track, in a center line between the two tracks of railway at
4152 distances of about two miles along said line. I lead a bend or bends, a branch or branches, of any required length from said mains, and to these, where they occur, I connect and establish the gas-explosive apparatus or engine *g g*, or parts thereof, de-

scribed in my said former specification, being fixtures upon said line of railway, in the manner hereinbefore described, reference being had to the several drawings and figures hereinafter referred to, or in any similar way. From the engine or apparatus so to be constructed I transfer or transmit the power or force induced at each station along a line of said railway in opposite directions by the effect of the explosive mixtures of gasses and air, the former supplied through said mains from gasometer stations placed at convenient distances, say ten miles apart, along said railway, and thus I vary the method of applying said power described in my said former specification.

Secondly. To effect propulsion on canals. I also vary the method described in my said former specification in manner hereinafter described and referred to in the accompanying drawings and figures.

Thirdly. I effect a motive force or power by applying the aforesaid gaso-pneumatic principle to impelling machinery, to wit, the impelling engine described in my said former specification dated twenty-fifth day of Feb-uary, one thousand eight hundred and forty-one, being the gaso-pneumatic engine therein referred to, and apply the said gaso-pneumatic engine to another and different use by combining with it a method of communicating a source of motive force, to wit, gas, which I take up from the public mains or pipes when laid down in cities, towns, and other places for the purpose of supplying gas for lighting and by the combination of method and apparatus hereinafter described construct and apply the same to the purpose of a fire-engine.

Fourthly. I further vary the methods of effecting propulsion on said railways or said canals by one of said motive powers or forces,
to wit, steam power, in combination with the same or parts of
4153 the same, impelling machinery or apparatus in lieu of gaso-
pneumatic power, in manner hereinafter described.

Fifthly. I effect impulsion or propulsion on and along railways, common ways, and canals and over, along, or through fields by inducing or generating a well-known source of motive power, force, or influence, being electrical, whether electro-magnetic, voltaic, frictional, or otherwise. These or any of them I supply from stationary wells or batteries, whence I transfer or transmit the motive influence along a line of railway, common-way, canal, or field to put in motion apparatus and impelling machinery consequent upon the combination of method and apparatus hereinafter mentioned, and effect the other things hereinafter described. In the following parts of this specification and the drawings and plans accompanying the same numbered from No. 1 to No. 10 and the parts thereof the same figures of reference apply to all the diagrams, plans, elevations, sections, and views respectively for each distinct subject, by reference to all or any of which the varied applications, combinations, effects, circumstances, and other things referred to in the title of my patent will more plainly appear.

And, first, as to the varied application of one of the combinations of gaso-pneumatic power to engines, apparatus, and machinery, whereby and by means whereof I construct what I denominate a differential railway, drawing No. 1 as seen in plan, figure 1, elevation, figure 2, and end view, figure 3; 1, 2, 3, 4 represent the rails on a double line of railway. At a central point between the double lines I construct a fixed engine or apparatus suited to any of the motive powers herein referred to. If for gaso-pneumatic, then I combine with the said apparatus the gaso-explosive engine described in my said former specification, which is therein described in detail as well as in the method of working it, referring to which renders it unnecessary that I should do more than shew without minute detail the parts in this specification or the accompanying drawings herein. On a suitable foundation at A, figure 1, under the surface level of the railway, I frame a base, *a a a a*, of any suitable material, on which I suspend or support a cast-iron wheel or wheels, *b b b b*, in a horizontal position, figures 1, 2, 3, of such diameter as that the 4154 peripheries shall revolve at about the centre of each track of railway. On the peripheries of these wheels are grooves or flanges one inch in depth, the width of the grooves about five inches. Two of these wheels are laid parallel one to the other, and are connected with a double crank, *c c c c*, the crank journals to be at right angles to each other. The under part of the crank axle revolves in a step, *e e e e*. Over the wheels *a a a a* is a cast-iron frame, *f f f f*, bolted to the frame which supports the wheel, *bolted to the frame which supports the wheel*, for the purpose of supporting the upper end of the crank axle on the frame that supports the wheels *b* and in a central position between the double lines of rails, and in a horizontal position are placed the piston cylinders *g g g g*, whether for gaso-pneumatic or steam power, from the piston rods of which are attached the connected rods *h h h h*, uniting the piston rods with the journals of the crank axle *c*. One of these wheels, namely, the lower one, may be thrown into and out of action by the application of a clutch, as used in the common manner, and therefore allows the crank axle to revolve loosely in it. To a cross-horizontal frame I support four horizontal friction or adhesion rollers, *i i i i*, two of which revolve in the groove of each of the wheels *b*. At a point, B, and at the distance of about two miles on and along the line of way, I construct and fix in similar position and in a like manner another one of the same engines and apparatus, and at a point, C, are two similar wheels being about one mile intermediate distance between the engines A and B so fixed. I construct in like manner another apparatus of the same construction, omitting only the piston cylinders *g g* and the connecting rods *h h* and the crank axle, and substitute in lieu thereof a straight axle. The wheels at C, however, must be supported on a movable frame, K, figures 1 and 2, having rollers that move on rails or bars fixed to the foundation on which the wheels and frame move. The distance between the centres of the two wheels may be about twenty feet, and the rails or bars on which the frames move of such a length as to allow the frames and rollers to move backward and forward for a distance of about ten feet each. Between the centres of the wheels B is constructed a well, E, several feet in diameter and about twelve feet in depth. On

and across the top of the well E is laid a circular frame-work, K, for the purpose of attaching two guide-pull*ies* about two feet in
4155 diameter. The frame K has a hole in the centre through
which a chain, *x x*, passing over the guide-pull*ies*, may move. A chain, *x x x*, connected with either frame of the wheels passes over the pull*ies* and is reeved through a metal block and pulley, *m*, and from the block *m* are suspended, in the well, weights *n n n n*. This arrangement will constitute one section of about two miles in length of a double line of railway. At similar points and equal distances along a line of railway I form, construct, and fix similar engines, constituting similar stations and sections of railway. The adjacent apparatus continuing from B will be a similar apparatus to that placed at C, and at the next fixed point or station beyond the apparatus C is placed a similar engine and apparatus to that fixed at A or B, and so on alternately along the whole line of railway. All along the central line, between the double line of railway, I lay a common gas main, 2, say five or six inches in diameter, having common syphon wells and intersecting valves, all of which are permanently laid under the surface level of the railway. At each of the engines, A or B, is a branch from said main communicating with the gaso-pneumatic engine *g g*, connected with the gas mains. At stations of about ten miles apart are gas stations for manufacturing the gas to supply the mains. Along the whole line of railway, near the centre of each double line of railway, I construct trenches L L, figure 3, nine inches wide by twenty inches deep, of brick, timber, or any other suitable material, the upper line of the trench being in a line with the surface level of the railway. Along the whole length of the railway and in the centre line of the trenches L L I place a series of pull*ies*, *q r s*, at any convenient distances apart, say forty feet, more or less. These are constructed in the following manner: — a frame or standard, *p p p p p*, figure 4, plan, elevation, and section on an enlarged scale, I suspend a roller, *q*, by its axis so as to allow it to revolve freely. The diameter of this roller may be about fifteen inches and its width four inches and a half, having a groove in its periphery four inches wide and half an inch deep. In the same standard and above the roller *q* I suspend a compound pulley *r*; 1 S, by its axis
4156 S, being of a larger diameter than *r*, three feet nine inches,
whilst *r* is the same diameter as *q*, about three and a half inches wide, the axis of *r s* is allowed to rise and fall in a slot having a bearing, *t*, on the side of *q*. Under the bearing is a spiral spring, *u*, of sufficient strength to lift *r s* from contact with *u*, say half an inch above it; *r* may fall into the groove of *q* and roll freely on it. I now form a band of metal, say steel, *w w w w w w*, of a continuous length, four inches wide and about quarter of an inch thick. I pass this band round in the groove on the periphery of the wheels *b* at the station A between the friction rollers *i i* and between the nearest rollers *q r*, on the standard *p q*, and *r* of the nearest rollers may be slightly conical, so as to twist the band from a vertical to a horizontal position; and I lead the said metal band between all the pull*ies* *q* and *r*, along one track of the double rail-

way, to one of the wheels *c* at the intermediate station and around in the groove in its periphery, and so pass it in like manner between all the pull*ies* *q* and *r* on the other track of the double line of railway, the nearest pulley to the wheel *b* at *c* being slightly conical, so as to twist the band from a vertical position on the wheel to a horizontal position. I thence continue the band between the pull*ies* *q* and *r* along this track of the railway and so bring it up to the wheel *b* at A, where I unite it to the other end of the band, so as to form an endless band. A round or circular metal rope, bar, or bars may be used instead of the aforesaid band; in that case there must be grooves in the peripheries of the rollers *q* and *r* to correspond with the form of the rope or continuous bars. When curves occur on a line of way the metal band may be made to conform to it by making the pull*ies* *q* and *r* conical, so as to twist the band whilst passing the curves; and, further, if in lieu of said gaso-pneumatic cylinders at the points A B steam engines be substituted, then the line of railway may be worked by stationary steam power, and in that case the aforesaid mains may be dispensed with. On the differential railway the carriages receive their impulsion
from the impelling wheels S fixed at the points aforesaid
4157 along the line of way. In order to bring the carriages in
contact with the wheel, I suspend under the floor of each carriage a movable flange bar, 1 (figure 2, drawing No. 1, A 2), having a length equal to the length of the carriages and buffers—say about twenty-eight feet. The mov*e*able bar may be made of rolled iron, about one inch thick in the web, of the form shown in section, figure 4, the flanges 2 2 of the bar about one inch deep, and the plain surface of the bar about eight inches between. The bar is suspended below the travelling wheels in the following manner: As one method which, however, may be varied by any simple mechanical arrangement, namely, two or more parallel *p*r similar bell-crank levers, 4, to be attached to the upper flange of the mov*e*able bar by the extremity of the short end of the lever 3; the other or long end of the lever or bell crank to have attached to its upper or extreme end a curved rack, 5, into which a pinion, 6, is moved by a crank handle, 7, the action of which tends to raise or lower the flanged bar 1, so as to bring it in contact with the impelling pulley S or raise it therefrom at will. The degree of pressure of the bar 1 on the wheel S may be regulated by an index, so as to induce any required degree of adhesion between S and 1. In order to fix the bar 1 when in contact with S, I attach to the frame a long wrought-iron rod, 8, joined at the ends of each carriage by a long clutch coupling, 9, with sufficient play room. Longitudinally upon this rod I fix a strong screw-thread which works in the periphery of a pinion wheel, 10, upon the axis of which I fix two excentrics, 11, placed in such manner as to press down the bar 1 on each side of the rib by the action of the screw-rod acting upon the screw-pinion in motion by a ratchet-wheel handle, 12, near the seat of the conductor or conductors of the train. On the front end of the bar 1 I attach a bent spring steel bar, 13, of the form shown, which is in-

tended to throw each pulley *s* into motion before it comes in contact with the curved end of the bar 1.

And I further vary one of the said applications or combinations of gaso-pneumatic power with engines, apparatus, and machinery described in my said former specification, as therein shown,
4158 to apply to impel or propel vessels on canals by a further
combination of method and apparatus to effect a like purpose; to which end I construct on and along the whole length of a canal, on one or both margins thereof, a suspension rail, A A A, figures 1, 2, and 3, drawing No. 2, as shown in plan, elevation, and sectional end view, by fixing piles or pillars *a a a a* along the said margin, about eight inches square, and these constitute the sleepers for supporting a single line of railway bars. These are let into the ground to the depth of about three feet and project to a height of about eighteen inches above the surface level of the towing path and are placed about nine feet apart. On the tops of the piles or sleepers are placed common railway chairs *b b b b*, fastened down to the sleepers in any convenient manner. Into these chairs are placed the ends of the railway bars and fastened by a bolt or pin, *c c c c*. The bars are about nine feet in length and have a convex up-er surface. Along the said canal, in a line with a line of the rail, I lay down the said gas main, *x x x*, described in my former specification, of the diameter of about four inches. This main is laid under the surface level of the towing path, and to the main is attached, at suitable distances, common syphon wells for the purpose for which such wells are usually applied to gas mains. At distances of from one to two miles apart along said mains I connect bends or branches *d d d d*, and to these, where they occur, I apply and connect gas-valve mains B B B. On each of the bends *d* I apply an intersecting valve for cutting off the communication between the gas main and the valve main, for which purpose I apply a lever action, the lever *e e e e* being made self-acting and is connected with another lever, *e*, by a wire, *f*, shown in a waived line. The valve of the valve main is constructed in the same manner as the gaso-pneumatic-valve main described in my said former specification and may be of any required length, say from one hundred to one hundred and fifty feet in length. On the rail *a* I suspend an impelling machine, C, as in plan, elevation, and sectional end view. This I construct in the following manner: To a cast-
4159 iron crutch or frame, *g g g*, I attach travelling wheels *h h h h*
by their axes in a slot in the crutch of the diameter of about fifteen inches. From the crutch are suspended weights *k k k k*. These are firmly attached so as to be inflexible. They are placed near the ends and on each side of the crutch. These are intended to support the travelling wheels *h* in a vertical position by suspending the principal metal of the weight below its centre of gravity. In the middle part of the crutch or frame between the travelling wheels *h* are suspended by axes two friction or adhesion wheels *l l l l* of about two feet diameter and one and a half wide on their peripheries, which are squared. These are pressed against the sides of the railway bars *a a a* by a strong spiral or other springs pleced

on one side of bearing blocks — as to regulate the required degree of adhesion or pressure against the railway bars. On the same ax*is* which carry the friction wheels *l* are attached pull*ies* *m m m m*. These pullies — about two feet in diameter and about two and a half inches wide and have circular grooves in the peripheries for the purpose of carrying a cord or tow rope, and the pull*ies* may be so arranged as that the peripheries may roll on the other and so press the cord when in the groove. The pressure of the friction wheels will tend as well as the weights to maintain the travelling wheels in a vertical position. To and on one side of the frame or crutch I attach, in a vertical position, by bolts, a tongue or compressed pipe, D D D, of the form shown in plan, horizontal section, elevation, and end view, being the hollow tongue described in my said former specification. On the upper surface of the tongue I connect a union joint or screw of the diameter of three inches. The machine so constructed I denominate the dynamic impelled. In a canal boat or vessel, E E, I fix the gaso-pneumatic explosive engine G G described in my said former specification or any modification thereof, to the piston of which I attach a connecting rod, *m*, to the journals of a crank or cranks. In the vessel E I place a horizontal fly-wheel, F F, of any convenient diameter, supported in any suitable manner, on the top of the crank axle. The fly-
4160 wheel may be placed under the deck of the vessel or under
the floor. On the upper surface of the fly-wheel I attach a pulley, *o o o o*, by pins to its rim or arms; the connecting rod *m* may be united with the crank journal or journals. In any convenient situation in the vessel, either under the deck or over the deck, I place a reservoir, 2 2, for gas; this may be in the form of long wrought-iron pipe or pipes of light construction and of any convenient length and about twelve inches diameter. In this reservoir I place a flexible diaphragm, being the diaphragms of the gas reservoir described in my said former specification. This reservoir communicates by a pipe with the explosive engine G, and from another pipe, 3, connected with the reservoir, of the diameter of, say, 3 inches, I connect by a union joint, flexible tube, or pipe, P, by one of its ends; this tube may be about three inches diameter, of any convenient length say about the length of the tow-line or cord of the vessel; the other end of the flexible pipe I attach by the union screw on the tongue D, and so unite the reservoir in the vessel with the said tongue. In the tongue D is an intersecting valve, namely, the intersecting valve described and shown in the gaso-pneumatic engine referred to in my said former specification. I apply one of the said sources of motive power, namely, the said gaso-pneumatic power, by a farther varied combination of method and apparatus, to another useful purpose, namely, the purpose or purposes of a fire-engine; for that object I vary the mechanical arrangements, or some of them, of the gaso-pneumatic locomotive engine described and shown in my said former specification, to which I refer, referring herein also to the accompanying drawing No. 3, figures 1, 2, 3, in plan, elevation, and end view. In these figures *a a a a* are the travelling wheels, *b b* the frame, *c c* the springs, *d d* the axles, *d* 1 *d* 1

the crank axle, *d* 2 the fly-wheel, *e e* a gas chamber, *g g* the piston cylinders, *h h* the slide-boxes, *k* a double-acting air or gas pump, *k k* 1 another double-acting air pump, *l l* a supply pipe leading from the gas chamber *e e* to the globular explosion chamber M M 1, on which — igniting slides *i i* and safety valves *j j*; *n n* 4161 branch pipes leading from the explosion chamber M and M 1 and into the slide-boxes *h h*; *o o* is a four-way valve or cock intersecting the supply pipe *l* and communicating with the explosion chambers M M 1; *p* is a leaver fixed on the top of the four-way valve and is attached to the rod *q*, which is connected with the lever *r r*, and so to the excentric S S on the crank axle *d* 1; *t t* are the guides and *u* the frames, *v v* the connecting rods, *w w* the reversing gear attached to the reversing bent lever *x* 2 *x* 2; *y y* is a bent lever, one part of which is connected with the piston rods of the gas and air pump *z z*; the middle part has a rack, on which is an adjusting chuck, *z* 1 *z* 1, at the end of an eccentric rod, *z*, on the crank axle *d* 1. In the fire-engine there are stuffing boxes at both ends of the cylinders *g g*, through which the rods 1 and 2 of both pistons work. — one end of the frame of the fire-engine are fixed two single-acting force pumps 3 and 4, connected with the water tank 5 5 5 by square water-ways 6 6, in which are placed common lifting valves. To each of one end of the piston rods 1 and 2 are solid plungers 7 7, working through a stuff space, 8 8. 9 9 is a metal globe communicating with the water-ways of the force pumps 3 and 4, on which one or more branch pipes 10 10 may be attached by union screws. 11 is a metal air globe, on the top of which is a pressure valve, 12 12. At the forward end of the fire-engine there is only one wheel, being an ordinary swivel wheel acting under an arched end frame. 13 13 are long screws, on the top of which are hand wheels for screwing the rods down against the ground, so as to steady the engine while in action. To the turn-plate of the front wheel of the engine may be attached a common tongue or shaft, to which horses may be geared for the purpose of drawing the engine from place to place. On a portable drum wheel, which may be placed on or lifted from the engine, may be wound two or three hundred feet of a cylindical flexible pipe about from an inch to an inch and a half internal diameter; this may be made into lengths of fifteen or twenty feet and united at their ends by union screws of the size and thread ordinarily applied to common gas-4162 service pipes or gas fittings. Several corresponding union screws, 14 14, may be attached to the gas chamber *e e* of the engine, by which one or more flexible pipes may be attached to it.

I further vary my methods of impelling vessels on canals by applying another kind of motive power, namely, the motive power of steam in combination with parts of the apparatus and machinery already described in its application to gaso-pneumatic power; to this end I construct the before-mentioned rail A A A, but I dispense with the use of the gas main and all their attachments and connexions, and I dispense with the tongue D, with its connexions (and I dispense with the flexible pipe P), with the exception of the construction of the dynamic impeller A. Figure 1, drawing 4, remains as before described, only that I further add to it by constructing a circular rail, *a a a*, which I divide into three parts, as shown by the moveable stop-joints *b b*. The top of the curved rail is the same diameter as said rail A and has the same convex surface.

Figure 2 is a canal-boat designed for goods or passengers; in this boat may be placed a steam engine of high or low pressure; *c* is a horizontal fly-wheel, supported, as before, on the top — a crank axle, to the journal or journals of which the connecting rod or rods of the steam engine may be united. On the upper side of the fly-wheel a pulley, D, may be fixed, as before described. An endless cord or tow-line, *e e*, may be passed round the groove of the pulley of the fly-wheel, and also round one of the pull*ies* on the off side of the dynamic impeller. A friction roller, *f*, may be fixed to roll on the periphery of the pully *d*, and press the tow-line by revolving in the pulley. The object of the curved rail is to enable one dynamic impeller to pass over the back of another impeller, for which purpose the rail is jointed as aforesaid.

In that part of my said former specification whereon two sources of motive power therein described *as* applicable to field operations in agriculture I refer to drawing No. 1 accompanying said former specification, and also drawing No. 5 accompanying this specification, wherein D is the locomotive impelling engine in said
4163 drawings 1 and 5, to both of which the said letters of reference in said former specification apply. In No. 5 the stuffing box placed on the vertical column *x* 1, in which the end hollow axis *x* of the drum *w* revolves, is a fixture. The flexible pipe S, drawings No. 5, should be three inches internal diameter and of any convenient length, say two hundred and twenty yards.

I apply one of the methods of motive power or influence to the other things referred to in the title of the present specification, reference being had to the drawings hereinafter referred to, namely, to the things hereinafter described, all of which result from the combinations of methods and apparatus hereinafter described; and 1st, in one of the methods of constructing the roads or ways on which carriages may be impelled and by which apparatus may be put in motion or action the combination of methods, engines, and apparatus hereinafter described are the bases upon or from which all the actions, effects, or things result or obtain. The power or influence which I apply is the electric influence in any of the forms which I may find most convenient, by any of the well-known methods of inducing the electric currents, whether voltaic, electro-magnetic, frictional, or otherwise, and whose induction, tension, or influence may be transferred, transmitted, or induced at points or places distant from prime sources or batteries. One of the objects to which I apply said motive force or influence is to put engines, apparatus, machinery, and implements in motion in, along, over, or through fields for agricultural purposes; with that view I*n* erect in any given area of land, say one or more square miles of land, a station, A, drawing 5, placed in a central or any convenient situation. A is a building, in which I construct and place an electric battery or batteries of any of the common or well-known constructions, or I construct wells or tanks A A 1 in any part or parts of such ar*rear* of any suitable material or any required size or form; those I place under the surface level, the tops of which are so far below the surface as that they may be covered up with soil, so as not to interfere or impede agricultural operations.

4164 From the station A or any of the stations A A 1 I lay down a system of mains or pipes, B B B B, of the diameter of about two or three inches, united by flanged joints connected in the common manner. These may be laid through various fields, either below or above the drainage, and in any direction, as shown by the dotted lines passing through B, one of said mains B. One is uncovered to show its position under the surface level. All along said mains, at convenient intervals of from one — two hundred yards, I erect short vertical branches, *a a a a*, communicating with the pipes B. These terminate in a box, *c c c c c*, having a moveable lid, the top of the box to be so far below the surface level as not to interfere with tillage. From the station A or from the wells A 1 I lead through the pipes B continuous metallic wires, rolls, or ribands or bundles of fine wires, as shown at 1 2 3 4 5 6, drawing No. 6, say of copper, of any required thicknesses or surfaces. The wires, rods, ribands, or bundles may be insulated by silk and varnished in the common manner, so that one wire or rod or riband or bundle shall not be in contact with another. These may be laid in pairs and colored with different colors—for example, black and red, blue and yellow, brown and green—the black and red corresponding with the positive and negative poles of the battery, and in like manner the blue and yellow and the brown and green and so on for any other pairs and colors. Any pair so arranged may be turned into the vertical branch or branches *a* and terminate in the box or boxes *c*, in which they may diverge and be fixed at points *d d*. The apex of *d* may be sufficiently long to bend over to *d* 1, with which it may be brought in contact by a screw and from which it may be released at will. A similar arrangement is made in all the boxes *c*. All the said wires, rods, ribands, or bundles must be so properly arranged and be so continuous as that when connected in the boxes or the pairs united with any other wires connected with apparatus or machinery and their ends at the stations or wells are brought into proper contact with the positive and negative poles of a battery they shall form or constitute proper metallic circuits.

4165 The wires, rods, ribands, or bundles may be of any desirable dimensions suited to convey by their means the largest intensity, effect, or influence *or* what is called an electric current when the wires and battery are properly — for conveying or communicating the electric force and when the electric influence is continued under induction or tension and so long as the ends of the wires forming the metallic circuit are in proper connection with the poles of the battery or batteries at the stations A or A 1.

In order to put imp*el*ments into action for field or other operations, namely, such imp*el*ments and apparatus as are referred to and described in my said former specification, I construct a locomotive engine, D, drawing No. 5 A, with similar wheels *a*, frame *b*,

spring *c*, axle *d*, or crank axle *d* 1, having the columns *x* 1, revolving drum W, the wheels *a* having the studs 1 2 3 4 or any other implements described as appertaining to said locomotive engine in my said former specification, but dispensing therefrom with the cylinders *g g* and their appurtenances and the piston rods *h* and the connecting rods *k* and the guide frames *o*. The drum W may be of smaller dimensions than therein described, namely, ot the dimensions of three or four feet diameter and of the width of two feet, but suspended in the manner formerly described. Around the said drum I wind a coil or pair, S S S S, of the aforesaid wires or bundles, of any required length and dimensions—say from one to three hundred yards. One extremity of said pairs I pass through the drum hollow axis and through the fixed stuffing box; the other extremity I attach and properly adjust to a similar pair, terminating in the box *c*, for which purpose the ground may be opened and the lid of the box raised. To the locomotive engine D I apply an electro-magnetic engine, namely, any well-known and effective electro-magnetic engine or machine capable of imparting motion to machinery—for example, Taylor's (patented) electro-magnetic engine or one on the principle applied as hereinafter described. If Taylor's engine be used, then I apply one or more of said engines to the axle *d* on the locomotive engine D, to the poles of the magnets, which I connect, and properly ad-
4166 just the wires S S, so that from said pole of the electro-mag-
netic engine, on the axle *d*, through the pair of wires S S, passing through the stuffing box on the column X 1, on through the hollow axis, through the continuous coil on the drum, to the corresponding wires connected as aforesaid in the box *c* on the vertical branch *a*, thence through the main B 1 and the main B to the station A and properly to the poles of the battery therein, or when connected in like manner at the wells A 1 or any of them, so that when the aforesaid connections are ma*id* and properly adjusted there shall be an unbroken communication between the battery at the station A or wells A 1 or any of them and the locomotive engine D, so that between station A or A 1 and D there shall be a proper metallic circuit established.

And, further, I apply the said method or source of motive power, to wit, the electric, to another of the things referrred to in the title of this specification, namely, to the preservation of life and property on railways by acting on br*eak*s to stop and prevent the collision of trains. With that view I lay down all along a line of railway, in a central position, between the tracks of a double line, a light railway bar or bars, P, figures 1, 2, cross-section and elevation, drawing No. 7, supported on cross-sleepers when such are used or on one line of block sleepers when such are used; the railway bar may be fixed in chairs about nine feet apart or bolted on the cross-sleepers or into the blocks when such are used. The form of the rail may be of the same as shown in cross-section H, wherein *a a* is the cross-section of the railway bar, having flanges *b b* on the upper surface, into which is let continuous bars of hard wood *c* about two inches square; the bar is a hollow bar, as at *d*. I

divide the line of bars H into half-mile lengths or sections, No. 1, No. 2, No. 3, No. 4, by continuing a space of about three feet between the bars in the middle of the section, and I so continue them in half-mile lengths by similar spaces all along the line of the railway except where points or switches occur; at those places the spaces may be as many feet as to prevent their action or interfere
with trains when passing on them. All along the line of
4167 railway, say of one or two miles or more or less distance
apart, at convenient points or places I construct the aforesaid battery or batteries. From these batteries I lead a pair of metallic rods or wires of any required dimension or dimensions, having continuity as before described and insulated as before described; these I lead through the space or cavity *d* of the bar H on the angular surface of the wooden bars *e*, as at *e e*, continuous copper rods or wires *x x* 1 of any required dimensions, say three-quarters of an inch wide on their upper surface. These are attached to the wooden bars *e* by copper pins. The rods or wires are each as long as the said section of the bars. At the extremity of the half-mile section *a* 1 *a* 2, in plan form *a a*, the rod *x* communicates by contact with the rod or wire *x* 2 in the cavity of the bar, and the rod *x* 1 communicates by contact at the same extremity with the wire *x* 3 in the cavity *d*. From that end of the bar *a a* the wires *x* 2 and *x* 3 lead to one of the aforesaid batteries, No. 1, plan view, drawing No. 9 (where the ends of the pair of insulated wires communicate with and are properly adjusted to the positive and negative poles of said battery), and from another division of said battery or an independent battery at the said point or station another similar pair of insulated wires lead to the next succeeding half-mile section of the railway bar H, No. 2 in plan, drawing 9, where the said pair are in a like manner connected or adjusted, or in section No. 1, and a similar pair of insulated wires lead from the same station or battery A to similar sections No. 3 and No. 4 on one line of the railway, and from the same section of battery or batteries similar pairs of similar insulated wires lead in like manner to similar sections on the parallel line of railway. The rods of wires *x* and *x* 2 and *x* 1 and *x* 3 from a perfect continuity from the beginning of the section *a a* along the wires *x* and *x* 1 to the extremity of the section *a* 1 and *a* 2, when they join the extremities of *x* 2 *x* 3, and thence lead through the cavity *d* to the station of battery or batteries A, where, being properly adjusted to the poles of
a battery, — established a metallic circuit whensoever the
4168 wires *x* and x^1 may be made to communicate by contact,
and so in like manner do all the wires of all the sections when properly adjusted to poles of battery or batteries. In order now to transfer or communicate the electric influence to breaks connection with locomotive or other vehicles on railways I suspend from a moveable joint fixed on a wooden frame attached to a locomotive engine in elevation D, drawing No. 7, and as seen also in elevation No. 8, a pair of copper conductors, *g g*, figure 1, No. 8, and in figure (7) and in No. 7. This is suspended by a moveable joint attached to said wooden frame fixed on the locomotive engine. To

the lower extremities of the rod *g g* I attach by another moveable joint what I term an electro-magnetic coupler, *h h*, composed of two masses of copper of the form shown in section *h h*, elevation drawing No. (7) and in elevation No. 8. These are attached to a wooden block, *k*, by wooden pins *i i*, the lower extremity of *g g* being connected with the upper surface of *k*. The couplers *h h* are in contact with wires $x\ x^1$ in elevation drawing No. 8 and in drawing No. 7, x^1. From the upper extremities of the conductors *g g* a pair of insulated wires, *m m*, in elevation (drawing 8) pass through wooden guides *n n* attached to the locomotive. In a wooden frame fixed on the locomotive I place an electro-magnetic engine—for example, say, Taylor's rotatory engine. To the wire of one of the poles of the magnet or magnets I connect a corresponding wire, *m*, and to the end of the wire of another pole of the magnet I connect the other corresponding wire, *m*, by which means I complete a metallic circuit by means of the electro-magnetic coupling slide *h h*, because whilst one of the rods or wires leading from one of the poles of the battery through the wire x^3 from the end of the section *a a*, through the cavity *a*, to the wire x^1 at the extremity a^2 and by contact with one of the couplers *h*, thence through one of the conductors *g* and one of the wires *m* through the guide *n* to one pole of the corresponding wire wound round a magnet of the rotatory engine; then from the other pole of the magnet I connect the other corresponding wire *m*, which leads to the other conductor *g*, to the other 4169 coupler *h*, to the rod or wire x^2 in the cavity *d*, and so long to the other pole of the battery at A, to the pole of which said pair of wires are properly adjusted. so that when all the said connections are properly arranged a metallic circuit will be established, in which an electric current may be induced and through which it may be transferred. On the axis of said electro-magnetic rotatory — I attach a pulley, 1, about twelve inches diameter, insulated at its axis by ivory bearings, to the periphery of which I attach one end of a wire or cord, 2, and pass around the pulley 1, over which it passes to a lever, 3, on the whistle of the engine, with a branch cord or wire, 1, to the lever 4 of the steam-throttle valve of the engine.

And, further, instead of attaching the apparatus herein last described to the locomotive engine I place the same or a similar apparatus with a similar arrangement to one of the carriages of a train for the purpose of acting upon the br*eak*s of a carriage to impede or stop their progress, and from such carriage and the apparatus, when placed thereon, lead a cord of wire to the whistle and steam-valve of the engine in similar manner as before described, or, instead of Taylor's rotatory engine, I construct an electro-magnetic engine, P, of any required dimensions, figures 1, 2, 3, elevation drawing No. 10, in the following manner—that is to say, supported on a cast-iron frame, *a a a a*, laid on a suitable foundation, or constructed on columns *b b b b*, I erect a column, *d d*, on the apex of which I suspend a vibratory beam, *e e e e*, on a platform, *g g g g*. I construct and fix one or more electro-magnets *h h h h* of any required dimensions or capacity by any of the common and well-

known methods, each having a magnetic surface, say 1 2 3 4, sixteen square feet, more or less, according to any required force or power of an engine. The upper surfaces of these may be laid in a horizontal, angular, or vertical position on moveable points or axis *i i i i*. I connect one edge of flexible metallic plates *k k k k*, having superficial surfaces equal to the area of the magnets. When the plates *k* are connected with the axis *i* the flexible plates may lay flat on
the magnets *h h h h*, on those sides of the plate *k* which
4170 *which* are on the sides opposite the surfaces. In contact with
the magnets are raised surfaces or beads *m m m m*, riveted on the plates or rolled in the solid mass. These lay across the plates in lines which are at right angles with the beam of the engine, and must be of such proportions and so far one from the other as not to neutralize the required degree of flexibility in the plates in their actions hereinafter described. On the centre parts of the raised surfaces are eyes *n n n n*—iron joints intended to form movable joints. From the ends of the beam 1 2 are suspended movable connecting links, 2 2, which are keyed onto the axis 3 3, into which are keyed flexible steel bar connecting rods *p p p p*, or the rods hereinafter described, which terminate in the moveable joints *m m m m*, to which they are held by bolts or pins. The connecting rods so formed are of such lengths as that when the beam of the engine is in a horizontal position the connecting rods *p p p p* shall stand in diverging lines from the points *m m m m* to the links into which they are keyed, 2 2. From points 4 4 on the beam B B, in manner hereinafter shown, and from a point, 5 5, on the beam, I suspend a connecting rod, *q q*, which is connected with the crank *z*, on which is a pinion wheel, S S, which gears into a spur-wheel, — may be attached to the fly-wheel *u u*, moving on the centre *v*.

And, further, having in the foregoing part of this my specification described and shown the combinations of method and apparatus whereby and by means whereof I am enabled to apply and use one of said forces or influences, to wit, electricity in any of its forms, and shown how the same may be laid down on a line of railway for the purpose of acting on the br*eak*s of carriages and putting and impelling machinery in motion, I further vary said application by placing an electro-magnetic machine as the moving power on a locomotive engine for the purpose of impelling trains of carriages; for example, if Taylor's rotatory wheel, then on the axle or axles of the locomotive; or if one on the application of the electro-magnetic principle before described and shown in drawing No. 10,
which may be varied in its forms and construction so as
4171 suitably to apply to locomotive-impelling engines, then I
put such machines in motion or continue them in motion along a line of railway by taking up the electric force from the wires *x* and x^1, arranged as aforesaid, and the electro-magnetic slide *h h*, which communicates to the impelling machinery in manner aforesaid and establishe*d* a metallic circuit or circuits in manner before described; and, further, when I apply the said source of motive power or source to impelling vessels o*r* canals I apply the said arrangement of the metallic circuits to the rail *a a a* along a line of canal, slightly

varying the mechanical arrangements by supporting the wooden bar or bars *c* on each side of the rail in any convenient manner and bringing the electro-magnetic coupling slide down on each side of the rail to the wires x and x^1, which should be attached to the bars *c c*, all the required parts being properly insulated; then on the aforesaid dynamic impeller I place an electro-magnetic engine, being either of those referred to, either the aforesaid Taylor's or that on the principle applied and described and shown in drawing No. 10. These, by any simple gearing, may put the travelling wheels in motion, or either of the said engines, being placed in the vessel *e*, may put said fly-wheel, pulley, and cord in motion; but in lieu of said flexible tube, already described, conducting wires, communicating with the engines through the said electro-magnetic coupling slide, may be applied, and by their action impel vessels on canals; and in like manner said electro-magnetic engines may be applied to impelling machinery on the railway, the combinations of which I denominate the differential railway, by substituting for the gaso-pneumatic engines *g g* electro-magnetic engines, which may be used to put said impelling wheels which give motion to the metallic bands, ropes, or bars before described into motion; and, further, having shown some of the methods by means whereof I apply one of the said sources of motive power, to wit, electricity, and, amongst other things, described impelling engines in motion from fixed points or stations, I further vary my methods, as well along common roads or ways, along, over, or through common roads or ways and streets or places, and to manufacturers' houses 4172 or buildings in a like or similar manner as I have already described them along railways and through fields, and when so applied for the purpose as in manner herein described for putting said impelling engines or any similar impelling engines into motion for manufacturing purposes. In making such application of said motive force or influence I form on, along, over, or through from stations as aforesaid, properly established, electric metallic circuits, and to and with the said engines or any similar constructed engines placed along or in said ways, streets, places, buildings, or manufactories, I unite said engines with said metallic circuit and the said battery or batteries at stations as aforesaid, which said battery or batteries may be placed in any convenient situations as stations and constitute a part of said metallic circuit or circuits and when so established put engine, apparatus, and machinery in motion in manner aforesaid. Having now described the several combinations of methods and apparatus by means whereof I apply said several motive powers or forces to the said several uses herein described, I hereinafter set forth and described the operations of all the applications successively, reference being had to the drawings and figures applying to each subject herein and in the said former specification described.

Firstly. Differential railway. Operation: Gas being supplied for said gas stations, and fitting said mains along the whole line of railway, in which mains the gas may be under compression to any required degree, but say under a pressure equal to a barometric

pressure equal to several inches of mercury, the intersecting valves of the main at the engines A and B and at similar stations along the line being opened, gas will flow into the reservoirs of the engines and into the gas pump *k* and through the supply pipe *l*, through the four-way valve *o o o o*, into one of the explosive cylinders M or M 1, when it will mix with atmospheric air and f*ro*m an explosive mixture that may be ignited through the holes under the slides *i i* of the globes, and will dilate and pass through
the branch ways *h h*, on the opposite heads of the two
4173 pistons in the cylinders *g g*, drawing No. 1. The 2 pistons
will be forced in opposite directions through the cylinders.
The piston rods will give motion through the connecting rods *h h h* to the crank axles *c c c* of the wheels *b*, which will revolve to the metallic bands *w w*, by their adhesion on the periphery of the wheel *b*, with which the bands are kept in close contact by the adhesion rollers *i i i*, the alternating actions of said piston and connecting rods being continued by the working of said engine, as described in said former specification. The metallic bands, bars, or ropes will be drawn along the double tracks of railway between the pull*ies* *q* and *r* all along the line, which will put them in motion on both tracks of railway, the lower one, *q*, in the line of direction of the metallic band, and the upper one in a direction opposite to the line of direction or motion of the band. When the compound pull-y *r* and *s* are pressed down by any weight, so as to bring *r* in contact with the band, and when no weight presses upon the driving pull-y *s* of the compound pull-y, then the before-described springs lift all the compound pull*ies* so high above the band as not to be in contact with its upper surface, and in that case no motion will be given to any of the compound pull*ies* along a line of railway; but when the pull*ies* *r* of the compound pull*ies* are pressed down in contact, and motion is so given to them by the pressing band *w*, then, the pull*ies* *s* being of twice the diameter of the pull*ies* *r*, the pull-y *s* will revolve so that its periphery will move through twice the space of the pull*ies* *r*. Thus if the metallic band *w* be moved in one direction with a motion or speed of, say, eight miles an hour, then the driving pull*ies* *s* in contact with the band will move through spaces with a velocity equal to twenty-four miles an hour. The revolution of the wheels B at the stations A and at all the similar stations will put the wheels *b b* in operation at the station C or similar stations all along the line of railway. The band which moves through the said trenches L is kept properly stretched at the points C or any similar points by the weights *n n n*, suspended in the wells E, which act on the mov*e*able
frames at K at the points C, through the medium
4174 of the chains *x x*, connecting the frame and passing over the
guide pull*ies* on the top of the wells, and which are reeved
through the metal blocks and pull*ies* *m*. By means of clutches or any simple gearing either of the sections of the bands mov*e*ing between the stations A and station C or that section lying from station A in the opposite direction may be put into or out of motion by disconnecting the upper or lower wheels *b b*. If now on the

double line of differential railway trains be placed on the up or down line of the railway the carriages of a train or any required number of them having the adhesive flanged bars 1 2, drawing No. 1, A 2, with their connecting apparatus before described attached to them, the said bars 1 and 2 or some of them, in order now to start the trains and move them over the up and down lines of railway by turning the handle 7 on the pinion 6 round it will move the rack 5 on the quadrangular lever 4 and cause it to move in the direction of the arrow near it. This will cause the prop of the same lever 3 and its support 3 at the end of the bar to move in the opposite direction and in the line of the arrows near them, and cause the bar 1 to descend and press on the driving pull*ies* S. If on a pull-y fixed on the pinion 6 a cord or wire be fixed so as to reach to similar quadrangular levers 4 4 attached to the other carriages of the train, then when motion is given to the pinion 6 it will move the other levers 4, and so bring the bars attached to them to bear on any of the other driving pull*ies* S. The cords may be attached and detached on changing carriages. The bars 1 may thus be pressed down to effect any degree of adhesion on the pull*ies* S consequent upon the weight of the carriage and the yielding of the springs that support the carriage; but if to effect greater adhesion between the bars 1 and pull*ies* S on ascending inclined planes be required, then the lever of the racket wheel 12, being moved backward and forward, causes the rod 8 to turn the screw, which acts in the teeth of the screw-pinion 10 and causes it to turn, bringing down the excentric cams 11 to press the bar down with greater force, and so any of the other bars in the train be pressed down in like manner.

4175 When the band W is in motion and moving in an opposite direction to the moving train the weight of the carriages overcoming the springs that lift the pull*ies* *r s* from contact with the band causes *r* to descend on *w*, the driving pull*ies* S would be put into rapid motion, and rolling on the bar 1 impels the train of carriages forward. Some of the bars of the trains will always be on some of the pull*ies* S of the railway, and will be impelled forward by them in like manner. When the bar of the forward carriage has passed over one pull-y and approaches another pull-y S the flexible steel bar 13 will touch the next pulley, and rolling over and pressing on it will put it in motion before the curved end of the bar 1 begins to move over it, and so on for all other pull*ies* in advance of a moving train. When a train is moving on the up line in any section of the railway another train or trains may be moved on the down line of the railway by the same band on the same section of the railway, and as the train passes the stations A or C or any similar ones, then the forward carriage, leaving the pull*ies* acted upon by one band on one section of a railway, runs on to the pull*ies* S put in action by the band moved on another section of railway, and so on along the whole line of railway. When it is desired to stop a train the action of the handle 7 raises the bar 1 from contact with pull*ies* S, and by the cords leading the other levers 4 on the carriages raises all the bars 1, and the action of br*eak*s in the common manner stops the train. When action is given to the ratchet 12 and the rod 8 it produces pressure on the other bars of the carriages of the train by means of the coupling jaws 9, which are in contact and that slide one in another. Operation: The gaso-pneumatic power to effect propulsion on canals, reference being had to drawing No. 11, figures 1, 2, 3, the gas main *x* being filled with gas from said gas station, and the gas being under moderate pressure, filling mains all along the line of the canal, and the intersecting valve *d* of the valve main B being opened, gas will flow into the valve main through the hollow cavity of the tongue D, through the flexible tube P, and through the pipe 3, connected with the reservoirs 2 2 in the boat E. In the reservoirs are the flexible diaphragms described in the said former specification. When the explosive engines G, 4176 which is the same as the explosive engine described in the said former specification, is brought into action, the gas from the reservoir 2 2 will flow, as before described. The explosion globes in which the explosive mixture is formed and igniting will dilate as aforesaid, and will expand on either side of the piston, whose rod will give motion to the connecting rod *m* and crank axle of the fly-wheel F, and consequently to the pulley *o*. This will give motion to the cord acting around the pulley *o* and pull*ie*s *m*, figure 3, and to the adhesion wheels 1 1, figure 2, which will cause the traveling wheels *h h* to roll forward on the convex rail A, and in moving will impel the boat E. When the dynamic impeller advances on one of the valve mains B and the tongue enters the flexible valve, the dynamic impeller coming in contact with the lever E, figure 3, will move another lever, E, and another lever on the intersecting valve *d*. Whilst the tongue is passing through the flexible valve the gas flows as before through the valve main B and the flexible pipe P into the reservoir, 2 2, as before, thus suppl*u*ing the reservoir with gas to keep the engine in action until the dynamic impeller arrives at another valve main along the line. When the tongue D has moved through the flexible valve, the dynamic traveller acts upon the lever *e*, on that end of the valve which it is leaving, and so to the lever *e*, at the other end of the valve, through the wire *f* to the intersecting valve, which it closes, and so on through all the valves along the line of canal. The pressure of the adhesion wheels 1 1 can be adjusted by their springs, which are pressed upon by a screw-bolt to increase the adhesion, and so the impelling power may be increased. In order to apply one of said sources of motive power to impelling engines or machinery — operation — I use the locomotive gaso-pneumatic engine described in said former specification and the drawing No. 4, therein mentioned, reference being also had to the drawing No. 3, figures 1, 2, 3, accompanying the present specification. I apply the use of the said engine in combination with method and apparatus for the purpose of fire engine, *is* required; for the purpose last afore- 4177 said, horses may be harnessed to the pole or shaft on the frame *b*, near the wheel *a c d*, to drag it to the place of conflagration, on arriving at which place the flexible pipe before described is unwound from the portable drum. One end is attached

to one of the unions, 14, on the gas reservoir *e*. The other end should be taken to the nearest service pipe connected with the gas mains laid down in any public street or other place, or to the fittings in any building, by a union screw or screws that will fit any of the given diameter in the ends of service pipes. A communication is thus formed between any such gas mains or fittings and the fire engine, the public mains being charged with gas, or the gas, being let on, will flow from such said mains or fittings to the gas reservoir *e*, on the engine, and from it through the supply pipe 1 and the four-way valve *o* into the explosive globular chambers *m m* 1, where it will mix with the atmosphere and *from* an explosive mixture. The slide *i* being then moved and a light applied to the aperture under it explosion will take place in that chamber, and consequently dilation will ensue; passing down through the ways *h h* to the opposite heads of the piston in the two cylinders *g g*, will move the pistons and rods, which give motion through the connecting rods *v v* to the crank axle *d* 1. Whilst explosion and dilation is proceeding in the chamber *m*, the gas pump *k* and air pump *k* 1, being put into action by the first stroke of the engine, forces regulated quantities of gas and air through the supply pipe 1, through the passages of the four-way valve *o*, into the chamber *m* 1; the slide *i* being open on that chamber by the action of the lever *q*, and the lever *p*, on the four-way valve, being adjusted in its passages from the chamber *m* 1 through the passages *h h*, and the ways of the cylinders *g g* being adjusted by the slides on the cylinders, which are regulated by the eccentrics *s s* and their rods, dilation will now take place through the ways *h h* to the opposite ends of the cylinders *g g*, when, the pistons and rods being thus continued in motion, which is communicated through the connecting rods *v* to the crank axle as before, a continued action in the engine will ensue. The flywheels *d* 2 *d* 2 equalize the motion of the working parts
4178 of the engine and the pumps *k* and *k* 1, the pistons of which
are acted upon by their rods *z z* on the bent lever *y y*, and so regulated quantities of explosive mixtures are formed and flow into *m* and *m* 1 in regulated quantities aforesaid, such regulation being measured by the action of the bent lever *y*, the length — whose motion is regulated by an eccentric, *z*, on the crank axle *d* 1 and an adjusting slide and thumb-screw moving in a rack on the lever *y*. On one end of the frame of the engine I fix two single-acting force pumps, 3 4, leading from the ends of which into a tank, 5 5, suspended under the frame of the engine, are water-ways 6 6. On the force pumps are stuffing boxes 8 8, through — solid plungers 7 7 work, each being connected with one of the piston rods of the cylinders *g g*. In the ways 6 6 there are common clack or lifting valves. The action of the piston *g g* putting the plungers 7 7 in motion, water being in the tank 5 5 will be drawn into the force pumps and into the globular chamber *g* at each stroke of the pistons in the cylinder *g*. The upper globe 11 is an air chamber in which the air will be compressed by the rising of the water into it, so as to induce a more continuous stream through the branch pipes attached to the

screws 10 10, through which water may be forced in large quantities. The bent lever *x* 2, acting on the reversing gear W, reverses the motion of the pistons and slide. The screws 13 13 are screwed down onto the ground to steady the action of the engine.

In order to apply one of the said sources of motive power referred to, to wit, steam power, in combination with method and apparatus, reference being had to drawing No. IV, Fig. 1, 2. Operation: In the canal-boat I place a steam engine which gives motion to the fly-wheel G and the pulley *d* and the cord *e e*, which, passing the impelling pullies, give motion to the adhesion impelling wheels and a forward motion to the dynamic impellers *a a a* which impel the boat through or along the canal. In order that a single line of suspended rail may suffice to impel vessels in opposite directions of the canal I cause one of the dynamic impellers to move over the
curved rail on its upper surface, against the sides *a a* of which
4179 the adhesion travelling wheels act to move the one impeller
over the other impeller and so again onto the rail A. The momentum with which the two impellers meet from opposite directions will assist this action. The cord *e* of one of the boats, to wit, the cord acting on the under impeller, should be slacked by shutting off the steam, stopping the action of the fly-wheel and pulley, so that the other boat may pass over the slack cord, the cord of the other boat being in motion whilst the upper impeller is passing over the under impeller. Electro-magnetic force to impelling machinery for agriculture. Operation, reference being had to drawing No. V and drawing V *a* and the letters of reference therein: I induce chemical action in the batteries placed at the stations A or A 1 and so generate electrical influence, the force of which, acting through the metallic circuit established as aforesaid between said stations and the impelling engine D through the mains *b* and the vertical branches *a* and the wires *s s* to the magnet or magnets of said rotatory engine or engines or either of them or any modification thereof, an electric current passing through the metallic circuit aforesaid will put the impelling engine in motion, will move D over or through fields, and put agricultural implements in motion such as or similar ones to those described in the said former specification. As the engine advances, the drum, being put into action by the gearing aforesaid, turns the *drum*, unwinds the insulated wires *s s*, and lays it off on the ground, and when the impelling engine reverses its action and returns towards the point of its departure or near to where the wires *s s* are attached in the box *c* of the branch *a* the drum again winds onto it these said wires so before laid off on the ground. In order to stop the action of the engine the metallic circuit is broken by the common methods and again established at will. When the impelling engine has operated for a given distance along or near to one of the mains *b*, then I break contact of the metallic circuit at the point of its said connexion and remove the wires to a corresponding connexion in any other of the boxes *c* along the line of
the mains, and in order that the electric current may not be
4180 induced along to the point so disconnected as aforesaid I
disconnect the said bent end of the wire of one of the poles

of the circuit by detaching the screw before mentioned; the box then may be closed and the ground filled in over it; and so I disconnect and connect at all or any of the points *c* on the mains *b* in any part or parts of said fields or area, and so form at said points metallic circuits and convey electric currents from time to time, when the electro-magnetic force is applied to prevent the collision of trains on railways, reference being had to drawing No. IX and (figure 1, No. 8) elevation and drawing (D and 9 plan). Operation: The metallic circuit being established between the batteries at the stations aforesaid and the electro-magnetic engine on the locomotive through the medium of the electro-magnetic coupling slide as aforesaid, chemical action at said stations being induced and electric currents or influence communicated along the sections of the rails, the electric current may be broken and re-established all along the line at will at the spaces between the sections along the line by well-known methods, and therefore, when from any cause whatever, arising from accident or otherwise, it is desired to stop a train or trains, the batteries being at all times prepared and efficient, the persons charged with the guarding of the railway may at any time establish a metallic circuit between the electro-magnetic br*eak*s aforesaid attach- to the carriages, or any of them, of a train through the medium of the electro-magnetic coupler, which is always in contact with the conducting wires *x* and *x* 1 on the wooden bars *e* and sliding over *x* and *x* 1, the conducting wires leading from the coupler *h h* leading to the poles of the wires round on the magnet, which brings the flexible armature 2, drawing Q P, or armatures with which a lever or levers acting on br*eak*s are connected. The magnet, in drawing the armature 5, which is flexible iron bar, one end at 6 fastened down at that part of the magnet 7 and in contact with it, when the electric current is on or passing through the magnets or helix, moves the lever attached to the armature by flexible rods or cords or wires 1, 2, 3, 4, which
4181 brings the br*eak* or br*eak*s in contact with the wheels of
carriages, and so stop the progress of a train. As the magnet when in action is drawing the armature down upon it by absolute contact of the armature on the magnet, the lines, as it were, of the armature are lines at right angles with the length of the armature and helix, the latter being about two feet six inches long and about six inches wide and the armature of the same length and width and about the eighth of an inch in thickness. When it is desired to release the brak-s from the carriages, the conductors of a train may break the contact of the poles of the wires leading to the magnet or magnets by any convenient means; but when it is desired to prevent the collision of trains, then a battery may be placed on the locomotive carriage D, drawing No. IX in elevation and No. IX A, shown on drawing IX A, at first train or other carriage of the same train. The ends of the wires leading to the electro-magnetic coupler being properly adjusted to the poles of a battery on the locomotive No. IX, the electric current will [illegible] along the railway. If, now, another train, marked 2nd train, drawing IX and IX A, come upon the same section following train No.

IX, then, the coupler h h of the second train being in contact with the wires x and x 1 of the same section, a metallic circuit will be established between the couplers of the two trains from the battery of the train No. IX to the br*eak*s of the second train or the train that has followed and arrived on the same section to the train No. IX. The said *section* train will thus be stopped or impeded until the first train shall have advanced into another section, when the space between the wires x 1 on one section and the wires x 1 on the other section, being broken by the wide space between them, and the wires x 2 and x 3 being always broken at the space and similar spaces, except when it is desired to stop a train from the batteries at the stations aforesaid, the metallic circuit is broken, and can only be again established by the second train again coming on the same section on which the first train may happen to be; thus the collision of trains may be
prevented when the metallic circuits between approaching
4182 trains are properly formed between the battery of engine No.
IX and the coupling rod and br*eak* on a second train; and, further, when the electro-magnetic coupler is on the engine of the second train and the conducting wires m m lead to an electro-magnetic machine on the top of an engine, as at d, drawing No. IX, from whence a cord, passing over a pulley on said electro-magnetic machine, and passes over another pulley or pull*ies*, whence a branch cord from the cord on the pull*ies* leads to the lever, first, on the whistle on the engine, and, second, to a lever on the steam valve of the engine, then when said second train comes upon the same section on which is the engine No. IX and between the battery on No. IX and the electro-magnetic coupler on the engine of the second train and on the same section, and the metallic circuit between said two engines is properly established, the current putting the electro-magnetic engine on said second train in action, the pull*ies* being turned, the said branch cords will pull on the lever of the whistle, and opening it will sound an alarm, and the further movement of the other branch cord will act on the steam valve and shut off the steam. In application of one of said sources of power, namely, the electric power, in any of its forms to one of the things referred to, namely, the electro-magnetic engine, drawing No. X, reference being had to said drawing, the principle of application ha*b*ing already been shown in its application by br*eak*s of carriages on railways. Operation: I effect as one of the common methods of generating said source of power by inducing chemical action in commonly constructed batteries B B, from the poles of which batteries I lead conducting wires to the pedestals C C, in which they terminate in small masses of copper having a smooth horizontal surface. From the poles of the wires wound on the magnets h h h h on the frame a a a a I lead wires to four seperate masses of copper insulated from each other and fixed onto the pedestals C C at c c, having si*n*ilar horizontal surfaces near to the other corresponding masses of copper leading from the poles of the batteries and placed in the
pede*de*stals C C, but made moveable in the following man-
4183 ner: The masses so far apart as completely to break metallic
circuit; the masses of copper at the termination of the wires

leading from the poles of the battery are attached to the lever 1 fixed on its fulcrum 2; at the opposite ends of the lever 1 are balls 3 of greater weight than the masses at the termination of the wires; the masses of copper at the termination of the wires leading from the magnets are attached as aforesaid to the levers 1 in such a manner as that the horizontal surfaces of the masses leading from the poles to the batteries and magnets when brought in contact shall coincide in all parts throughout their surfaces. The method of detaching and bringing in contact the masses of copper connected with the batteries and magnets for breaking and reconnecting the circuit is effected as follows: The masses of copper at the termination of the wires leading from the poles of the battery are raised and depressed by the motion or action of the lever 1, to which they are attached, but the opposite end of the lever being rendered heavier by the balls would tend to keep the masses of copper at the termination of the wires leading from the batteries and magnets always in contact. To effect a separation I employ the following or any other simple mechanical arrangement—that is, I put a spindle, 4, in motion round its axis by means of a band, 5, or any other contrivance, passing over the pull*ies* fixed onto the fly-wheel shaft and spindle. On the spindle 4 I fix a circular cam and to its periphery I fix what I denominate an electro-magnetic hammer by the end of its handle 7, where it forms a hinge joint with the periphery of the cam. By the circular motion of the spindle the cam is turned round, and by its motion the hammer is drawn round the periphery of the cam. The handle of the hammer will rest upon the periphery of the cam on the opposite side to where the masses of copper are placed; when the spindle, in its circular motion towards the masses of copper, brings the hammer beyond its centre of gravity on the side of the spindle next to the masses of copper, it will fall with a stroke of its own gravity upon a projecting flange, *q*, of the masses of copper that are undermost or those leading from the poles of the battery. The combined weights 4184 of the masses of copper and hammer are heavier than the balls at the opposite ends of the lever; hence the masses of copper leading to the poles of the battery will be disconnected from those that are fixed leading to the poles of the magnets and thereby break the connection or metallic circuit. The length of the projecting flange and hammer handle are so arranged as to — the hammer to remain upon the projecting flange for such length of time as shall be necessary to complete the upward motion of that end of the working beam. When the beam is at the top the hammer leaves the projecting flange and the masses of copper are raised upwards by the counterbalancing balls and brought in contact with the masses leading to the poles of the magnets, so that by the arrangement aforesaid, when the parts are properly arranged, the armatures suspended from the beam of the engine may be thrown into and out of power at any desir*e*able and regulated periods. The flexible armature may be formed of thin laminated plates lying on one another so attached to the connecting rods *p p p p* as to allow the plates to slide backwards and forwards upon each other, upon the principle

of a coach spring. The connecting rods *p p p p* are formed in two or more parts. The upper parts *q q* are divided in such a manner as to allow the end of lower parts S S to pass up into the cavity of the divisions, upon the principle of the tubes of a telescope. At the lower end of the division of the upper part *t t t* is a circular ring connecting the division of the upper part through which the under part *u u* passes. Upon a sliding portion of the under part of the connecting rods, as at *v v v v*, are fixed a couple of screw-nuts. These nuts can be moved higher or lower so as to lengthen or shorten the connecting rods at pleasure and so adjust them. The same arrangements as hereinbefore described are made and connected with the other end of the beam on the other side of the engine, — when in action are so arranged as to produce an alternating motion, which is communicated to the crank axle of the fly-wheel by connecting
rods either by the method hereinbefore described or by the
4185 connecting rods K K, a bell-crank action, L. In order to
apply the said source of motive power to the several things hereinbefore described, namely, the electric force of influence by the combination of method and apparatus before mentioned, I further apply the said combination of method and apparatus or some of them to another one of the things referred to in the title of my said patent, namely, to illuminate reflectors or produce lights for lighting said railway or tunnels, or roads or ways or streets, or buildings or mines. To that end I establish the metallic circuits hereinbefore described or similar ones communicating with batteries at similar stations or places as in manner before described, with communicating metallic circuits, which I lead along, through, or to any described places. At such places I construct and fix apparatus into or through which I pass the electric current or concentrate it by well-known common methods, so as on or in said apparatus I *a*ffect by well-known methods or any variation of them what is termed an electric glow or brush, which glow or brush or sparks or heated surfaces being placed in the focus of reflectors yields rays of light, and which reflectors being made to revolve by any of the impelling apparatus hereinbefore described produce revolving lights, which may be used as night signals or signals in tunnels, or which glows being produced by electric effect by known methods, hermetically sealed in glass globes, in which may be placed air or gases or other substances, which may be rarefied or compressed, or in which gases may be generated to increase the illuminating power of the said glow or brush or sparks or heated surfaces, and which globes or apparatus may be placed along roads, streets, buildings, or in mines, into which metallic wires as before arranged may be led and connected and disconnected at fixed points, and to which the electric influence may be communicated from batteries or apparatus at stations aforesaid. Having in my said former specification in the valve main of the gaso-pneumatic railway described a method of unsealing the valve by an electric wire therein
described, I further vary said method by attaching in
4186 the fore part of the locomotive impelling engine or on one of
the carriages of a train a metal bar of the form, when in

elevation, of the metal bar shown in elevation on the driving pulley *s* of the differential railway, the bed being on the lower surface and tapering to a thin edge. The bar being only two inches high, one-half inch thick, and tapering to one-eighth of an inch on the lower edge, on which it is rounded, being then placed on the carriage in advance of the tongue, the lower edge laying along the edge of the valve and on the cemented surface, into which it is slightly pressed, as seen in figure C C C, sectional view, and at *c c*, then being brought in communication with an electric battery, the bar *c* will be heated and the cement will be softened under its contact while moving along the valve.

Claim.

Having set fo*u*rth and described my methods of applying motive power or force or forces to the engines, apparatus, machinery, and the several things and circumstances and shown and described their various applications and uses, I claim the various applications to the uses hereinbefore mentioned and set fo*u*rth and the various methods of combinations, and although the varied combinations of methods and apparatus works, and machinery may be varied in mechanical arrangements, proportions, or quantities to effect the objects or uses herein described, I claim the general arrangements of the methods herein described and combinations aforesaid making up the differential railway described and shown in the drawings No. 1 and 1 A, and the methods and combinations making up the gaso-pnuematic power on canals shown and described in drawing No. 11, and the method and application making up the fire-engine described and shown in drawings No. III, figures 1, 2, 3, and the motion of taking up their source of power from public mains or pipes, and I claim the combinations of method and apparatus making up the impelling steam power on canals described and s*n*own in drawing No. IV. I claim the combination, method, and
4187 apparatus described and shown in drawing No. V, and I
claim the combination of method and apparatus described and shown in drawing No. V A, and I claim the combination of method and apparatus described and shown in drawing No. VI, referred to in other drawings, and the combination of method and apparatus described and shown in drawing No. VII, and the other drawings relating thereto marked No. VIII, and I claim the combinations of method and apparatus described in drawings No. IX and IX A, and I claim the combinations of method and apparatus described and shown in drawing No. X, and I claim the combinations of method and apparatus herein described for putting said engines or similar engines in operation in manufactories or places for manufacturing purposes, and I claim the combination of method and apparatus herein described for applying said electrical currents or influence for the purposes of lighting places.

In witness whereof I, the said Henry Pinkius, have hereunto set my hand and seal the twenty-fourth day of March, in the year of our Lord one thousand eight hundred and forty-one.

H. PINKUS. [L. S.]

And be it remembered that on the twenty-fourth day of. March, in the fourth year of the reign of her majesty Queen Victoria, the said Henry Pinkus came before our said lady the Queen in her chancery and acknowledge- the instrument aforesaid and all and everything therein contained and specified in form above written, and also the instrument aforesaid was stamped according to the tenor of the statute made in the fifty-fifth year of the reign of his late majesty King George the Third.

Inrolled the twenty-fourth day of March, one thousand eight hundred and forty-one.

4188 DEFENDANT'S EXHIBIT STAITE'S ENGLISH PATENT NO. 1222 OF 1848. Mar. 13, '89. W. T. F., N. P. & S. E.

A. D. 1848. No. 12212.

Galvanic Batteries, Magnets, Application of Electricity to Lighting and Signalizing, &c.

Staites' specification.

To all to whom these presents shall come I, William Edwards Staite, of Lombard street, in the city of London, gentleman, send greeting:

Whereas her most excellent majesty Queen Victoria, by her royal letters patent under the great seal of the United Kingdom of Great Britain and Ireland, bearing date at Westminster the 12th day of July, one thousand eight hundred and forty-eight, in the 12th year of her reign, did, for herself, her heirs and successors, give and grant unto me, the said William Edwards Staite, my ex'ors, adm'ors, and assigns, her special license, full power, sole privilege and authority that I, the said William Edwards Staite, my ex'ors, adm'ors, and assigns, or such others as I, the said William Edwards Staite, my ex'ors, adm'ors, or assigns, should at any time agree with, and no others, from time to time and at all times during the term of years therein expressed, should and lawfully might make, use, exercise, and vend within England, Wales, and the town of Berwick-upon-Tweed, and in the islands of Jersey, Guernsey, Alderney, Sark, and Man, and in all her said 4189 majest*ie*'s colonies and plantations abroad, the invention of "improvements in the construction of galvanic batteries, in the formation of magnets, and in the application of electricity and magnetism for the purpose of lighting and signalizing, as also a mode or modes of employing the said galvanic batteries or some of them for the purpose of obtaining chemical products," parts of which improvements have been communicated to me by a foreigner resi*gn*ing abroad, in which letters patent is contained a proviso that I, the said William Edwards Staite, shall cause a particular description of the nature of the said invention and in what manner the same is to be performed by an instrument in writing under my hand and seal to be enrolled in her said majesty's high court of chancery within six calendar months next and immediately after the date of the said in-part-recited letters patent, as in and by the same, reference being thereunto had, will more fully and at large appear:

Now, know ye that, in compliance with the said proviso, I, the said William Edwards Staite, hereby declare that the nature of the said invention and in what manner the same is to be performed are fully ascertained and described in and by the present specification thereof, reference being had to the drawings hereunto annexed—that is to say:

Firstly. My improvements in the construction of galvanic batteries consist in making them on what I call the "perfluent"
4190 system of supply and discharge to contradistinguish it from the "percolating" system, which has recently come into extensive use. According to the percolating system the liquid employed (usually sulphuric acid) is supplied to and discharged from each of the cells of the battery in separate and distinct streams or series of drops, the liquid as it becomes exhausted, though not entirely so, dropping out through an orifice in the bottom of the cell and being then allowed to run to waste, and the place of the discharged liquid being supplied by fresh drops descending from above into each cell; but according to the new system, to which I have given the name of "perfluent," the liquid is supplied in one stream only, which passes continuously through the entire series of cells, entering by the first cell of the series and passing off through the last. The great loss attending the imperfect exhaustion of the portions of liquid discharged from each cell is thus avoided, for the liquid flowing in one stream through the whole of the cells, one after the other, becomes completely exhausted, or as nearly so as may be, before its final discharge from the last of the cells. In ordinary galvanic batteries, where a perforation is made in the partition between any two of the cells so that they may communicate transversely with one another a considerable diminution of electric intensity is known to be the result. That no such diminution is observed to take place in the perfluent battery from bring-
4191 ing the cells into communication with one another owing to the circuitous course it is made to take between cell and cell. In proportion, of course, as the duration of the transit through each cell is shortened the chance must be proportionately lessened for each portion of the liquid coming into contact with the acting metal or element in that cell; yet, as no drop of the fresh liquid supplied to the battery can make its way to the final-discharge outlet without going through the whole of the cells, what it misses in the first cell it is sure to encounter in one or other of the remaining cells. The cells last in order of a perfluent battery necessarily act less powerfully than the earlier cells of the series—as, for example, the last six cells of a series as compared with the first six. The diminution of power—that is to say, the quantity of electricity which the cells are capable of circulating—does not appear, however, to follow exactly in the ratio of the strength of the exciting liquids, for the difference in power between the middle and initial

cells of a series is proportionally not so great as the difference between the middle and the terminal cells. When it is desirable to obtain intensity in the electric current rather than great quantity the terminal cells should be made about equal to the quantitative power of the others by uniting the similar conducting wires of several cells together and using them as if 4192 proceeding from one cell. Thus, as it would be technically expressed, the last three cells in a fifteen-cell battery (say the 15th, 14th, and 13th) might be connected for quantity, and the two next preceding pairs (say the 12th and 11th and 10th and 9th) be con*du*cted also for quantity, and the first eight cells might be worked singly, in the usual manner of a series; but however great may be the differences in power between the initial, middle, and terminal cells of a series, I find that in each cell regarded by itself apart from the others the degree of exhaustion and, consequently, of electric action is always very nearly uniform throughout every part of the cell. In consequence, moreover, of the liquid being in a state of continuous flow and never acting on any one part of the cells more than another, the zinc or other metal employed wears much more evenly than in the percolating battery or any other with which I am acquainted.

The details of a battery constructed on this perfluent principle are represented in figures 1, 2, 3, and 4 of the drawings annexed.

Figure 1 is a view of the battery as seen from above. Figure 2 is a vertical horizontal section. Figure 3 is a view of the trough from beneath, and figure 4 is a vertical section. A is a wooden trough, the parts of which are firmly bolted together. *a a* are slate partitions, the edges of which fit closely into the sides and bot- 4193 tom of the trough and are about two and a half inches apart. *b b* are thicker partitions of wood, which are inserted at short intervals, say every six cells, and made fast to the sides by screws and nuts. *c c'* are two parallel rows of holes made in the bottoms of the cells, two in each. *d d'* are two corresponding rows of wooden covers, which are made fast by marine glue and screws to the bottom of the trough (see figure 3), one underneath each adjoining pair of holes, as *c' c'* or *c' c'*, with the exception of the two end ones, which cover one cell only. *e* is a groove cut out in the upper surface of each cover, and made just of width enough to embrace two of the cell holes, as *c c* or *c' c'*, and so establish a channel of communication between them. *f* is an aperture made in the bottom of the end cover of the series of holes *d* and *f'* a similar aperture in the bottom of the opposite end of the same series of holes, into each of which apertures there is inserted a piece of copper tubing, to which there is attached one end of a flexible hose, *g* or *g'* (made of vulcanized caoutchouc, gutta-percha, or other suitable substance or combination of substances), which terminates at the other end in a funnel, *h* or *h'*, and *i i'* are eyebolts affixed to the ends of the trough on the outside, which respectively sustain in an upright position the funnels *h* and *h'*, there being a slit or opening in the eye of such bolt to admit the neck of the funnel. The whole of the inside of the 4194 trough is well coated with marine glue. The mode of operation with this apparatus is as follows: The liquid is poured in at the funnel *h* and passes into the first cell through the hole *c'* of the cell; from the first cell it goes out through the hole *c* into the first of the grooved covers of the series *d'*, whence it flows into the second cell through the hole *c* of that cell; from the second cell it next passes through the the hole *c* of that cell into the second of the grooved covers of the series *d*, and so on to the end of the series (as indicated by the arrows in figure 1), when it discharges itself through the flexible hose *g'* and funnel *h'* into a receiving vessel, K. The arrangement just described is, however, chiefly suitable for such forms of battery that use but one sort of exciting liquid, but in batteries where two fluids are used, as those of Daniel, Groves, and Callan, it may be expedient to adopt the modification of the perfluent system represented in figures 5, 6, 7, 8, 9, and 10. The internal cells in this case are supposed to be made of earthenware or some other porous material.

Figure 5 is a side view of one of these cells and figure 6 is a vertical section across the middle. A hole is made in the bottom of this cell 2 and into this hole a copper tube, *r*, with a collar and washer of vulcanized caoutchouc at top is dropped. The tube is pulled tightly down upon the washer in order to prevent any of
the liquid escaping between the washer and the bottom of
4195 the cell; or, instead of this arrangement, one of the descrip-
tion represented in figures 7 and 8 may be substituted. S of the description represented in figures 7 and 8 may be substituted. S is a cradle which is cemented onto the under end of the cell by marine glue and encloses it completely. The tube R is screwed onto the bottom of this cradle and through it up to the hole in the cell. In both cases the tube has an oval aperture, *w*, cut transversely through it and terminates at its under end in a solid screw-point. The trough for the reception of porous cells of this description is made in the manner represented at figures 9 and 10, the former being a transverse vertical section of the trough through the centre of one of the cells, and the latter a longitudinal vertical section. In these figures the cradle on the plan, figures 7 and 8, is supposed to be adopted. Q is the internal porous cell and Y the zinc plate suspended therein. X X are the plates of negative surface (say copper), placed outside the porous cell. Z Z Z are the sides and bottom of the trough, the spaces (*m m*) between which the porous cell forms the external cell, which contains the second fluid (say sulphate of copper). A″ is an open channel for the discharge of the second fluid, which runs along the outside of one wall of the trough near to the top, and communicates by lateral apertures (*p p*) in the wall with the spaces inside, *m m*, appropriated to that fluid. V is a grooved or channeled under cover similar to
those employed in the apparatus first before described, which
4196 extends along the bottom of the trough from end to end and
comes immediately under the line of holes in the porous cells (Q). The lower end of the tube *r*, which is attached as aforesaid to the bottom of each porous cell and enclosed by the cradle, is passed downwards through an orifice in the bottom of the trough,

and also through another orifice in the bottom of the under cover V, till the oval aperture *w* in the tube coincides with the groove *t* in the bottom of V, so that when the whole of the cells are fixed in their places the channel *t* forms, through the medium of the apertures *w w*, a common channel of communication between all the cells. U is a nut which takes onto the end of the solid screw-point of the tube *r*, and by turning which the parts S, *r*, V, and Z are all screwed tightly together. For the sake of greater security against leakage and against the intermixture of one of the fluids with the other, washers of vulcanized caoutchouc are inserted between the cradle S and the bottom of the trough and between the bottom of the grooved channel V and the shoulder of the nut U. E is a second under cover which runs parallel to V (on one or either side of it), the groove *e*, in which second cover communicates by a series of holes, *n n*, with the external cells above, containing the second fluid, and thus serves as a common channel through which these cells may be supplied from a flexible hose similar to that before described. The second fluid is, after passing through the external cells, discharged from the ends of the channel A^a. The perfluent
4197 system may be also carried into effect by employing *cyphons*
instead of the grooved under covers (*d d'*, V, and E) before described to transmit the liquid from cell to cell successively, as shown in figure 11, which represents two adjacent cells of a battery. The long end, A, of the *cyphon* descends to near the bottom of one cell in order that it may carry over the densest portion of the liquid therein and deliver it through the short end, B, into the next cell, or if the liquid employed is of such a nature that it becomes lighter as it becomes exhausted (sulphate of copper, for instance), then the legs of the *cyphon* are reversed, the liquid entering it by the short end and being carried over by the long end. By adopting this *cyphon* plan, the breakage or upsetting of one cell of a series will not cause any loss of liquid from the rest, although the liquid will continue at the same time perfluent, nor will the *cyphons* empty themselves until the last portion of liquid is removed from the cells, which need not be done during the time of replenishing or changing the liquids.

The syphon plan just described may be applied with special advantage to a form of battery which has been for some time in use and is represented in figures 12, 13, 14, and 15, with some appendages, however, marked *f*, *g*, *h*, and *i*, which do not belong to this apparatus as originally constructed and hitherto known, inasmuch as that application would convert it at once into a perfluent battery nearly equal to that first hereinbefore described.

4198 Figure 12 is a top plan of this battery, figure 13 a longitudinal vertical section, figure 14 an under view of the trough, and figure 15 a vertical cross-section. In its general construction this battery resembles that first hereinbefore described with the exception that, though all the cells communicate at bottom with one common discharge channel, the liquid does not flow continuously from one cell to another through the whole series, but supposing all the holes in the bottoms of the cells were stopped up and syphons applied to each pair of cells as has been just described, then there would be a continuous flow of the liquid throughout the entire series, from the last of which it might be discharged in an exhausted state by a flexible hose similar to that represented in figure 2.

Secondly. My invention consists of certain improved modes of regulating the supply and discharge of the liquids employed in galvanic batteries.

The first mode which I shall describe will be found particularly applicable to a battery such as that referred to at the close of preceding head of this specification, and consists in using it with the new appendages to it, *f*, *g*, *h*, and *i*, before mentioned and in manner following: In that battery as hitherto constructed the discharge has been effected by the means represented in figures 16 and 17. Into the wooden partition at one end of the trough is imbedded a syphon, *k l*, one leg of which, *k*, opens into the channel *e* and the other
4199 leg, *l*, passes through the bottom of the trough. The short
end of the syphon is made to be on a level with the intended height of the liquid in the trough, and there is a small aperture, *m*, in the highest part of the bend, which communicates with a hole, *n*, cut in the wood, which has a seat around it half way, upon which lies a washer of vulcanized caoutchouc *o*. The broad end of a screw, *p*, screws down onto this seat, presses on the washer and closes the hole air-tight. When the cells are filled up the syphon discharges all the liquid from the channel out of every cell in the trough, and when the screw *p* is turned loose the bent tube *k l* no longer acts as a syphon, but simply discharges liquid as its lever may rise beyond the level of the bend. The fresh liquid is introduced in any convenient manner at the top of each of the cells. When it is desired merely to replenish the exhausted liquid or when it is required to fill up all the cells with fresh liquid after they have been partially emptied the whole quantity of liquid necessary is poured into one of the cells and spreads in equal quantities to every cell. My improvement in this arrangement consists in substituting the flexible hose *g* and funnel *h* and their respective appendages for the discharge cyphon represented in figures 16 and 17 and in working these in the manner to be next described. The flexible hose *g* is lowered as shown in figure 13 at regular intervals of, say, 15, 20, or 30 minutes (according to the quantity of liquid contained in the cells and the rate of action of the elec-
4200 tricity and the degree of steadiness required in the current),
and at each time a portion of the partially used liquid is allowed to run out, after which the hose is raised again and the funnel *h* replaced in its original vertical position, when a quantity of fresh liquid, equal to that which has just been discharged, is poured into the funnel and is conveyed thence into the cells through the common channel *e*. When this battery is so worked the liquid will be always kept about three-fourths exhausted, or nearly so, in which condition the battery may, in some cases, be worked up to about two-thirds of its power. There will always, however, be a

slight waste, as the liquid must, of necessity, be always discharged with about one-fourth of its power unused.

A second mode of supplying the cells has relation to the case in which the liquids become specifically heavier by working the battery (as, for example, dilute sulphuric acid). I cause a constant influx into each cell by means of a pipe or trough extending along the top of the battery having a small orifice over each cell so that the liquid with which the pipe is charged shall drop gradually into each cell, *c*, and the liquid is drawn off from all the cells simultaneously by means of a common under channel, *e*. The funnel or other vessel of supply is fixed in an upright bearing just above the level at which it is intended to keep the liquid inside the cells. By this arrangement all the cells are kept practically at the same level and no attention to each cell separately is requisite.

4201 A third mode of carrying this branch of my invention into effect has relation to liquids which become specifically lighter by the working of the battery (as, for instance, sulphate of copper). The cells are replenished by a continual outflow from a supply vessel fixed at a higher level than the liquid in the cells (similar to A^a in figure 9) through holes or spouts placed at the required level in the sides of each cell. This in practice insures an equal feed for every cell while the battery is working, because if any cell were worse supplied than the rest with fresh liquid from the bottom it would in a short time become more exhausted than the rest, and consequently specifically lighter, which would make it attain a higher hydrostatic level and overflow more abundantly than the others.

A fourth mode has reference to porous-cell batteries and is based on the supposition that the batteries are regularly supplied with liquid. The object in this is to so proportion the supply to the amount of current produced so that any given portion of the liquid (say sulphate of copper solution) supplied to the lower part of one division of each cell shall become exhausted by the time it has worked its way to the surface, when (supposing the solution to have been sulphate of copper it will have become transformed into a clear solution of dilute sulphuric acid) I allow the exhausted 4202 solution to flow over the upper edge of the porous cell into the zinc compartment (instead of drawing it away and supplying the acid to the zinc from another cistern), when this solution becomes gradually charged with zinc and is finally drawn off exhausted a second time from the bottom of the zinc cells by the means pointed out in figure 15 or by any other suitable arrangement.

Thirdly. My invention consists in attaching to all galvanic batteries in which a gradual change of liquid is required an equilibrited hydraulic cistern and graduated meter, such as represented in figures 18 and 19. A is a cask closed at top so as to prevent the free action of the atmospheric pressure on the surface of the liquid contained in it, and *b* is an orifice near to the bottom which opens into a small outer cistern, *c*. This arrangement ensures that the liquid flowing through any channel from the cistern *c* will always

flow at the same rate whether the cistern be full or nearly empty. From this little cistern a loose piece of vulcanized caoutchouc tubing, *d*, proceeds and is connected with the glass tube *e*, from which is suspended the meter *f*, having a small hole at the bottom so that the rate of flow out of this hole is indicated by the height at which the surface of the liquid stands. The meter is graduated to units
to show the amount of flow requisite to supply the chemical
4203 action which is going on in the battery when the electric
current is circulating at a rate indicated by corresponding units on the galvanometer hereinafter described (figure 20), which is included in the circuit. The meter, with its tube *d*, is suspended so as to enable the rate of flow to be adjusted by hanging it at an altered level (in relation to the cistern) according as the galvanometer may indicate to be necessary. The parts *d e* form, in fact, a syphon, which only requires to be filled with liquid when the apparatus is first set in action after the cistern is charged. The liquid issuing from the meter is received by a funnel, *h*, or otherwise led to the battery.

Fourthly. My invention consists in the employment in galvanic batteries having copper or mercury for the negative element of a liquid amalgam of zinc and mercury enclosed in a bag or case of lawn or horse-hair cloth or any other finely reticulated fabric, but not made of metal, which allows of the acid passing freely through its meshes to act on the bottom and sides of the zinc amalgam, which the bag or case retains the amalgam itself. I am aware that a liquid amalgam of zinc and mercury has been before used in place of an amalgamated surface of solid zinc, but to the best of my knowledge never in the way here proposed.

Fifthly. My invention consists in the substitution in galvanic
batteries of solid plates made of an amalgam of zinc and
4204 mercury in the proportion of five parts of the former to one
part of the latter for the zinc plates ordinarily employed.

Sixthly. My invention consists in the employment of lead as the positive element in galvanic batteries (instead of the zinc which is now commonly used) combined with a solution of nitric acid or of acetic acid in some one or other of the forms best calculated to act on the lead. The best negative element in this case would be a surface of platinum, but most of the other negative elements which have been hitherto used may be also employed with the lead.

Seventhly. My invention consists of an improved galvanometer, represented in section, figure 20, which is to be attached to the battery in order to indicate to the eye the exact amount of galvanic electricity which is being circulated at any particular moment. The galvanometers usually employed for measuring the quantity of an electric current are incapable of being used while the battery is applied to perform its work, nor can they indicate the amount of action or electricity circulating while such work is being performed, and these, with several other defects, such as their indications or degrees varying in a different ratio to that of the quantity of electricity passing, cause such galvanometers to be useless for most practical purposes.

My new galvanometer is such that it can be made a per-
4205 manent adjunct to or part of the battery, so as to be always
indicating what amount of electricity is circulating when any sort of duty is being performed by it and the weights of material combining or used per minute at any particular time. The importance of these improvements may be measured by this consideration—that the cost of working a battery depends but little on the size of its elements and varies according to the rate at which its electricity is used by any particular work which it is set to perform. This improved galvanometer consists of a thick piece of insulated copper wire, A, wound round a wooden or brass cylindrical centre fitted with ends, C C. One end of this coil is in metallic connection with the positive or negative pole of the battery, and the other extremity is placed in connection with the part of the lamp (or other piece of mechanism for actuating which the battery is used) which would receive the conductor from the said pole of the battery. In fact, this galvanometer forms part of one of the conductors of the battery which conveys its electricity to perform its assigned work. In the hollow cylindrical centre of the coil there is placed a rod of soft iron, *d*, as shown in the drawing, which moves loosely up and down in it and is prolonged by a short brass stem or index, *e*. A graduated scale, *f*, is fixed to and rises from the upper end, *c*, of the coil, so as to show the height at which the electric influence causes the index to stand. The graduations are represented
in the drawing as marked on a glass tube, within which
4206 the index and rod *d* slide. These graduations are so made
as to indicate the number of grains of pure zinc consumed per minute in each cell of the galvanic series, the current produced by which causes the index to stand at each such division of the scale. Any galvanometer of this kind may be graduated from a standard one by connecting both in the same circuit and by working at Wheatstone's rheostat, also included in the circuit, until the standard galvanometer indicates the particular units or degrees, when a similar mark should be made at the point to which the index is directed on the scale of the other galvanometer. The standard can be graduated by ascertaining, experimentally, the weight of zinc consumed per minute, but a less tedious process is to graduate it from a Petre's galvanometer, which indicates all the required units of electricity and their fractions by means of weights, the accuracy of that instrument being first tested by one such direct experiment on the zinc consumed.

My improved galvanometer may be made of a shorter and thicker wire, making fewer coils, if the iron rod is partially counterpoised by a spring or weights or hydrostatically with mercury.

Eighthly. My invention consists in the formation of magnets in manner following: The best Swedish charcoal iron is to be "converted," not in the ordinary manner, but only a slight carbonization, or what is technically termed carbonizing it "just steel through." The blistered product is then melted and cast and the ingot resulting from the process is rolled out into thick sheet metal.

4207 Ninthly. My invention consists in the following improved mode of hardening magnets previous to magnetizing them: Instead of heating them in an ordinary furnace or sand bath I heat them in a bath of melted metal raised to a red heat (using by preference lead), first polishing the magnets in order to prevent the lead or its oxide from adhering to their surfaces, the heat of the lead being only just sufficient to harden the magnets on taking them out of the bath. I afterwards plunge them into water.

Tenthly. My invention has relation to the mode of obtaining light by electricity, for which I obtain- former letters patent for England and the colonies on the third day of July, one thousand eight hundred and forty-seven, and consists, first of all, in an improved mode of giving motion to the lower electrode. Figures 21 and 22 are representations of a lamp embodying this improvement. The skeleton of this lamp is similar in all respects to that of the lamp represented in the specification of my last patent (that is to say), there is, as before, a foundation plate of wood, A, a sole plate, B, of brass firmly connected by pillars C, and a three-legged stand, K, rising vertically from the sole plate B, the feet of which are fastened to B by nuts beneath, but insulated from it by circular washers of dry hard wood (of the form shown in section *i g*). A hole is bored vertically down through the centre of the top of the stand K, into which hole the upper electrode N is fixed by three metal wedges jambed into keyways or channels sloping upwards and outwards, so as to keep the inner faces of the wedges parallel to the central axis, and a glass shade is fixed to
4208 the sole plate B so as to cover D. The new parts are as follows: H G is a shaft which slides vertically in the central axis of the lamp through holes in A and B and has a socket at top which carries the lower electrodes M. The lower part G is cut with teeth which work into a pinion, F, which turns on a spindle in fixed supports. A barrel, F′, is attached to the pinion F and a weight, W, is suspended by a string which passes round F′ and is fixed to it so as to counterpoise the weight of H G. On the spindle of the pinion F is fixed a wheel, E, having square teeth. A lever, T, turns loose on the same spindle as a fulcrum, and carries a double paul, U V, which turns on a pin which projects from the side of T, so that this paul U V can lock into the teeth of the wheel E in either direction. A long horizontal lever, Q, passes over this paul from a joint or fulcrum, *a*, and this lever carries a light spring or tongue, *b*, close beneath it, the end of which is kept from springing away from the lever by resting in a step in a little stirrup or fork, *d*, which is attached to the lever Q and embraces the wheel E and the end V of the paul. The paul and its lever T are kept in a state of slow vibration from side to side by means of a crank, S, which works in a fork at the end of T, the crank S being made to revolve by an ordinary train of wheel-work enclosed in a case, A^2, furnished with an escapement or fly wheel and driven by spring power or weight. When the lever Q is turned a little downwards its tongue *b* presses V into the teeth of the wheel E and the vibration motion

of T causes V to drive the wheel round notch by notch. The 4209 wheel does not follow the paul in its back motion at every stroke, for this is better ensured by having a spring, *n* (Fig. 22), fixed to A and pressing against the side of G. This motion of the wheel causes the pinion to elevate the rack G slowly, so as to raise its electrode M towards N. But when the lever Q is raised or turned upwards the notch in the stirrup lifts the tongue *b* off V and allows U, the heaviest end of the paul, to drop into the teeth of the wheel E. This drives it round in a contrary direction so as to lower the rack F and draw its electrode M further from N. Whenever the lever Q is raised the lower step in the stirrup *d* catches the sides V and draws it (V) up out of the teeth of the wheel in case V should have become jambed or hitched in the teeth, so that the counter-weight of U might be unable to release it. The means *of* which the end of the lever Q is raised or lowered are these: R is a regulator coil such as is described in the specification of my last patent. One end of its wire is connected with a binding screw, *e*, and the other end L is brought up and fixed in contact with K. An iron rod, O, moves freely up and down in the central hole of the coil, and is prolonged upwards by a stem of wood, *p*, by which it hangs to the end of the lever Q in the manner shown in the drawings (figures 21 and 22). The rod O passes through a hole in the centre of a cup, *y*, which screws into the bottom of the coil case. Around O there is a circular weight, X, called an equilibrium weight, which rests on a small step in O when O is raised, and when O sinks below its medium position is left behind resting on the edge of rim of *y*. The object of this arrangement 4210 is that when O is actuated by a force equal to its own weight added to half the weight of X, then it will have a tendency to return to its medium position with a force of half the weight of X, whether it be raised higher or sunk lower than that position. The mode of action is as follows: The end of the negative wire from the battery is set in the binding screw *f* and is conducted thence by a metal connection to the supports of the spindle of the pinion and to the spring *n*. The current passes through these into the rack; thence to the lower electrode M from which it passes to the upper one N producing the light between them. From N it proceeds through the stud K to the wire L of the regulator; thence to the clamp *e*, which is in connection with the other end of the regulator wire and into which the positive wire from the battery is clamped to complete the electric circuit. The current in passing through the regulator tends to raise the iron centre O, which, being connected to the lever Q, is counterpoised to the weight W′, which screws along an extension of the lever beyond the fulcrum *a*. To put the lamp into adjustment, the driving gear, being wound up and the battery being in a state of activity fit for the permanent action intended to produce the light and its wires connected with *e* and *f*, as described in lever Q, is raised by hand until the electrodes have separated to the greatest extent compatible with obtaining a permanent light from them. The screwed weight W′ is turned backwards or

forwards until it keeps O balanced just so as not to sink be-
4211 low its medium position when the electrodes are separated as
aforesaid. When in this position the shoulder of O touches the weight X, which is resting on the rim of *y*. The lever Q carries a little projecting piece or catch, *g*, which meets the bent arms attached to the crank spindle S, and thus arrests the motion of the crank, when the lever lies so that O is in its medium position; but whenever it rises above or sinks below that point the catch *g* allows *h h* to pass beneath or over it accordingly, so that the crank can revolve freely and work the ratchet U V.

Another improvement in the lamp consists in subsituting for the upper electrode previously employed a disc or circular electrode fixed on an axis, which disc has a slow motion imparted to it in any given direction by the moving power employed in the lamp. Impinging on the periphery of this disc there is a metal scraper, which keeps the edge of the disc clean and free from the particles of carbon which are projected upon it by the other electrode and which ordinarily collects in the shape of a button on the point of the electrode. A front view of a lamp on this plan is given in figure 23 and a side or edge view in figure 24. A' is the disc which is shown in section in figure 24; it resembles in its form two cones
placed base to base, so that there is always one sharp or feather
4212 edge in sight (so to speak) of the negative electrode, which is
of the ordinary single cone form. B' is the scraper. B^2 is a frame which carries the shaft C^2, to which the disc electrode A' is attached. D^2 and E^2 are a bevelled wheel and pinion which gear into one another, the latter being fixed to the shaft G^2. At the bottom of this shaft there is another wheel, H^2, to which the clock-work or other apparatus for giving motion is attached. The shaft G^2 may be insulated in various ways either by the interposition of plates of ivory or wood (J K) screwed together or by gutta-percha or India-rubber rings. Instead of the shaft G^2 and the wheel and pinion D^2 and E^2 a metallic chain may be used working over a pulley or pulleys, the object being to give a very slow motion only (say one revolution an hour) to the circular disc of carbon and for the purpose solely of keeping the edge of the disc sharp and free from the projected particles as described.

Another improvement consists in the employment of iridium as an electrode which is suitable for smaller lights. Iridium, being of all known metals the hardest and most intractable, will bear an excessive degree of heat without fusing. To adapt it for electrodes I prepare it as follows: I fuse oxide of the metal in a cupel of bone ash under the voltaic arc, by which means it is brought under the action of the most intense heat with which we are acquainted. Having obtained an ingot
of the metal, I submit the same to the constant action of heat
4213 for the purpose of annealing it, and for this purpose I use
one or more large jets from an oxyhydrogen blow-pipe. When the ingot is at a white heat I pass it between rollers or hammer it, repeating the process again and again until the metal is sufficiently annealed to be worked up into the required shape. Sometimes I mix platinum with the iridium and sometimes copper

in small quantities, which facilitates the annealing. Sometimes also I cut it into thin strips from the ingot in the same way as precious stones are cut by the lapidary. For lighting purposes I use either a thin strip of the iridium so prepared and cut off or a combination of iridium with platinum or of iridium with copper or a spiral coil of the iridium as a solid electrode. Platinum strips and platinum wire have been used before and are well known, but iridium so prepared has never, to the best of my knowledge, been before used for the purposes of lighting. To increase the temperature of the metallic electrode A′ I sometimes pass the metallic holders B B through a block of glass, D D D, or other similar bad conductor of heat (as represented in figure 25), so that the heat and radiant light may be developed with as little loss of the former as possible by radiation.

An elevation of a small iridium bracket lamp is given in figure-25*a* & 25*b*. A′ is the electrode of iridium which is fused on or otherwise fixed to two pieces of platinum B B which are fixed into two copper or other metallic holders C C. These holes 4214 are insulated by means of ivory wood or vulcanized India-rubber washers D D or some suitable non-conducting substance so as to prevent contact with the bottom metal plate of the lamp E. To one of the metallic holders a copper wire (*a*′) passing through the hollow tube B′ is connected with one pole of the battery, and the electric circuit is completed and the current made to pass through the brass-work of the lamp to the electrode by turning the ivory knob X which is attached to a screw-shank, Z, making a metallic communication with the other holder. The second wire from the battery may be attached to any part of the lamp or socket, as, for instance, by the binding screw W. Y is a ring of brass which is screwed into the bottom of the lamp. A glass shade of any shape or form may be placed on the plate E.

Figure 26 represents a triple electrode suspending lamp. Each electrode is independent of the others and insulated as before. A battery for working this lamp is divided into three parts, one for each electrode. One wire for the return current (which may be fixed to the lamp or any part of the metallic tube by which it is suspended) is sufficient for all three electrodes, but each electrode is rendered luminous by completing the circuit of that particular electrode as before described. A A A (figure 26) are three way knobs with metallic shanks for making the necessary communication, as before described.

Eleventh. My invention consists of certain arrangements for producing a regular intermittent light from electricity, which are especially suitable for light-houses and may also be applied to other purposes. An apparatus embodying the chief of these arrange- 4215 ments is represented in figure 27. The parts in this apparatus which are similar to those in the permanent-light apparatus, figures 21 and 22, before described, are indicated by similar letters. A helix coil of insulated copper wire, A, is employed for the purpose of producing the prime moving force which actuates the sliding shaft which holds the electrode. This helix is fixed to the bottom

of the frame-work C C′ C″. It is nearly of the same construction as the regulator coil before described, only it is a little longer, and instead of being used to regulate the occasions and degree of action of some other moving force it produces the moving force itself, and the number of concentric coils of wire varies at different parts of its length. A cylinder of soft iron, B, moves freely up and down in it. To the top of B is fixed the rack E, which slides through the hole at C″ and carries the electrode M, fixed in a socket, so that this shaft can move the electrode M to or from the lower end of the electrode N, which is fixed in the top of the tripod K by wedges or screws. K is fixed and furnished in the same manner as that shewn in figure 21 and before described. The weight of the shaft B E is rather overbalanced by the weight Q, which is attached by a string passing over a pulley, R to B. A pinion, F, works into the rack E and fits it loosely, with a "back lash" of about a tenth of an inch; or, instead of this pinion, may fit loose around its spindle, which may have a key or feather fixed on the spindle, working loosely (to the extent of an arc $\frac{1}{10}$ inch at the circumference) in a "keyway" in the pinion. The pinion F is connected with an ordinary train of multiplying wheel-work (concealed behind the brass plate
4216 C‴) and terminating by any well-known sort of fly or escapement motion of such kind that F will be prevented from revolving quickly, but will, at the same time, yield with a slow motion to any slight force from the rack E, so as to prevent the rack E from moving up or down too quickly. The negative wire *a* from the galvanic battery is connected with one end of the helix coil A, and the other end of it is soldered to the brass case, so that the current passes through the helix wire to its case, and thence, by means of the springs D D, which are fixed to the case and are in contact with the iron cylinder B, up the shaft D E to the electrode M, whence it flows through N, down K, and returns to the positive pole of the battery by means of the wire *y*. But when the current thus passes the helix A causes the shaft B to be drawn downwards, which motion separates the two electrodes M N, and light is evolved until the electrodes become too far separated, when the current suddenly ceases, the light becomes extinguished, and the helix ceases to draw B downwards, when the weight Q begins to draw it upwards again until the electrodes touch one another, whereby the electric current is re-established and the light is repeated as before. The slow gear and pinion motion used in the above apparatus may be dispensed with, and then it will produce a series of flashes of light at shorter intervals; or, instead of the pinion F fitting the rack with a "back lash" or being loosely keyed on the spindle, it may be placed on its spindle so as to revolve free upon it and the addition of a circular rack on the side or in the central hole of the pinion with a spring ratchet fixed to the spindle in such position as to work into the said circular rack. An opposite
4217 arrangement of the rack and spring ra-chet will cause the pinion to move quickly to one direction (for the electrode shaft E to move downwards) without the spindle turning with it, and the ratchet will prevent the reverse motion from being made

quicker than the slow-motion gear will admit of. This will cause a brief flash of light with intervals of darkness of any desired duration, or, thirdly, the electrode shaft may work two pinions, each working in a separate rack on opposite sides of the shaft or both on the same rack, each of them turning freely on their spindles in one direction, and the direction being different with each, each two being caught and made to turn its spindle with it when turned in its opposite direction. These pinions are each connected with a separate (or partially separate) slow-motion gearing, as before described. This will make both the flashes and the intervals of darkness to be of any desired duration. These intermittent lights are convenient applications of the electric light when it is desired to have an apparatus requiring little expense and attention, partly because by this arrangement an electrode of moderate length may be made to last a long time. An especial advantage is this when the light is fixed on a stand upon a rock, for instance, at some distance from any spot on which a light-house of the ordinary description could be built, and where consequently the battery is on shore or at a considerable distance and communicates with the lamp by
means of wires insulated after the manner of submarine
4218 telegraph wires and buried in the sand or cemented between
the rocks, and where with this arrangement the lamp itself may be difficult of access in stormy weather and require to remain in a good working state without new electrodes for some days together.

The apparatuses which have been described, figure 27, may be modified in manner following as to produce also a good permanent light. The helix A is made sufficiently powerful (more so than is necessary for the intermittent light), and the weight is so adjusted that it shall be balanced by the force of the helix acting on B just when the electrodes are not so far apart as to endanger the continuity of the light nor closer together than about one-quarter of the diameter of the lower electrode M. A chain is hung from the weight Q, with its end resting loosely on the stand C, and this chain is equal in weight to a similar length of the electrode M, so that as the electrode wears away the diminution of weight is just compensated and the weight of the shaft remains properly balanced. In this modification of the apparatus the rack and its slow-motion pinion are made to work smoothly together without any back lash or looseness of pinion on its spindle.

Another means of modifying the said apparatus, figure 27, to produce a permanent light is to fix a regulating coil with a properly weighted iron centre, &c., just like that described in figure 21 (at R *o*
p X *y*). This coil is fixed to C, figure 27, and its wire is per-
4219 manently included in the electric circuit, and instead of
P moving a ratchet, V V, when it drops, it presses a spring or lever in connection with the negative wire from the battery into contact with the shaft B, so that most of the electric current passes from the negative wire through the lever to B direct and B is no longer drawn down by the action of A, but begins to rise by the force of the weight Q, which in this modification of the apparatus

is made to overbalance the shaft as it does in figure 27. Hence this arrangement will preserve the electrodes from approaching too near or receding too far while the electric current is continued in action. The apparatus employed, figure 27, in any of the preceding modifications may be made to act by substituting the arrangement shown in figure 28 for the parts A and B, which gives a greater moving power and allows the electrode shaft to move through a long space, not limited by the length of the coil A.

A′, figure 28, is a helix coil similar in construction to A, but differing in form, as is indicated in the sectional view, figure 28. A short hollow cylinder, B′, is substituted for B; a brass rod, B″ (or a bar "feather-edged" for the sake of lightness), passes freely through B′ and ratchet teeth are cut in it, as shown, by which a spring ratchet, *q*, suspends B′ in the position shown in the drawing. An end, H, which screws onto the top of the central tube of the coil A carries the conducting springs D D, and guides the shaft B″. When
4220 the shaft B″ rises (carrying B′ with it) it brings the projecting end of the ratchet *q* against the slanting side of H, the pressure of which pushes the ratchet out of the teeth and lets B′ descend for the space of one notch or tooth, so that B′ is always ready when the current in A′ acts to draw the shaft B″ a fraction of an inch lower and yet does not prevent the shaft from gradually moving upwards to any extent to supply the waste of the electrode, while B′ never follows the shaft higher than H. The helix coil last described (figure 28) may have its action on B′ augmented by making certain parts of the case in which the coil is wound to be of soft iron in place of brass, as shown by the section of the case in figure 29, the parts marked *a* being iron and *b* brass. The exterior circumference of the case is also cooped round with bits of iron fitting round the case like the staves of a cask, bands of vulcanized caoutchouc being placed around them to keep them together; or a cylinder of iron may be slipped over the end of the coil and envelope it. These pieces of iron augment the magnetic power of the other parts in several ways, and the main result is magnetic attraction between the lower end of B′ and the ends of iron which project upwards from the lower end of the central hole in the helix case. An electro-magnet may be used in place of the said helix coil surrounding the moving piece of iron B′, the poles of the electro-magnet being presented obliquely or directly beneath B′ and the form of B′ being altered so as to be the better suited to be attracted by both poles of the electro-magnet.

4221 Reflectors may be adapted to electric light-house lamps as well as to electric lamps of all sorts. I prefer the arrangement for this purpose shown in section by dotted lines in figure 27. Portions of the reflectors are placed inside the glass bell or shade and supported by projections from the tripod, and their continuation is effected by a separate piece properly placed around the shade or they may be supported by wires branching from a ring which fits around the base of the glass shade. The form of these reflectors is described by the revolution of a hyperbola about its focal ordinate, which is coincident with the axis of the electrodes, the asymptotal plane of the hyperboloidal surfaces being at such an angle as will give a convenient amount of dispersion vertically to the horizontal sheet of light which they will produce, so that a slight variation in the height of the luminous focus will be of little moment by reason of the extent of the vertical dispersion.

Twelfthly. My invention consists in improving by the means following the intensity of the electric currents (whatever may be the nature of the lamp or apparatus used for producing the light). I effect this by including in the electric circuit a long coil of insulated copper ribbon wound in an iron case (such as shown in section, figure 30) and part side view with the cover removed in figure 31, whereby I am enabled at the same time to reduce the number of cells employed. The coil may be made in pieces separately
4222 wound on and their ends joined in succession, the two extreme ends, A *e*, of the first and last coils being made to pass through the holes *p q* in the case. A hollow cylinder of iron or a number of bits of flat iron bar, *g h*, are placed around the coil like the staves of a cask and are held together by elastic bands of vulcanized caoutchouc. A good proportion of the substance of the coil is $\frac{1}{100}$ of a square inch of copper in section to every forty yards of length. The ends of each coil are held from slipping back or unwinding while the next coil is being wound by being bent round and backwards over a pin, K K′, screwed into the side of the iron case. The numbers annexed to the arrows indicate the succession of the different portions of the coil on which they are placed. The letters A B C D E indicate the commencement of each of the coils and *a b c d e* their several terminations.

Thirteenthly. My invention consists in enclosing the solid electrodes employed in electric lamps in supporting tubes as represented in figures 32, 33, and 34. When the electrodes are required to last for a long time they have to be longer than is convenient for their strength or for the proper conduction of the electric current. I therefore use a tube, *e*, which serves to guard the electrodes to hold them steady, and to conduct the electricity freely up to the top part of the electrode, the current being passed into the tube through the sole plate *c″* which is put in metallic connection with the negative wire D″ D″.
4223 Figures 32, 33, and 34 are conductors (they may be of iron) fixed on the tube *e*, the tips of which embrace the electrode near the point where the light is developed. The electricity has by this means a free passage from the tube into the electrode. The tube may be fixed mechanically to the frame-work *c c″* and yet insulated electrically from it, as is shown in figure 33, by means of collars of dry hard wood *z z* on the same principle as the legs of the upper electrode stand K are insulated from the sole plate *c″*. The electrode may be composed of many pieces slightly joined together end to end and placed in a tube, figure 34, of any required length. To obviate the necessity of joining the parts firmly, the following arrangement, figure 34, is contrived, wherein the electrodes need never be drawn backwards in the tube. *c″*, figure 34, is a piece of the supporting frame-work of the lamp, made for the purpose of holding the tube steady. The tube has a free sliding motion for a

short space that is upwards until the nut f touches the under side of z^3 and downwards until the collar f' touches the upper side of z^3 (or, rather, until it touches the part q which rests on z^3). The weight of the tube is nearly counterpoised by the elasticity of the spring q', which is attached to an arm projecting from the tube, as shown, and has an arm, q, fixed to its other end, the further end, q, being forked so as to embrace the tube and to rest the pressure of the spring upon the top of z^3. The weight of the tube being thus supported, it rises with the electrode when it is pushed upwards by E' 4224 until f touches z^3, and after that the electrode rises by passing through the tube. The parts of the fixed supports $c\ c''$ through which the tube passes may be insulated from the rest of the frame-work by collars of wood, as represented by $z^2\ z^3$.

Fourteenthly. My invention consists in the following improved modes of preparing the materials for electrodes: I take the powder of various carbonaceous matters which make electrodes, of different qualities as to illuminating power and resistance to abrasion by the electric current. The materials preferred are, first, plumbago powder, having its iron, &c., extracted by washing and warming in acids; second, lamp-black; third, charcoal powder of sundry kinds of wood; fourth, the powder of carbonaceous concrete, which becomes deposited in gas retorts; or, fifth, grains of this latter substance sifted so as to obtain a somewhat uniform size of grain. Any one of these materials I mix with a quantity of brown sugar in such proportions as are requisite to form a free paste with the powder when the mixture is melted by heat, a much larger proportion being sometimes employed for making the product cohere better. This mixture is melted and boiled (without water) until it becomes stiff. It is then pressed (while hot) into iron moulds of suitable shapes, the inside being lined with paper or chalk or plaster of paris to prevent the mixture from adhering to the mould and to form a porous envelope through which the gases, &c., can slowly escape. The moulds have 4225 numerous small crevices or holes for the purpose of letting the gases and steam escape from the material when baked. The moulds when charged and closed tightly are heated very gradually so as to allow sufficient time for drying it and dispelling the gases without their d*i*stroying the compactness of the material. When a red heat is thus obtained it is after a time allowed to subside, when the contents of the moulds are carefully taken out and placed upright in a crucible which is filled with sand luted down and gradually raised to a white heat. At this high temperature they may be kept for some time to give them greater mechanical hardness and strength; they are then covered up and allowed to cool gently, and, being cleaned if they retain a coating of any other substance, they are put into close-fitting tin cases for use. I preserve these electrodes from becoming damp or otherwise injured by coating them with tin-foil. In some cases also I prepare electrodes for use by wrapping them tightly in several thicknesses of metal foil, such as tin, for the purpose of giving them greater strength and making them better conductors. Good electrodes may some-

times be cut out of a lump of plumbago, either natural- or artificially compressed from the powder. Before using the electrodes it is sometimes beneficial to prevent the liability of their cracking when they become suddenly heated; this is done by fixing them in the lamp ready to light and then passing the electricity
4226 through them without allowing the machinery to separate
their extremities: this heats them gradually and drives off any damp that may be in them.

Lastly, my invention consists in the employment of galvanic batteries for the purpose of obtaining various chemical products, and this either in conjunction with the employment of them for lighting and motive purposes or as substitutes for the ordinary processes of chemical manufacture. The batteries should be of one or other of the perfluent sorts hereinbefore described on account of the facilities which they afford for drawing off the products of the galvanic action, which products may consist either of matters in a marketable state or which require some additional treatment to make them of commercial value. The elements proper to be employed will vary in each case with the chemical product or products desired to be obtained or, to state the matter conversely, the perfluent products will vary with the elements employed; for example, where juice is used for the positive metal with sulphuric acid sulphate of zinc is formed; but sulphate of zinc in large quantities would not be of great commercial value. When, therefore, I use zinc as aforesaid, I collect the sulphate of zinc and treat it as follows: I add in a separate vessel to the solution of sulphate of zinc a solution of sesquicarbonate of ammonia which precipitates the oxide of the (metal zinc) and releases the acid which may be used again. This oxide of zinc is a valuable substitute for
4227 carbonate of lead as a pigment and may be used extensively for painting purposes. Again, suppose any of the salts of lead are required to be produced, such as nitrate of lead (white lead) or sulphate of lead or any other chemical substance to the production of which these salts may be auxiliary, the battery should be constructed of lead or other metal plates platinized and excited to action by dilute nitric acid. The acid acting on the oxide of lead formed by the electrolytic process or decomposition of water dissolves it and forms with it a solution of the nitrate of lead, and this solution is afterwards treated in a separate vessel or vessels with the carbonate or bicarbonate of potash, when a double decomposition takes place and, the carbonate of lead being precipitated, the matter of commerce remains in solution and is obtained by evaporation. Supposing, further, the platinized plates of (lead or other metal) are used with muriatic acid (dilute or not), then the acid is decomposed and a solution of chloride of lead is the resulting product. If for the platinized plates we substitute iron or zinc plates the chloride of iron or of zinc is respectively obtained. Should a battery of copper and of iron plates charged with a solution of sulphate of copper be employed the iron is oxidized and sulphuric acid unites with the oxide by superior affinity and forms with it sulphate of iron (the green copperas of commerce), which remains in

solution and may be obtained by evaporation as before. The hydrogen which is released goes to the other pole—that is, to
4228 the copper plate—and, meeting there the disengaged oxide of copper, reduces it to the metallic state, and, in fact, plates the copper with it. This form of battery is directly applicable to the production of metallic copper from the ores of the sulphuret decomposed by water or from the water drawn from certain copper mines which contain sulphate of copper in solution. The sulphate of iron obtained forms also a very fine ocher.

And having now described the nature of my invention in the several parts thereof and in what manner the same is to be performed, I declare that the improvements that I claim are as follows:

First. I claim the construction of galvanized batteries on the perfluent principle before explained and illustrated, whether the perfluence of the liquid is effected by means of intercommunicating channels at the bottom of the trough or by syphons at top or by any other equivalent means.

Second. I claim the employment, in galvanic batteries, of flexible hose, with funnels attached thereto, to charge and discharge the cells, as before described.

Thirdly. I claim the construction of the double-fluid battery before described, so as to cause the perfluence of two separate and distinct exciting liquids, as hereinbefore described.

Fourthly. I claim the equilibrated hydrostatic cistern for the purpose of supplying galvanic batteries, as before described.

Fifthly. I claim the graduated metre to be attached to a
4229 cistern or supply vessel for the purpose of regulating or adjusting the quantity of exciting fluid which may be intended to pass through the battery, as before described.

Sixthly. I claim the mode of enclosing a liquid mercurial amalgam of zinc in a bag of lawn or horse-hair cloth or other finely reticulated fabric for the purpose of being used in lieu of the amalgamated zinc plates or rods of galvanic batteries, as before described.

Seventhly. I claim the amalgam of zinc and mercury in the proportions and for the purpose hereinbefore described.

Eighthly. I claim the combination of lead (instead of zinc) as the positive element with any suitable negative element and with nitric acid as the exciting fluid in galvanic batteries, as hereinbefore described.

Ninthly. I claim the improved galvanometer and graduated scale, hereinbefore described.

Tenthly. I claim the several improvements in the formation of magnets, before described.

Eleventhly. I claim the several improved modes of actuating the electrodes in electric lamps represented in figures 21 and 22, as hereinbefore described.

Twelfthly. I claim the improved regulator for electric lamps (shown in figures 21 and 22), and hereinbefore described.

Thirteenthly. I claim the revolving circular electrode with con-

ical edges in combination with an edge scraper for electric
4230 lamps, as before described.

Fourteenthly. I claim the mode of making the electrodes of electric lamps of iridium and alloys of iridium in manner and for the purposes hereinbefore described.

Fifteenthly. I claim the employment in electric lamps of glass or other similar imperfect conductor of heat to envelope the metallic holder to which the electrode is attached, as hereinbefore described.

Sixteenthly. I claim the enclosing of the electrodes of electric lamps in supporting tubes and the making them in pieces, as before described.

Seventeenthly. I claim the insulation of the said electrode tubes from the metal stand in manner before described, so as to allow of two or more separate lights being worked with separate currents of electricity independently of each other, but near together and under one glass shade.

Eighteenthly. I claim the several arrangements for producing a regularly intermittent light from electricity suitable for light-houses, as before described, and the various modifications by which the same may be adapted to the production of a permanent light, as before described.

Nineteenthly. I claim the combination of an intensity coil, shown in figures 30 and 31, with a galvanic battery, in manner and for the purposes hereinbefore described.

And, lastly, I claim in the formation of galvanic batteries
4231 for the purpose of obtaining products the several combinations of galvanic elements and exciting fluids, as hereinbefore described.

In witness whereof I, the said William Edwards Staite, have hereunto set my hand and seal this twelfth day of January, in the year of our Lord one thousand eight hundred and forty-nine.

W. E. STAITE. [L. S.]

And be it remembered that on the twelfth day of January, in the year of our Lord 1849, the aforesaid William Edwards Staite came before our said lady, the Queen, in her chancery and acknowleged the specification aforesaid and all and everything therein contained and specified in form above written, and also the specification aforesaid was stamped according to the tenor of the statute made for that purpose.

Enrolled the twelfth day of January, in the year of our Lord one thousand eight hundred and forty-nine.

(Here follow diagrams marked pp. 4232 to 4240, incl.)

A.D. 1848. July 12. Nº 12,212.
STAITE'S SPECIFICATION.
(3rd Edition)

(3 SHEETS)
SHEET 1.

FIG. 2.

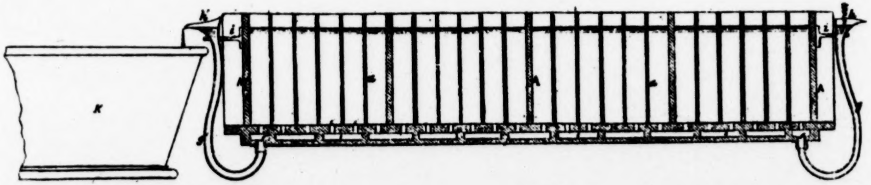
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FIG. 1.

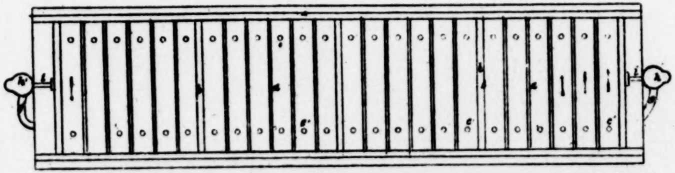


FIG. 4.

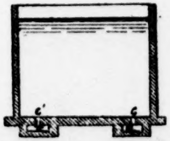
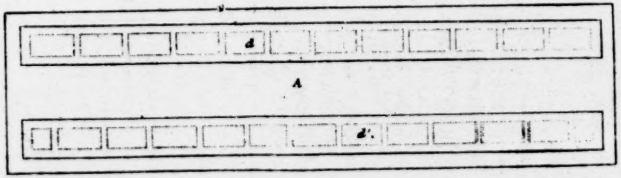


FIG. 3.



No. 286.
C.E. Light Co.
v
McK. Light Co.
p. 4232

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Printers to the Queen's most Excellent Majesty. [illegible]

A.D. 1848. July 12. No. 12,212.
STAITE'S SPECIFICATION.
(3rd Edition)

(9 SHEETS)
SHEET 2

FIG. 18.

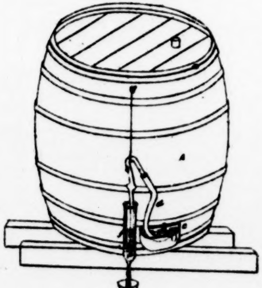


FIG. 19.

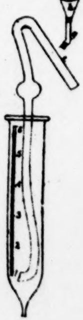


FIG. 5.

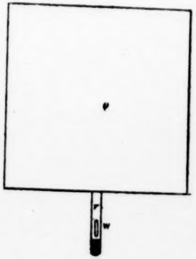


FIG. 6.

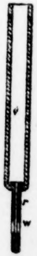


FIG. 7.

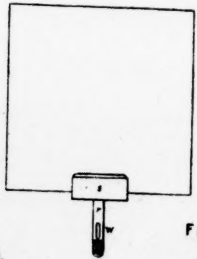


FIG. 8.

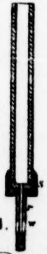


FIG. 9.

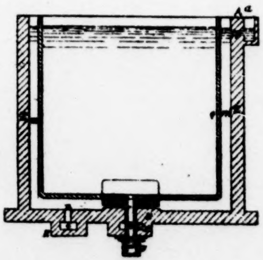


FIG. 10.

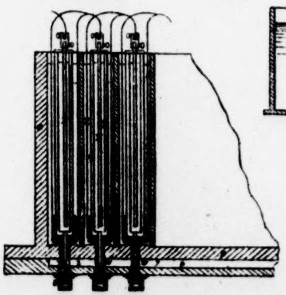
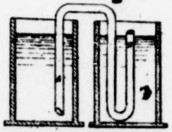


FIG. 11.



No. 286.
Ch. Light Co.
v.
Met. Light Co.
} p4233

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A.D. 1848. July 12. Nº 12,212.
STAITE'S Specification.
(3rd Edition)

(9 SHEETS)
SHEET 3.

FIG. 13.

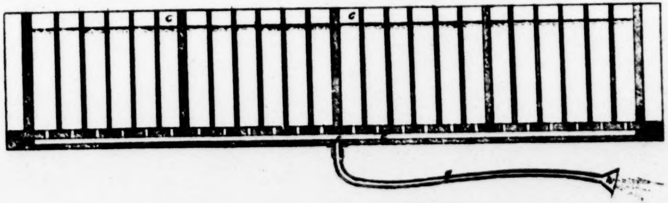


FIG. 15.

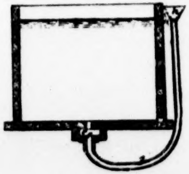


FIG. 12.

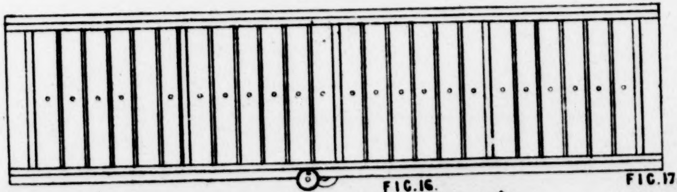
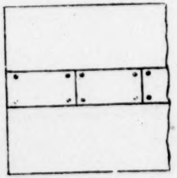
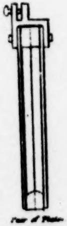


FIG. 14.





Pair of Plates

FIG. 16.

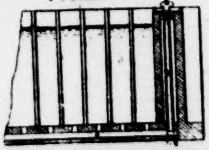
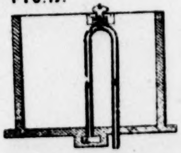


FIG. 17.



No. 286.
Ch. Light Co.
v
McK. Light Co.
} p.14 & 34

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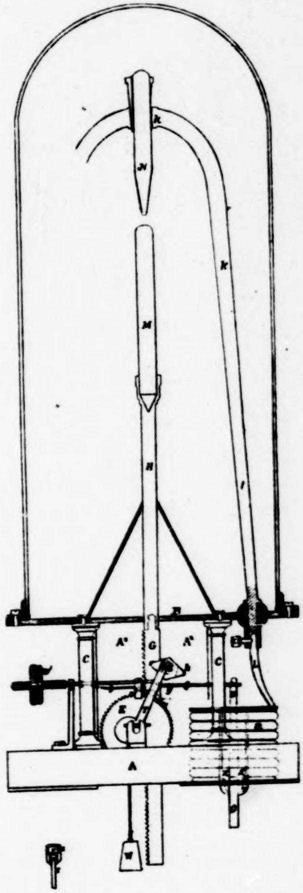
A.D. 1848. July 12. No 12,212.
STAITE'S SPECIFICATION.
[illegible] (Carbon)

(5 Sheets)
Sheet 4

No. 286.
C.E. Light Co
v.
McK. Light Co
} p 4235

FIG. 21.



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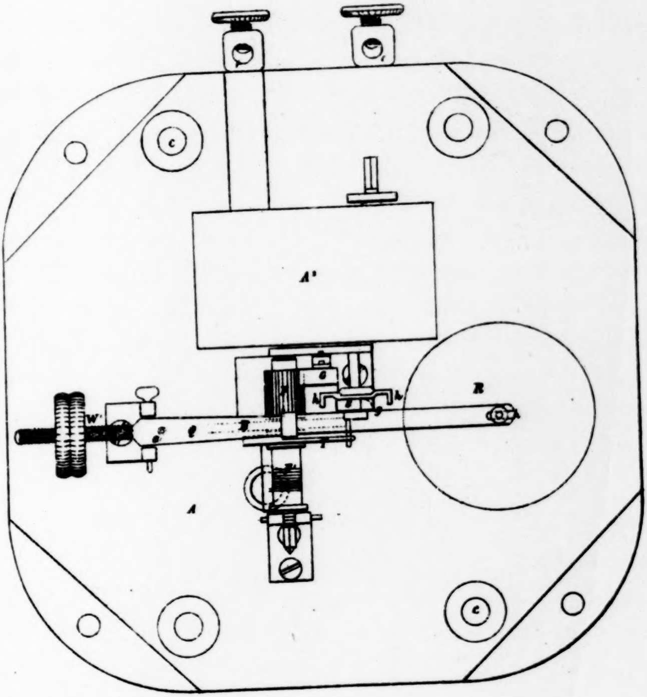
STAITE'S Specification.
(3rd Edition)

(9 SHEETS)
SHEET 5

No. 286.
C. E. Light Co.
v.
McK. Light Co. } p. 4236

FIG. 22.



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No. 286.
C. E. Light Co.
v.
McK. Light Co. } p. 4237

FIG. 23.

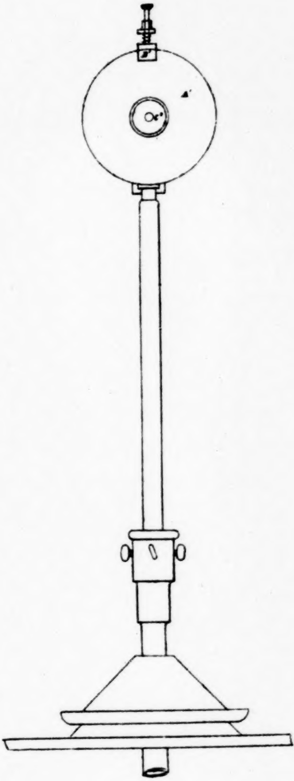
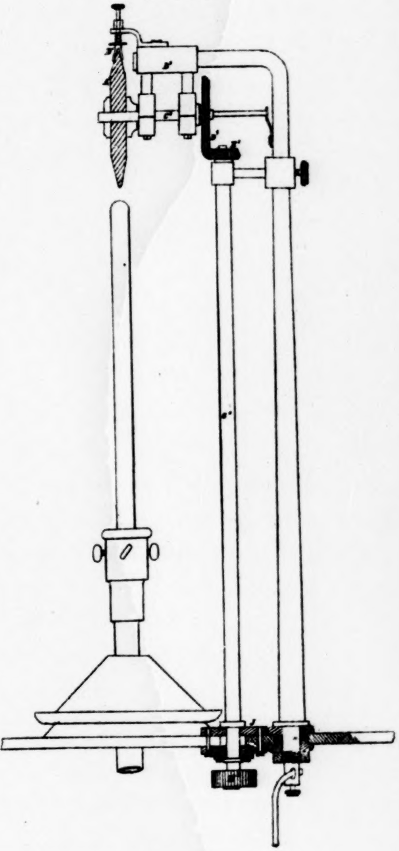


FIG. 24.



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STAITE'S SPECIFICATION.
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(9 SHEETS.)
SHEET 7.

No. 286
C. Light Co
v.
McK. Light Co. } p 4238

FIG. 26.

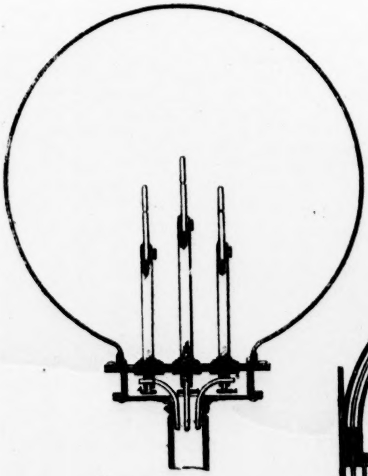


FIG. 25A

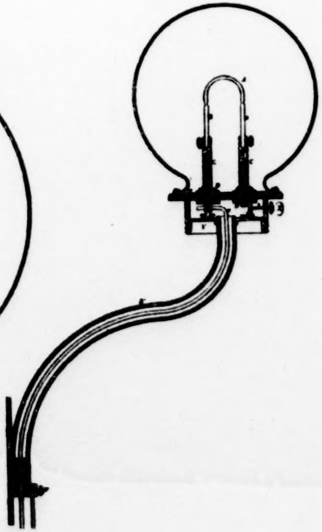


FIG. 25.

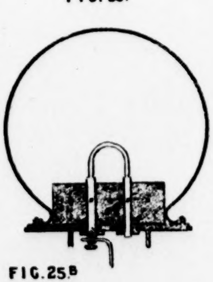
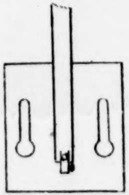


FIG. 25B



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No. 286.
E. Light Co. v.
McK. Light Co. } p. 4239

FIG. 27.

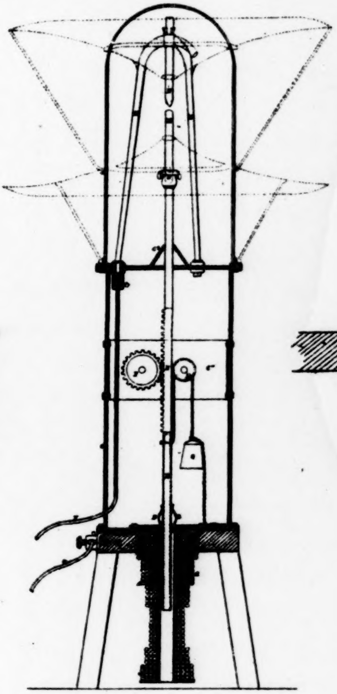


FIG. 29.

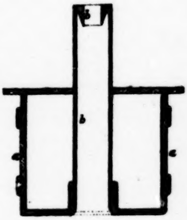
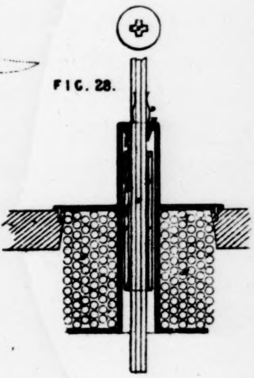


FIG. 28.



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A.D. 1848. July 12. No 12,212.
STAITE'S SPECIFICATION.
(3rd Edition)

(9 SHEETS)
SHEET 9

No. 286.
C. E. Knight Co.
&
W. K. Knight Co. } p. 4240

FIG. 32.

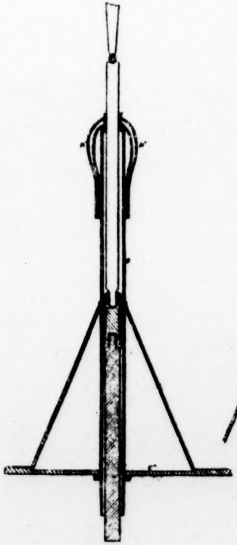


FIG. 33.

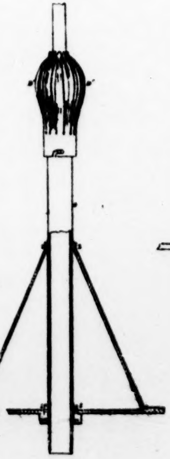


FIG. 34

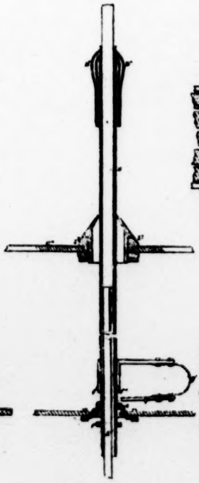


FIG. 31.

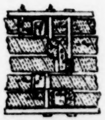


FIG. 20.

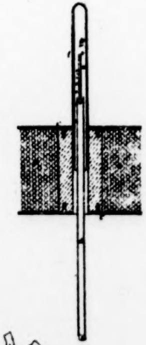
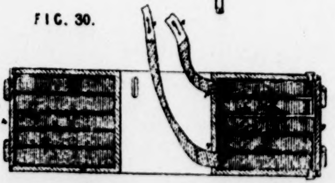


FIG. 30.



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4241 DEF'T'S EXHIBIT DE MOLEYNS' ENGLISH PATENT NO. 9053 OF 1841. Mar. 13, '89. W. T. F., S. P. & S. E.

(Third edition.)

[British coat of arms.]

A. D. 1841. No. 9053.

Specification of Frederick De Moleyns.

Production or development of electricity and its application to illuminating and motive purposes.

London: Published and sold at the patent office sale branch, 38 Cursitor street, Chancery lane, E. C. 1886. Price, 11d.

4242 (Third edition.)

A. D. 1841. No. 9053.

Production or Development of Electricity and Its Application to Illuminating and Motive Purposes.

De Moleyns' specification.

To all to whom these presents shall come I, Frederick De Moleyns, of Cheltenham, in the county of Gloucester, Esquire, send greeting:

Whereas her most excellent majesty Queen Victoria by her letters patent under the great seal of Great Britain bearing date at Westminster the twenty-first day of August 1841 in the fifth year of her reign did give and grant unto me the said Frederick De Moleyns my ex'ors adm'ors and assigns her especial licence full power sole privilege and authority that I the said Frederick De Moleyns my ex'ors adm'ors and assigns or such others as I the said Frederick De Moleyns my ex'ors adm'ors and assigns should at any time agree with and no others from time to time and at all times thereafter during the term of years therein mentioned should and lawfully might take use exercise and vend within that part of the United Kingdom of Great Britain and Ireland called England the dominion of Wales, and town of Berwick-upon-Tweed my invention being "certain improvements in the production or development of electricity and the application of electricity for the obtainment of illunation and motion" in which said letters patent there is contained a proviso that I the said Frederick De Moleyns shall particularly describe and ascertain the nature of my said invention and in what manner the same is to be performed by an instrument in writing under my hand and seal to be inrolled in her majesty's high 4243 court of chancery within six calendar months next and immediately after the date of the said in-part-recited letters patent as reference being thereunto had will more fully and at large appear.

Now know ye that in compliance with the said proviso I the said Frederick De Moleyns do hereby declare the nature of my invention and the manner in which the same is to be performed is particularly described and ascertained in and by the following instrument in writing

My improvements as embraced by the title of the said letters patent may be resolved into three branches namely improvements in the production or development of electricity by certain novel combinations of known substances whereby the electric power is largely developed by small quantities and superficies of those substances with the important advantages of nearly perfect freedom from the noxious effluvia arising from certain combinations previously known avoidance of the use of mercury and of undiluted acids and the preservation of equal power for a long period—Secondly the application of the electric power or principle whether produced by the improved combinations above referred to or by previously known combinations to a new and improved mode of producing what is commonly called "electric light" whereby that light may be sustained and increased so as to make it available for lighting apartments or for any other illuminating purpose—Thirdly improvements in the application of electricity in its voltaic form when developing magnetic power in iron to the production of a motive force of increased effect by means of improved modes of producing magnetism in iron and of arranging and combining the electro magnets—For convenience I shall describe my improvements in each branch separately but before detailing the nature of those relating to the production of electricity I will recount briefly the most approved combinations hitherto known and publicly used in order that the improvements and modifications effected by me may be the more readily comprehended and distinguished Electricity as produced by metallic combination with fluids was first developed in quantity by the pile of volta which consisted of two metals with moistened flannel interposed and piled in series—Cruikshanks and Wollastons batteries succeeded at intervals which were troughs divided into compartments—acidulated water being interposed between the zinc and copper—the difference between the latter and former being that in Wollastons battery both sides of the zinc are brought into action by being surrounded by copper whereas in Cruikshanks only one side of the zinc had a copper surface opposed—These batteries variously modified by Hare Faraday and others were in general use in Great Britain until 1836 but the powers of all diminished greatly after a few minutes
4244 which limited their application to scientific research—In 1829—Becquerel of Paris discovered the possibility of obtaining a constant current by the use of two metals and two fluids with a diaphragm interposed and his voltaic combination consisted of a solution of nitrate or other salt of copper in contact with the copper separated by a diaphragm of animal membrane or plaster of Paris from a solution of sulphate of zinc in contact with the zinc The diaphragm prevented the adhesion of positive elements to the negative surface and the nascent hydrogen was removed by deoxydating

copper—This grand discovery laid the foundation of various modifications and improvements subsequently effected in the voltaic battery—In 1836 Daniel's constant and Mullin's sustaining batteries were brought forward both being similar in principle to Becquerel's in the use of two fluids two metals and the diaphragm the fluids in Daniels being solution of sulphate of copper and acidulated water with amalgamated zinc and copper the fluids in Mullin's being a weak solution of muriate of ammonia (the use of which obviated the necessity of amalgamating the zinc and using acids) sulphate of copper in solution zinc and copper—In 1838 Grove introduced the nitric acid battery which consisted of platina in undiluted nitric acid both being contained in a porous diaphragm amalgamated zinc and water acidulated with sulphuric acid This the most powerful combination of any hitherto known is not fitted for extensive use by reason of the noxious fumes arising from the decomposition of the nitric acid—the inconvenience in the use of the acid itself—the impossibility of preserving an equally powerful current for a long period and the use of mercury in amalgamating the zinc It now only remains to describe the combination I have discovered which obviates the greater part of the inconveniences arising from the use of other batteries and at the same time developes extraordinary power To one pound of nitrate ammonia I add twelve fluid ounces of soft water and as soon as the salt has fully dissolved I add to one measure thereof the like quantity of pure sulphuric acid of commerce taking the precaution to place the vessel containing the solution in ice or salt and water or some other frigorific mixture and gradually introducing the acid so as to prevent the mixture from attaining a high temperature—the fluid is to be stirred as the acid is poured in—and as soon as the preparation above named has been added the vessel is to be placed in a cool place until the liquor becomes cold—it is then to be put into stoppered bottles and is fit for use it may be well to observe that as what is called the pure sulphuric acid of commerce is never really pure and as the same objection applies to the nitrate of ammonia a sediment will be found in the bottles at the end of a few days and the liquor will
4245 then be perfectly clear and colorless in such circumstances it
will be adviseable to decant the liquid into other bottles before laying by for use—I next prepare a saturated solution of hydrochlorate of ammonia which is to be filtered and then bottled for use the battery combination of which the liquids before named form part and which I find most economical and powerful—is arranged as follows—In a strong glass or well glazed porcelain or cemented wooden vessel three inches by two and a half internal measurement ~~and three~~ and a half deep is placed a piece of Mosselmans sheet zinc of the annexed form U the sides being nearly the height and width of the vessel and the narrow part or bottom one and a half inch wide within this upturned sheet of zinc and resting on it is a cell of seasoned sycamore or porous biscuit ware three fourths of an inch internal diameter and of the depth and breadth of the zinc which surrounds it—within this cell is suspended by a binding screw from a lacquered brass or gilt metal bar which crosses

the outer vessel and rests thereon—a piece of thin sheet platina cut so as to pass freely into the cell and of similar depth—the battery is now perfect and to put it in action the nitrate of ammonia acidulated solution is to be poured into the cell holding the platina to within half an inch of the top of the cell—the saturated solution of muriate of ammonia is to be poured into the glass vessel in contact with the zinc until it attains a level with the other solution, a binding screw with a copper shank is to be rivetted to the zinc as preferable to soldering and on closing the voltaic circle the battery is in immediate and powerful action and will preserve its original strength until the nitrate solution assumes a very light green color when it will be requisite to draw off by means of a syphon arrangement or syringe the exhausted liquor and replenish with fresh while it is in the act of passing off which can be done without any difficulty or loss of power by many simple contrivances which are well known the muriate solution may be removed similarly but will not require to be changed unless the battery is maintained in action more than twelve hours, what I here observe in regard to changing the solutions is only applicable to the simple and diminutive form of battery which I have been describing In batteries of a larger size the plates of which are five or six inches square and the containing vessels larger in proportion (which size be it observed is best adapted for the production of powerful electro magnetic effects) the nitrate liquor may be preserved in its original strength by a convenient apparatus attached to the battery which will gradually supply the inner and outer compartments with a given quantity of fresh fluids in a given time while the weak liquors are carried off into a reservoir connected with the battery for the purpose of obtaining therefrom by simple chemical operations various substances whose 4246 mercantile value will tend to reduce considerably the cost of the battery consumption in this combination there are various advantages which I do not believe to be attainable in any other battery known the use of a saturated solution of muriate of ammonia in contact with the zinc obviates the unwholesome troublesome and expensive process of amalgamation for there is no local action therefore the zinc lasts much longer in this combination than in any other again wooden cells or partitions which are the most durable diaphragms of any may be used with the prepared liquor the noxious fumes produced by the nitric acid battery are avoided the action is sustained without a fresh supply of fluids for a long period and the electric effects are so proportioned in regard to quantity and intensity that the electricity developed is peculiarly applicable to the production of great electro magnetic power it is to be particularly observed that although I have hitherto confined myself to the description of the effects of the combination of certain proportions of nitrate of ammonia water and sulphuric acid I do not restrict myself to the use of those particular proportions for I frequently use the salt of ammonia in various other proportions with water and sulphuric acid although I prefer the mixture described herein neither do I confine myself to the use of nitrate of ammonia alone for I use nitrate of potash and other nitrates in combination with sulphuric acid but prefer the nitrate of ammonia as most effective and most manageable in consequence of no precipitate being formed while the battery is in action neither do I restrict myself to the use of muriate of ammonia in connection with the zinc for I use occasionally muriate of soda and sulphate of zinc in saturated solutions but none of the muriates or sulphates aid in developing a current nearly so strong as the volatile alkaline salts hereinbefore described I would here remark that whenever the action is stopped it will be proper to remove the diaphragm cell and place it in water slightly acidulated and in any form of battery where the diaphragm is not moveable then to draw off the liquid contents and pour in acidulated water

The second part of my invention consists of the application of electricity—no matter by what combination it may be produced—to the attainment of continued light by the adoption of a mode of arrangement which enables that light to be maintained and regulated and applied to any purpose for which light may be required It is very well known that electric light (so called) of great intensity has been frequently produced by the instrumentality of powerful voltaic combinations but beyond establishing the fact—the light itself was of no use inasmuch as the arrangements by which it was developed were imperfect which prevented the light from being sustained the usual mode of exhibiting this electrical effect was by arming the electrodes of a powerful
4247 voltaic battery with charcoal points or one charcoal point
and a fine platina wire which points were brought into contact either in the atmosphere or in an air pump vacuum and then removed slightly apart when an arc or brush or starlike light was developed which however ceased or declined after a few seconds and was only renewed by bringing other parts of the electrodes into contact now my invention consists of the follow arrangements—A glass globe similar to that in present use for shewing electric light *in vacuo* is similarly furnished with two brass caps in opposite parts of the sphere through which communication may be made with the interior and by one of which the globe may be exhausted at pleasure we will suppose the caps to be in vertical line when the globe is fixed on its stand and the upper cap to *to* contain a glass or insulated metel tube which passes through the cap and reaches nearly to the centre of the interior of the sphere this tube is made to taper cone-like from within an inch of its internal extremity to the extremity itself so that the opening at that end shall not be more than an eighth of an inch in diameter through this tube a thick copper wire working in an air tight collar in the brass cap is made to pass until it reaches within a quarter of an inch of the conical end of the tube where it is united to a fine platinum wire which projects beyond the tube being wound into a spiral form externally the coiled part being one eighth of an inch in diameter and a quarter of an inch in length—The thickness of this wire (and this remark applies to the other proportions of the apparatus) must depend upon the power of the battery and quantity of light required for its object being to develope a white heat when acting as the positive electrode if too

thin it would be liable to melt if too thick it would not produce sufficient heat Opposed to this wire which forms one electrode of the battery is another thick copper wire passing through the opposite brass cap and also through an air tight collar having at its extremity within the globe a coil of thin platina wire similar to that already described and for a similar purpose and with this difference only that within this coil is a small piece of spongy platinum these electrodes can be made to touch or separate by means of screw arrangements in the caps—The glass or other tube already described is now to be filled with finely pulverized box-wood-charcoal or plumbago and on connection being established between the electrodes and the battery one of the fine platina coils becomes white hot the charcoal which falls through and around both coils is ignited and a light pure and intense is thus obtained which is kept up by the continually changing points of contact of the coils with the charcoal powder as by its gravity it descends slowly through the tube and falls to the 4248 bottom of the sphere thence to be withdrawn for future use for the better understanding of the arrangement just described I annex a sectional view of the apparatus A A represents the glass globe B the glass or metal tube with conical end holding pulverized charcoal, C C brass caps through which the electrodes and glass tube pass—through air-tight collars—D D copper electrodes to which the terminal platina coils are attached E E the thin platinum wires coiled F F bending screws to connect electrodes with battery It will be apparent that the apparatus described may be constructed in divers forms so as to fit it for the various illuminating purposes to which it may be applied the annexed form attached to an ornamental stand is applicable to the lighting of public or private apartments

The third part of my invention consists in certain improvements in the application of electricity to the obtainment of motion—The first improvement consists in a mode of constructing electro magnets by which from a given weight of iron more attractive power may be obtained than has been hitherto developed in any other known form of electro magnets thick copper or other wire covered with cotton or ribbon or from eight to ten very thin wires bound together and similarly covered are laid upon a strip of sheet iron previously softened say six inches in width three feet long and one eighth of an inch thick the wires are placed parallel to each other and to the sides of the sheet iron and separated by intervals of one eighth of an inch or more (or laid close together) and by an interval of half an inch in the centre of the strip before the wires are so laid one end of the strip of iron is to be rolled upon a cylindrical rod of iron or other substance of half an inch or an inch in diameter according to the size of the magnet required so as that upon the withdrawl of the rod one end of the sheet shall form a hollow cylinder the wires are then to be laid as before described upon the remaining length of the strip and that part of the iron which has been already turned up is to be rolled on thus enclosing the wires previously laid upon its surface and when rolled to the other end presenting a compact electro-magnet each wire having a surface of iron on both sides and

thus exercising a double magnetising effect when the electric current is sent through it an enormous surface in a given weight of iron is thus obtained and the course of the current being short upon this encreased surface it will be evident that in the construction of large electro magnetic engines immense power may be obtained in small space and much unnecessary weight and cost of iron got rid of it will be observed that the strip of iron when rolled up is hollow in its centre this hollow may be filled when desired with a solid rod of iron or a bundle of iron wires which will increase the
magnetic effects and the roll of iron itself may be covered on the
4249 outside with insulated wire like any common electro mag-
net—The annexed diagram represents the strip of iron before rolling—A A A A The strip of sheet iron laid flat—B B one end of the sheet rolled once so as to leave a hollow for the introduction of a rod of iron or a bundle of wires—C C the covered wires laid upon the sheet before rolling their ends being turned out at each end of the sheet for the purpose of connection with the battery or with each other—It is to be borne in mind that the iron strip may be of any degree of thickness that will admit of its being rolled that it may be of any length of any breadth—or that very thin strips may be laid one on the other and rolled up together and should the sheet iron beyond a certain thickness prove refractory in rolling and danger of injury to the intervening wires be apprehended this difficulty is easily obviated by placing a strip of lead or other soft metal upon the sheet iron in the first instance then rolling the iron upon the lead—then melting out the lead and finally coiling and packing the wires in the spaces occupied previously by that metal.

My second improvement is a modification of the first and is simply a combination of soft iron hollow cylinders of quarter inch or any thinner substance upon which covered wire is coiled singly from end to end and one cylinder so covered introduced into another a size larger—the larger covered in a similar manner and introduced into a third of greater diameter and so on until the combined cylinders attain the size required the whole are then bound together by a screw passing through their centres from side to side of the external cylinder

My third improvement consists in applying the above described electro magnets or any others to the production of motion in machinery by an improved mode of arrangement whereby greater force is obtained than by any of the methods in present use A series of electro magnets as above described or any others are passed through circular holes at regular distances all round the felloes or rim of a wooden wheel fixed in a metal or other frame and parallel to its axis—an equal portion of each magnet projects at either side of the rim of the wheel and fixed in frames on each side of the wheel and parallel to it are a number of electro magnets of equal size and strength corresponding with the number in the wheel and of equal stength The spokes of this driving wheel are of sufficient substance to admit of a certain number of straight electro magnets being passed through them also parallel to its axis and in the frame work on each side of this wheel are fixed electro-magnets radiating from a centre formed by the axis of the driving wheel which works in the frame and in their relative distances from each other corresponding with the magnets fixed in the driving wheel—The 4250 poles of the magnets in the frames are opposed to the poles of the magnets in the wheel during the revolution of which attraction is converted into repulsion by a change in the polarities of the fixed magnets effected by a commutator worked by the wheel I deem it proper to add that I prefer suspending or cutting off the electricity of the fixed magnets to changing their polarities but am prevented applying this method in my improved engine it being patented by another party—The fixed magnets are worked by one battery or series of batteries and the moving or wheel magnets by another and the connections with the batteries are effected by those modes which are generally known and adopted in electro magnetic motive arrangements

Having thus fully described and set forth the nature of my said improvements and the manner of carrying out the same I will now explain what I claim as my invention.

First I claim as my invention the developement of the electric principle by means of a combination consisting of a liquor composed of nitrate of ammonia or nitrate of potassa or other soluble nitrate water and sulphuric acid in the proportions hereinbefore described and also in other proportions (those however herein given being the best) in association with platina or other negative metal or precipitate of one metal upon another or other substance not metallic which may be substituted for the negative metal and which is capable of resisting the action of such compound fluid and further consisting of a saturated aquous solution of muriate of ammonia or muriate of soda or other soluble muriate or sulphate or nitrate in association with zinc or other positive metal the whole forming a voltaic circle or combination consisting of the acidulated nitrate solution platina saturated solution of muriate of ammonia and zinc with the addition of a wooden or other diaphragm and I not only claim this particular combination as my invention but I also claim specially as my invention the compound liquor of which nitrate of ammonia sulphuric acid and water *form* the ingredients in the proportions hereinbefore set forth (which I consider best) or in varying proportions—or of which a different soluble nitrate—a different acid—and water are the ingredients—inducing however when combined a similar play of chemical affinities during the development of electricity in a closed vol-aic circle.

Secondly I claim the application of electricity whether produced by my combination or by any other to the development of a sustained light by the mode hereinbefore set forth and explained that is to say by the use of pulverised charcoal or plumbago in connection with fine platina or other wire or spongy platinum or 4251 both and also the mode or mechanical means whereby the charcoal is brought into contact with the platinum or other metallic electrode.

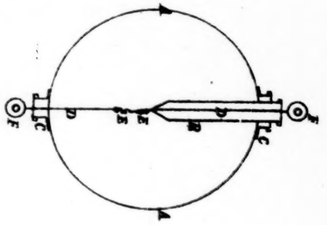
Thirdly I claim as my invention the two modes of forming power-

A.D. 1841. Aug. 21. N° 9053

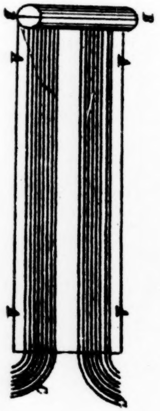
DE MOLEYNS' Specification.

(3rd Edition)

(1 SHEET)



No. 286.
C. E. Light Co
v.
McK Light Co } p. 4252



London. Printed by Eyre and Spottiswoode.
Printers to the Queen's most Excellent Majesty. 1886

Malby & Sons, Photo-Litho.

ful electro magnets herein described and also the particular modes of arrangement of the said improved electro magnets or other forms of electro magnets in the electro magnetic engine herein described.

And I further claim as my invention the particular mode of construction of the motive apparatus hereinbefore set forth as intended to convey motive power to machinery and to display the greatly encreased force produced by the described arrangement of the electro magnets.

In witness whereof I the said Frederick De Moleyns have hereunto set my hand and seal this twenty first day of February in the year of our Lord one thousand eight hundred and forty two

FREDERICK (L. S.) DE MOLEYNS.

Neale, Extra.

And be it remembered that on the twenty first day of February in the year of our Lord 1842 the aforesaid Frederick De Moleyns came before our said lady the Queen in her chancery and acknowledged the specification aforesaid and all and every thing therein contained and specified in form above written and also the specification aforesaid was stamped according to the tenor of the statute made for that purpose

Inrolled the twenty first day of February in the year of our Lord one thousand eight hundred and forty two

London: Printed by Eyre and Spottiswoode, printers to the Queen's most excellent majesty. For her majesty's stationery office.
(2666.—50.—3 | 86.)

(Here follows diagram marked p. 4252.)

4253 DEF'T'S EXHIBIT KING'S ENGLISH PATENT NO. 10919 OF 1845.
Mar. 13, '89. W. T. F., N. P. & S. E.

(Fourth edition.)

[British coat of arms.]

A. D. 1845. No. 10919.

Specification of Edward Augustin King.

Electric lights.

London: Published and sold at the patent office sale branch, 38 Cursitor street, Chancery lane, E. C. 1888. Price, 8d.

4254 (Fourth edition.)

A. D. 1845. No. 10919.

Electric Lights.

King's specification.

To all to whom these presents shall come I, Edward Augustin King, of Warwick street, in the county of Middlesex, gentleman, send greeting:

Whereas her present most excellent majesty Queen Victoria by her royal letters patent under the great seal of Great Britain bearing date at Westminster the fourth day of November in the ninth year of her reign did for herself her heirs and successors give and grant unto me the said Edward Augustin King my ex'ors adm'ors and assigns her especial licence full power sole privilege and authority that I the said Edward Augustin King my ex'ors adm'ors and assigns or such others as I the said Edward Augustin King my ex'ors adm'ors or assigns should at any time agree with and no others from time to time and at all times during the term of years therein expressed should and lawfully might make use exercise and vend within England Wales and the town of Berwick upon Tweed the islands of Jersey Guernsey Alderney Sark and Man and also within all her said majesty's colonies and plantations abroad the "Invention of improvements in obtaining light by electricity" communicated to me by a certain foreigner residing abroad in which said letters patent is contained a proviso that I the said Edward Augustin King shall cause a particular description of the nature of the said invention and in what manner the same is to be performed to be inrolled in her said majesty's high court of chancery within six calendar months next and immediately after the date of the said in part recited letters patent as in and by the same reference being thereunto had will more fully and at large appear.

Now know ye that in compliance with the said proviso I the said

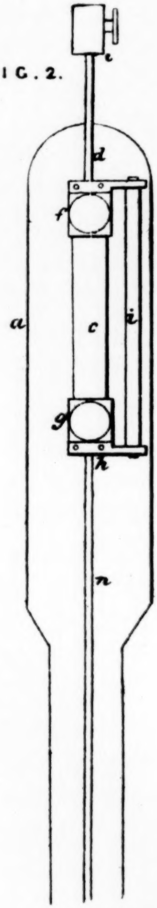
A.D. 1845. Nov. 4. Nº 10,919.

KING'S SPECIFICATION

(4th Edition)

(2 SHEETS)
SHEET 2

FIG. 2.



No. 286
C. E. Hight Co.
v.
McKnight Co
p. 4259

London. Printed by Darling and Son
for Her Majesty's Stationery Office. 1887

Malby & Sons, Photo-Litho.

Edward Augustin King do hereby declare that the nature of 4255 the said invention and the manner in which the same is to be performed are fully described and ascertained in and by the following description thereof reference being had to the drawings hereunto annexed and to the figures and letters marked thereon (that is to say)—

(Here follow diagrams marked pp. 4258 and 4259.)

The nature of the invention consists in the application of continuous metallic and carbon conductors intensely heated by the passage of a current of electricity to the purposes of illumination. The metal found to be the most advantageous to use for the purpose, is that which, while it requires a very high temperature for its fusion, has but a feeble affinity for oxygen, and offers a great resistance to the passage of an electrical current. Platinum though not so infusible as iridium, has but little affinity for oxygen and offers a great resistance to the passage of the current, and as it is abundant and easily worked into the requisite form, it appears to be preferable to any other metal. The platinum should be worked into those exceedingly thin sheets known as leaf platinum. This may be accomplished by the ordinary process of the gold beater, but a more accurate method is to place a piece of platinum foil between two thick plates of rolled copper and reduce the whole to a thin sheet by rolling, when on separating the *the* copper pieces the platinum leaf will be found of uniform thickness in every part. In this way it may be obtained so thin that on holding it before a printed page the letters can be distinguished through it. A strip is to be cut from one of these sheets of a width proportionate to the quantity of the current which with Grove's cells having the platinum plates three inches long and two inches wide, is about one-fourth of an inch and of a length proportionate to the intensity which of course varies with the number of cells. Great care must be taken to cut the platinum strips of an equal width throughout, and with a clean edge, as if this is not carefully attended to, the strip will be unequally heated and will be fused in one part before the other parts have obtained a sufficiently high temperature to produce a brilliant light. The platinum strip is now to be suspended between two forceps in an instrument made for the purpose one form of which is shown in section in the drawing hereunto annexed and marked N°. 1. A is a square brass bar fixed into the wooden stand C having a binding screw F attached to its lower end. The two arms E D are attached to sockets which slide on this bar so as to admit of their being placed at different distances from each other. They are both bent at right angles as seen in the figure and terminated by broad forceps tipped with platinum. These forceps are closed by the milled screws H I; the arm E has a rod N with a screw cut on it passing through it and by means of the two nuts B B working on this rod, the arm may be adjusted to 4256 any required height and the distance between the forceps thus regulated. The rod passes through the stand and is

attached to the binding screw G. The socket K is lined with ivory or some other non conducting substance, so as to prevent any metallic communication between the arm E, and the bar; S is the strip of platinum leaf which is first clamped in the upper forceps; the arm E is now adjusted to any required height, and the lower forceps are closed so as to clamp the lower end of the strip of platinum. It may now be included in the battery circuit by attaching one of the wires to the binding screw at F and the other to that at G. The current should be one of considerable intensity and the distance between the forceps should be sufficient to prevent the platinum being fused. The distance may be lessened by raising the arm E, and shortening the strip of platinum until it attains the highest temperature it will bear without fusing or the same object may be attained by increasing the intensity of the current. The glass shade R which serves to screen the platinum from currents of air, dust &c. may then be placed over the apparatus as seen in the drawing annexed. When carbon is used it becomes necessary on account of the affinity this substance has for oxygen at high temperature, to exclude from it air and moisture. To accomplish this in the most perfect manner it should be enclosed in a To*o*ricel-i*eu* vacuum. One form of the apparatus for this purpose is shown in section in the drawing annexed and marked No. 2, *a* is a glass tube similar to those used for barometers, except that it has its upper end enlarged into a cylindrical bulb, and a stout platinum wire sealed in at the top. A binding screw is fixed on the top of the wire, whose lower end screws in the iron piece, *d*, to this piece the forceps *f* are attached, and it is connected with a similar piece at *h* by the porcelain rod *i*. The forceps *g* are attached to *h*, and clamp the lower end of the carbon piece *c* which has its upper end held by those at *f*. *n* is a copper wire which is fixed into the piece at *h* and extends to the bottom of the tube, the tube is filled with mercury in the same manner as a barometer, the usual precautions being taken to expel the air; its length independent of the bulb, should be about thirty inches, so that when it is inserted in a cup of mercury, a vacuum will be formed in the bulb.—The instrument is included in the electrical circuit, by connecting one of the wires from the magnetic or voltaic battery with the binding screw fixed on the wire, *e* and the other with a wire which passes into the mercury in the cup at the bottom of the tube. The circuit is thus completed by the column of mercury, and when it is depressed in the tube by the formation of vapor of mercury, the connection is preserved by the copper wire *n*; that form of carbon found on the interior of coal gas retorts which have long been used, is well suited for this purpose, and may
4257 be worked into the form of either small pencils or thin plates by the aid of the saw and file. As carbon will bear a very high temperature without fusion or volatization it may be employed when a very intense light is required. When an intermitting light for the use of light-houses or for other purposes is required it may be obtained by breaking the circuit at intervals by clock work; to effect this, one of the wires from the magnetic or voltaic battery is connected with a spring which is made to press on the circumfer-

ence of a metallic wheel fixed on one of the arbors of the clock, having certain portions of its surface cut away so as to break and close the circuit at any required intervals. When the apparatus is suitably sealed it may be applied to submarine lighting, and also to the illumination of places where it is necessary to guard against the inflammation of highly combustible or explosive compounds, as in powder magazines mines &c. When a current is of sufficient intensity two or more lights may be made in the same circuit, care being taken to regulate the power by increasing or diminishing the number of armatures if a magneto-electric machine is the source of electricity or the number of cells if a voltaic battery be used, so that the united resistance of the strips of platinum or carbon shall be sufficient to prevent the passage of such a quantity of electricity as would destroy them.

Claim—What is claimed as the invention is the application of continuous metallic and carbon conductors intensely heated by the passage of a suitably regulated current of electricity to the purposes of illumination as hereinbefore mentioned.

In witness whereof I the said Edward Augustus King have hereunto set my hand and seal this second day of May in the year of our Lord one thousand eight hundred and forty-six.

EDWARD A. (L. S.) KING.

Dowdeswell.

And be it remembered that on the second day of May in the year of our Lord 1846 the aforesaid Edward Augustin King came before our said lady the Queen in her chancery and acknowledged the specification aforesaid and all and everything therein contained and specified in form above written. And also the specification aforesaid was stamped according to the tenor of the statute made for that purpose.

Enrolled the fourth day of May in the year of our Lord one thousand eight hundred and forty-six.

London: Printed for her majesty's stationery office, by Darling and Son.
(G 159.—100.—1 | 88.)

4260 DEF'T'S EX. GREENER & STAITE ENGLISH PATENT NO. 11076 OF 1846. Mar. 13, '89. W. T. F., N. P. & S. E.

(Third edition.)

(British coat of arms.)

A. D. 1846. No. 11076.

Specification of William Greener and William Edwards Staite.

Electric light.

London: Published and sold at the patent office sale branch, 38 Cursitor street, Chancery lane, E. C. 1885. Price, 4d.

4261 (Third edition.)

A. D. 1846. No. 11076.

Electric Light.

Greener & Staite's specification.

To all to whom these presents shall come we, William Greener, of Birmingham, in the county of Warwick, gunmaker, and William Edwards Staite, of Peckham, in the county of Surrey, Esquire, send greeting:

Whereas her present most excellent majesty Queen Victoria by her royal letters patent under the great seal of Great Britain bearing date at Westminster the seventh day of February in the ninth year of her reign did for herself her heirs and successors give and grant unto us the said William Greener and William Edwards Staite our ex'ors adm'ors and assigns her special licence full power sole privilege and authority that we the said William Greener and William Edwards Staite our ex'ors adm'ors and assigns or such others as we the said William Greener and William Edwards Staite our ex'ors adm'ors or assigns should at any time agree with and no others from time to time and at all times during the term of years therein expressed should and lawfully might make use exercise and vend within England Wales and the town of Berwick upon Tweed our invention of "certain improvements in ignition and illumination" in which said letters patent is contained a proviso that we the said William Greener and William Edwards Staite or one of us shall cause a particular description of the nature of our said invention and in what manner the same is to be performed to be in- 4262 rolled in her said majesty's high court of chancery within six calendar months next and immediately after the date of the said in part recited letters patent as in and by the same reference being thereunto had will more fully and at large appear.

Now know ye that in compliance with the said proviso we the said William Greener and William Edwards Staite hereby declare

that the nature of our said invention and the manner in which the same is performed may be stated generally as consisting in effecting the illumination of public and private buildings, streets, squares, and other public places by means of solid prisms or cylinders of carbon, enclosed in air tight vessels of glass or some other transparent substance and ignited or rendered luminous by currents of voltaic or magnetic electricity, such carbon being previously freed from the impurities with which it is ordinarily combined and divided on the surface thereof into numerous acute points or by means of rods or strips of platinum or some other like difficultly fusible metal enclosed in transparent air tight vessels and ignited or rendered luminous by currents of voltaic or magnetic electricity as aforesaid such metal being also divided on the surface thereof into numerous acute points or by means of hollow cylinders of carbon with surfaces either plain or acuminated, partially inserted within and placed in perfect contact with hollow cones of platinum, either plain or acuminated, the whole being enclosed in transparent air tight vessels as aforesaid, and the carbon being ignited or rendered luminous by voltaic or magnetic electricity also as aforesaid—or by a combination or combinations of the whole of the said means or methods or of any two thereof or of any of the parts thereof respectively—Both carbon and platinum have been before employed as media for the developement and exhibition of electric light, but carbon even in the purest states in which it has hitherto been obtainable, when ignited, or rendered luminous in an air tight glass vessel by means of electric currents has been found to give out various extraneous matters which interfere with the continuity of the light and which being precipitated on the inside of the glass vessel obscure and darken the same; and plain surfaced platinum when substituted for the carbon in the air tight vessel has never yielded more than a comparatively very feeble light. Now to obtain for the purpose of our invention a carbon absolutely pure or at least more nearly approaching absolute purity than any heretofore known, we proceed as follows—We take a quantity of what is known in commerce under the denomination of lamp black or of charcoal reduced to a state of powder, or of coke also reduced to powder which has been purified by the application of electricity from sulphur and other metallic mixtures according to the process for which Jabez Church of Colchester
4263 has obtained letters patent of date the twentieth of December one thousand eight hundred and forty five; and digest the same in dilute nitro muriatic or other acid—We then strain the lamp black, or charcoal, or coke, from the acid and wash it several times with water and we next wash it in some weak alkaline solution or carbonated alkaline solution and finally we wash it with distilled water until no traces of impurity are perceptible The carbon thus highly purified we next bring into a state of great dryness and then convert it into solid prisms, or into cylinders both solid and hollow by means of a hydraulic or screw or fly press (in the same way as the well known porcelain buttons are formed) and sometimes the better to ensure perfect dryness and homogeneous-

ness we expose the said prisms or cylinders to intense heat in a furnace for about twenty four hours—To give the solid carbon prisms or cylinders the numerous acute points on their surfaces before mentioned they are cast in suitably indented dies, or the points are afterwards cut out in them by means of a fine saw—By opposing two such acuminated surfaces the one to the other, we secure this advantage, that should the electric currents cease between any two points (as happens frequently in the ordinary mode of igniting carbon by electricity when there are only two points in opposition) the currents will be kept up by the remaining points and the light be so maintained without any material interruption or abatement—The same purpose may in some cases be effected by substituting for bodies with such acuminated surfaces a multitude of thin strips of charcoal separated from each other by platinum foil, and bound together by platinum wire—Instead also of employing either lamp black or charcoal or coke we sometimes substitute plumbago, or black lead, prepared formed and used in the same way; but the sort of carbon we prfer before all others is that prepared in the manner before mentioned from coke by Church's patent process—When we use platinum or any other difficultly fusible metal as the illuminating medium we multiply as much as we conveniently can the number of separate points on its surface, and with this view we either perforate a solid sheet of the metal with a multitude of minute holes or we take it in the form of wire and weave it into a gauze of sufficient thickness to resist the heat produced by the electric current without fusing—When we employ the combination before mentioned of hollow cylinders of carbon with hollow cones of platinum, we arrange them as follows—Supposing a voltaic battery of any of the most approved forms to be employed, we connect each of the two conducting wires namely the positive and negative with a hollow cone of platinum either plain or acuminated and place the cones with their bases facing, but at a little distance from one another—we then connect the two cones by placing between them
4264 a hollow cylinder of carbon either plain or acuminated, and
insert it so far into the cones at the two ends as to be in perfect contact therewith all round—The relative diameters should be such as to render it necessary to introduce the cylinder but a small way into the cones—Such cones and cylinders may be used either in single sets or in any number of sets which the battery or batteries employed may be adequate to supply—The sets too, may be arranged in any order and they may be of any variety or varieties of size best calculated to produce an equable well sustained and brilliant light—When the platinum or carbon or other difficultly fusible metal (in whatever form employed) is placed within the air tight vessel of glass or other transparent substance, it may be either kept stationary or made to rotate on its axis—We think it unnecessary to describe either how the air tight vessel which is to enclose the illuminating bodies should be mounted or how the electric currents are to be conveyed to them from the voltaic battery or magnetic machine employed because there are many well known modes of doing so and we do not claim to have invented anything new in

these respects—We desire it farther to be understood that we lay no claim to the employment of carbon or platinum or other like difficultly fusible metal enclosed within air tight vessels as a medium for the developement and exhibition of electric light the suitableness of both bodies for the purpose when so enclosed (subject to the exceptions aforesaid) being long well known—But we declare that what we do claim as of our invention is—

First the employment as a medium for the developement and exhibition of electric light of carbon purified and prepared as before described.

Second, the employment for the said purpose of carbon and platinum or any other like difficultly fusible metal in solid prisms or cylinders divided on the surfaces thereof into numerous acute points, or in such other forms as to present numerous acute points as before described And

Third the employment for the said purpose of hollow cylinders of carbon either plain or acuminated in combination with hollow cones of platinum or other like difficultly fusible metal either plain or acuminated as before described.

In witness whereof we the said William Greener and William Edwards Staite have hereunto set our hands and seals this fifth day of August in the year of our Lord one thousand eight hundred and forty six.

WILLIAM (L. S.) GREENER.
W. E. (L. S.) STAITE.

4265 And be it remembered that on the fifth day of August in the year of our Lord 1846 the aforesaid William Greener and William Edwards Staite came before our said lady the Queen in her chancery and acknowledged the specification aforesaid and all and every thing therein contained and specified in form above written And also the specification aforesaid was stamped according to the tenor of the statute made for that purpose.

Duckworth.

Enrolled the seventh day of August in the year of our Lord one thousand eight hundred and forty six.

London: Printed by Eyre and Spottiswoode, printers to the Queen's most excellent majesty. For her majesty's stationery office.
(4932.—100.—6—85.)

4266 DEF'T'S EX. SHEPARD ENGLISH PATENT NO. 13302 OF 1850.
Mar. 13, '89. W. T. F., N. P. & S. E.

(Third edition.)

[British coat of arms.]

A. D. 1850. No. 13302.

Specification of Edward Clarence Shepard.

Electro-magnetic apparatus for obtaining motive power, light, and heat.

London: Published and sold at the patent office sale branch, 38 Cursitor street, Chancery lane, E. C. 1887. Price, 1s. 1d.

4267 (Third edition.)

A. D. 1850. No. 13302.

Electro-magnetic Apparatus for Obtaining Motive Power, Light, and Heat.

Shepard's specification.

To all to whom these presents shall come I, Edward Clarence Shepard, of Parliament street, in the city of Westminster and county of Middlesex, gentleman, send greeting:

Whereas her present most excellent majesty Queen Victoria by her royal letters patent under the great seal of the United Kingdom of Great Britain and Ireland bearing date at Westminster the twenty-fourth day of October one thousand eight hundred and fifty in the fourteenth year of her reign did for herself her heirs and successors give and grant unto me the said Edward Clarence Shepard my ex'ors adm'ors and assigns her especial license full power sole privilege and authority that I the said Edward Clarence Shepard my ex'ors adm'ors and assigns or such others as I the said Edward Clarence Shepard my ex'ors adm'ors or assigns should at any time agree with and no others from time to time and at all times during the term of years therein expressed should and lawfully might make use exercise and vend within England Wales and the town of Berwick-upon-Tweed and in the islands of Guernsey Jersey Alderney Sark and Man and in all her said majesty's colonies and plantations abroad my invention of "certain improvements in electro-magnetic apparatus suitable for the production of motive power of heat and light" communicated to me by one Floris Nollet of Brussels in which said letters patent is contained a proviso that I the said Edward Clarence Shepard shall cause a particular description of the nature of my said invention and in what manner the same is to be performed by an instrument in writing under my hand and 4268 seal to be enrolled in her said majesty's high court of chancery within six calendar months next and immediately after the date of the said in part recited letters patent as in and by the same reference being thereunto had will more fully and at large appear.

Now know ye that in compliance with the said proviso I the said Edward Clarence Shepard hereby declare that the nature of the said invention and in what manner the same is performed according as the same have been communicated to me by the said Floris Nollet are fully set forth and ascertained in and by the present specification thereof reference being had to the drawings hereunto annexed that is to say the said invention may be described generally as consisting

Firstly of certain improvements in the means and apparatuses used for developing electricity and applying that physical agent to various useful purposes.

And secondly in certain improvements in magneto-electric apparatuses or arrangements having for their object the production of different physical and chemical phenomena and more especially the disengagement of certain gaseous elements which by their elasticity their dilatation and their combination produce either motive power or light or heat.

I.—*Description of the Improved Apparatuses.*

Figure 1 A B and A^1 B^1 are parts of four compound magnets each composed of from 7 to 9 bars of very hard tempered cast steel not less than eighty-four centimetres (33 inches) in length 5 centimetres (2 inches) in breadth eight centimetres (three and one eighth inches) in thickness magnetised by means of electro-magnetism. Each bar is bent into two parallel legs about four to five centimetres (one & five eighths of an inch to two inches) apart. These four magnets are arranged in two pairs by means of plates of wood or brass and brass adjusting screws *c c* the magnets being kept at the same distance apart as the bars of which each magnet is composed. The two pairs of magnets are fixed horizontally on the base of the frame of the apparatus so that their opposite poles A B A^1 B^1 face one another and at such a distance that the ends of four helices pass during their rotation immediately over and between the poles of these magnets and as near to them as may be without touching. The positions of the magnets A^1 & B^1 are indicated by dotted lines C C. C^1 C^1 are the four helices forming part of a set of eight connected by the armatures D D and D^1 D^1 figure 2 which cross one another being furnished with an insulating substance interposed between them at the point of intersection. The helices
4269 are united in pairs by being mounted upon a wooden spindle
the whole are joined together by the armatures D D and the axle *a*. These helices are formed of two wires of very fine copper about one millimetre (one thirty-second of an inch) in diameter covered with some insulated substance as silk cotton varnish or what is still better a thin layer of gutta percha, through which the wire has been drawn while both wire and gutta percha are at a temperature nearly that of boiling water (one hundred degrees centigrade). These two wires are wound in the ordinary manner round a hollow soft iron axis about five to six centimetres long

(two to two & three eighths inches) and about four centimeters (one & five eighths inches) in diameter. The length of each of these wires should at least be about one hundred and fifty metres (one hundred and seventy yards). The hollow cylindrical centres or axes of the helices terminate in two plates of about three centimetres (one and a quarter inch) in width bent back against the discs or ends of the helices and the extremities of the plates are bent up at right angles to a height of from five to six millimetres (three sixteenths of an inch) and kept sufficiently apart to allow of the poles of the magnets passing freely without touching during their rotation. The horizontal axis *a* is centred on two steel pivots and passes through the middle of the armatures where it is firmly secured to them. This axis carries two pairs of ivory discs E E E¹ E¹ into which are inserted four segments of copper cemented by means of gutta percha and separated by slips of ivory of about one millimetre (one thirty-second of an inch) in thickness which last are kept a little in relief to prevent the copper segments from ever touching two of these slips at once. Figure 3 is a side view of one of these discs. The metallic segments communicate by means of arms arranged in the form of a cross the direction of the diagonal of one disc corresponding to the diagonal of the other of the same pair whereby all the currents are made to flow in one direction. F is a pulley about three centimetres (one and a half inches) in diameter over which is carried a gutta percha band which passes over a second pulley of about 1.5 metres (fifty-seven inches) in diameter placed immediately above the other which arrangement allows of a rotary speed of from fifty to one hundred revolutions per minute being obtained with at the utmost not more than half a man's power. By these means two pairs of primitive currents constant in one direction and of an intensity capable of producing various physical phenomena such as of heating to redness and melting metallic wires and rendering large cones of carbon incandescent causing rapid chemical decompositions, &c., but instead of making them thus act on the poles of the wires which terminate this arrangement of primitive current helices they are made to communicate and pass into one or other of two supplementary
4270 systems herein-after described namely the system of spirals or the system of current condensers. In figure 4 G and G¹ represent two arrangements of spirals composed of a hollow central cylindrical axis made of magnetized metal from eight to ten centimetres (three and a half to four inches) in diameter about twelve centimetres (four and three quarters inches) in length and terminating in two discs of dry varnished wood. To form the spirals two series of round or flat copper insulated wires of as nearly equal diameter as may be to that of the electro-multiplying helices and exactly of the same length as the distance between the two discs are arranged on a horizontal plane like the warp of a web. The wires thus arranged are wound on the central axis and parallel with it so as to form a cylinder of about fifteen centimetres (six inches) in diameter one of these cylinders communicates by the central end of the first spiral with the wire of the positive pole of two pairs of

primitive currents. The other end of that spiral is soldered to the central extremity of the third spiral so that the second spiral has its two ends free. The upper end of the third spiral is in its turn soldered to the central end of the fifth spiral leaving the fourth free and so on throughout the series the same arrangement being adopted for the second pair of currents. It results from this arrangement that all the spirals of odd numbers are soldered together and form one immense helix traversed by the primitive current whilst each of the spirals of even numbers is individually traversed by a current of induction. The same phenomenon takes place in the second cylinder but here the currents are reversed because the large helix likewise formed of the odd spirals communicates with the negative pole of the first pair of primitive currents. By soldering the centre or inner end of an odd spiral of the first cylinder with the end of the circumference of the corresponding spiral of the second cylinder the two free ends of these spirals form the two poles of a powerful induced or secondary current capable of producing the same phenomena as the primitive current. It has been proved by experiment that a wire traversed by an electrical current will produce a current of induction or secondary current in an adjacent wire bent back in any given direction as long as it is parallel to and does not cross the direction of the wire of the primitive current but in all helices with double wires hitherto contrived the induced or secondary currents do not perfectly realize these two essential conditions because the wires are forced to cross each other and to return in an opposite direction to the other extremity of the helix. Now in my arrangement of spirals on the contrary the direction of the wires remains constant from one end to the other and each spiral of the induced or secondary current is enclosed throughout
its whole length between two spirals traversed in the
4271 same direction by the primitive current whence it necessarily
follows that the two currents must act concurrently so that
each shall have a tendency to increase the power of the other. If this primitive current did not exist and the two spirals placed one to the right and the other to the left were traversed by currents in the same direction as they are in the case supposed it is evident that they would produce in the spiral interposed between them an induced current in the same direction as that of the actual primitive current. It appears farther from recent experiments that the electric current traverses a copper wire such as I employ with a speed of at least one hundred thousand leagues per second so that if the wire were of that length and an intermittent current were passed through it each second it would be continuous in the wire because it would always enter by one end of the wire just as it passed off by the other but if instead of one vibration or one induction per second it were possible to produce one hundred or more in the same time it is evident that a current of proportionately increased intensity would be produced. In place of the wires flat spirals of thin metal two or three times broader than the wires may be substituted with advantage.

II.—*Oscillating System.*

Another arrangement of the system of helices which I have found to succeed well consists in fixing the whole of the eight helices at the end of a pendulum of about one metre (thirty-nine inches) in length mounted in a frame as represented in figure 5 having a vertical oscillatory movement between the poles of the magnets which are arranged horizontally a similar arrangement being adopted at the other end of the lever. Eight pairs of helices h h h^1 h^1 may be then set to work at the same time and this number may be doubled trebled or even increased at pleasure within a certain limit by prolonging the arms of the lever to a sufficient extent for which purpose the levers may if necessary be composed of several parts articulated or jointed together. The movement of the pendulum is communicated and the range of the oscillations regulated by means of an excentric L the lower end of the rod M of which is jointed to one of the arms B of the pendulum or lever N at a convenient distance from the fulcrum O. This excentric is fixed on a shaft placed perpendicularly over the lever and put in motion by two pulleys P P^1 and band R the small pulley P is placed on the shaft of the excentric and the large pulley P^1 is about twenty or twenty-five times the diameter of the smaller one—is put in motion by means of a handle S.

III.—*Rolling System.*

In this system (see figure 6 and figure 7) the magnetic bars
4272 are kept in their horizontal position but the helices (h h h^1 h^1)
are carried on a little carriage C which runs on rails R R and passes alternately in front of the poles of the magnets by means of a to and fro movement derived from two excentrics keyed on one common axis side by side but diametrically opposed in their excentricities in order that there may be an equilibrium of action on both sides of that axis each excentric moving the same number of pairs of helics. For the eccentrics cam wheels may be substituted or any other equivalent mechanical means. By this sort of movement little force is expended and at the same time there is little risk of derangement of the parts. The different parts of the rails R R are insulated from each other by ivory plates B B. C is one of the carriages by which the helices are made to travel in front of the magnets. Any desired number of these little magneto-electric waggons may be placed on the same rails and may be put in motion by the same mechanism. The ivory plates B B serve to break the flow of the currents and the cross bars X X unite them again so that they may all flow in one direction.

IV.—*The Actions and Re-actions of Soft Iron on the Helices with Primitive Currents and on those with Induced Crrents.*

Experiments which have been made proved that the actions of currents for developing magnetism in soft iron and the re-action of this same soft iron transformed into a temporary magnet are not reciprocal in the different relative positions which may be given to them. For example it is known that if soft iron is enveloped in a helix of wire or metallic ribbon covered with some insulating substance and brought near to the pole of a soft iron magnet there is an electric current induced in the wire and if reciprocally an electric current is made to pass through the helicoidal wire, magnetism is developed in the soft iron without the presence of any magnet, but if the metallic wire helix is placed in the hollow soft iron cylinder and the soft iron is subjected to the action of the poles of a magnet even of a very powerful one no current is developed in the helix. But it is not the same thing as to the action and re-action of two insulated helices mounted end to end upon one hollow axis. In this case if the primitive current is made to pass into the upper helix a current of contrary direction is produced by induction in the lower helix while at the same time the soft iron centre is magnetized which in its turn re-acts on the lower helix in a manner corresponding with the action of the upper helix. There is thus obtained in the lower helix a very powerful current by double induction and the primitive current far from being weakened is increased by the re-action of the electro-magnet so that it can 4273 be made to pass into a numerous series of double helices (arranged as aforesaid) before closing the circuit of the primitive current. And these different induced currents may evidently produce phenomena like those which the primitive current itself produces.

V.—*Current Condensers.*

When the positive polar wire of the primitive current is brought into communication with a thin leaf of metal or even with leaves of paper thinly coated with metal such as copper silver or gold leaf or with varnish and also against another similar sheet communicating with the negative polar wire the current is condensed on these leaves and by separating them quickly and repeatedly a very remarkable increase in the intensity of the current is produced accordingly it has been found that the prolongation of the conducting wires soldered to the end of these leaves yields to a decomposing instrument (rheometer) a quantity of gas greater than when the polar wires of this current pass directly to the rheometric apparatus. The idea therefore suggested itself that if there were placed in the middle of this condenser another similar condenser charged with a considerable quantity of electrity that condenser would transmit its electricity to a second condenser of the same sort or to the pole of induced or secondary currents as before-mentioned and thereby greatly increase their intensity. These condensers acquire a still greater power when constructed of very thin metallic bars varnished and wound round a roller or hollow cylinder made of well annealed thin sheet iron. From these arrangements I obtain a series of very powerful induced or secondary magnets. The success attending the preceding arrangements led to the trial of an experiment to make the primitive current pass through dry piles (piles sêches) and through secondary piles (piles secondaires) and the result has shown that a considerable increase may be thus effected both in the primitive current and in the induced or secondary currents. So also it seemed that a very advantageous improvement might be made in the apparatus for decomposing water acids salts &c. by charging the portions of any liquid desired to be composed with fluid of a corresponding character. For example if the portion of the liquid (say water) required to be decomposed in which the positive pole has been plunged and at which pole the oxygen should be given off were already positively electrified then it should seem to follow that on the discharge of the positive currents taking place the action of the positive fluid with which that portion of the water is already saturated would unite with the action of the polar fluid to attend the oxygen and repel the hydrogen and a like arrangement being applied to the negative wire it ought also to produce an analogous action. If so then that concurrence of actions ought to increase 4274 the decomposition of the liquid and consequently the production of gas. And this is in fact what is accomplished by the arrangement of decomposing apparatus next to be described. I bend a glass tube into two branches A A as represented in figure 8 which I contract or narrow at the bend B. I insert into each branch a tube of copper C C and connect it closely to the glass by a resinous luting. To the lower end of this tube which is open there are soldered from ten to fifteen ends *a a a* of fine platina wire ~~placed at~~ equal distances from one another and disposed in the form of a circle. These wires are immersed about one centimetre (three eighths of an inch) in the liquid to be decomposed which is contained in the glass tube. The copper tube C C should be carefully varnished on the inside especially in all that part which is inserted into the glass tube. The copper tubes are closed at top by well luted stoppers D. D made of varnished cork through which two tubes are passed one of which E is of glass and immersed in the liquid to be decomposed outside the glass tube E is connected to or prolonged by a tube made of gutta percha or India rubber or of glass or metal varnished on the inside and of about one metre (thirty-nine inches) long. The outer surface of this last tube is coated with metal that may act partially as a polar conductor and communicate with the copper tube from which the platina wires are dependent. Both branches of the tube are alike in their construction. By these means the liquid contained in the outer tube is electrified by induction and consequently charged with fluid of the same character as that of the polar wire which acts upon it. The liquid of one side passes to the polar tube of the other and reciprocally. It may here be observed that in order to preserve the flexibility of the gutta percha or India rubber tubes without impa-ring their quality as conductors either inside or outside they are covered with a thin continuous metallic surface by means of electrotyping and if necessary the surfaces are also varnished over with a solution of lac added to gutta percha. When decomposition is required to take place in a great number of vessels at the same time it will be found advantageous to employ a long prismatic porcelain trough divided by cross partitions into compartments communicating with one another two by two in order to separate the gases as in the case of the tube with two branches. This trough should be provided with a rather larger edge or flange to which an overlapping cover should be carefully luted and further fixed by means of a metallic frame with adjusting screws. There should be two circular openings in the cover above each of the two cells of the same compartment as shewn in figure 9 and the openings should be luted where the tubes are inserted as represented at figure 8.

4275 When great quantities of hydrogen gas are desired to be obtained it is advantageous to employ hydrochloric acid, and in this case the chlorine which would be disengaged like oxygen at the negative pole might be utilized for the manufacture of chlorides. If the hydrogen gas is intended for lighting I make it pass in a very divided state through camphine or other combination of alc*h*ohol or ether with an essential oil or other suitable hydrocarburet in order to render the flame more white and more intense.

VI.—*Apparatus for Lighting in a Vacuum.*

When it is desired to light by means of the incandescence of charcoal I employ an arrangement of apparatus similar to that which is represented in figure 10. A is a globe of glass which may if desired be ground or obscured on the inside in order to disperse and soften the intensity of the light. The stopper B of this globe is very carefully luted, and two insulated polar wires P and N of about two millimetres in diameter are passed through it. One of these wires is soldered to the side and towards the upper end of a copper tube C of about 1 decimetre (4 inches) in length. This tube is intended to hold a little cylinder of charcoal which is kept constantly pushed down from above by a small cylinder of lead which is of a weight adjusted to the purpose. The other polar wire comes out under the lower end of this tube at about one centimetre (three eighths of an inch) distance from its extremity and terminates in a little cone D of prepared charcoal or coke and against the top of which the little charcoal cylinder E rests which when the current is established becomes incandescent and remains in that state a very long time because the small portions which are consumed are continually replaced by a portion of the cylinder which the metal presser forces onto the top of the cone. A tube of glass or other suitable substance also passes through the stopper and admits of its being connected to the pneumatic receiver in order to create a vacuum in the globe. The tube is afterwards cut and hermetically sealed in order to prevent the re-entry of air.

VII.—*Prime Motive Power.*

The motive power engine most proper for the purpose of this invention is one of the form of an atmospheric steam engine without the boiler feeding pumps and condenser. The dimensions of this motive power engine ought to be proportionate to the force desired to be obtained but the bottom of the cylinder (see figure 11) 4276 should be provided with a valve V opening from the inside to the outside whereby any slight excess of steam will pass away with the water of condensation and produce the effect of reaction at the moment of the combination of the oxygen and hydrogen gases in order to reconstitute the water in the state of steam. This valve is held up by a helical spring *h*. Just above the bottom of the cylinder is a small tube T with a neck to which is screwed a stuffing box S in which is placed an insulating ring through which passes a rod R which forms the axis of a small toothed brass wheel W. The upper side of this box is perforated with an opening also provided with a boss *r* of some insulating material in which a metallic wire P is luted which communicates with one of the polar wires of one of the pairs of helices of the electro-magnetic apparatus the other polar wire N being attached to the end of the prolongation of the axis of the wheel a little beyond its bearing G. This prolongation carries a pully L to which motion is imparted by means of a strap from another pulley of a greater radius and which is not shewn in the drawing. There is fixed on the same axis R a little toothed wheel *w* which gears into another wheel fixed on the axis of the fly wheel of the machine and which is provided with teeth only on a very small portion of its circumference so that in one entire revolution of the fly wheel it may transmit its motion only during an exceedingly short interval to the wheel W and just at the instant at which the piston has made about one-fourth of its stroke. Numerous electrical sparks are thus thrown out every time that the teeth of the little wheel W enclosed in the box slide over the flattened end of the conducting wire P communicating as aforesaid with one of the polar wires these sparks then ignite the gaseous mixture arising from the decomposition of water and admitted into the cylinder through a distributing apparatus (slide box). The quantity of gas admitted into the cylinder should be equal to about one fourth of its capacity experiments having shewn that under the pressure of the atmosphere the ignition of gases generated by the decomposition of water causes them to dilate during explosion to four times their bulk. The piston will then be forcibly driven to the end of its stroke when immediately the water resulting from the combination of the gases will become condensed on the cold sides of the cylinder and a vacuum is formed beneath the piston then the atmospheric pressure acting with its entire force on the upper side of the piston will cause it to descend rapidly and these motions continued will produce the rotation of the engine. Thus by keeping up the supply of gases and successively exploding them a continuous movement of the machinery connected with the piston may be obtained.

4277 VIII.—*Apparatus for Covering the Wires and Making the Helices or Spirals.*

In all electro-magnetic apparatuses the most delicate of the operations and that which involves the greatest expense is the manufacture of the helices and the spirals. An apparatus very suitable for these purposes is represented in figure 12. I generally prefer using very fine cotton of ten or twelve strands which will perfectly cover the metallic wires without much increasing their diameter. Four small bobbins of cotton may be arranged on one circle and then cotton of only three or four strands is employed but it should always

be as fine as possible. The apparatus above referred to will allow of a metallic wire being covered of whatever length without being necessary to cut it. *a* is a bench frame one end of which is provided with a spring-vice *b* for guiding the metallic wire and giving it the necessary tension. The wire passes through the hollow axis of a little pulley *c* which is furnished with from one to four arms perpendicular to the axis at the end of which there is affixed at right angles a small steel rod *d* threaded at its free end, on these rods are mounted the bobbins filled with cotton. A screw nut pushes before it on each rod a little spiral spring which presses a friction float against the bobbin in order to prevent it from turning too loose on its spindle and thus exercises a slight tension on the thread of cotton. The end of the cotton is fastened with a little insulating varnish after passing it through a small glass ring (which serves as a guide). Upon the metallic wire a cord or band passes from the small pulley *c* (which is at the utmost one and a half centimetres (five eighths of an inch) in diameter) into one of the numerous grooves of a long wooden cylinder *e* of about three centimetres (one and a quarter inch) diameter. This cylinder with numerous and equi-distant grooves has motion given to it by means of a band from another pulley *f* (of about one metre (thirty-nine inches) in diameter, so as to impart a very great quickness of rotation to the bobbins which supply the cotton for covering the metallic wires *g* thus great quantity of metallic wires may be covered at the same time in fact as many as there may be sets of cotton covering bobbins. On the axis of the large pulley *f* there is a fusee *h* provided with an endless chain or band which imparts motion to a cylinder *j* the diameter of which is about four inches which is also the size of the diameter of the top of the fusee so that the band at this point causes the cylinder to make one revolution at every turn of the large pulley. The steel axis *k* of this cylinder is about two centimetres (three quarters of an inch) in diameter and is prolonged over a support whence it passes
into two metallic sockets which allow of its making a to and
4278 fro movement. This movement is determined and regulated
by two long screw threads in relief on the main shaft one of which is threaded from right to left and the other in the reverse direction. Two half nuts each fixed on one of the ends of the arms of the levers *l l* gear alternately into the right and left hand threads and push the shaft backwards or forwards. A rod *s* attached to the spindle *k* alternately pushes the weighted lever l^1 from one side to the other and effects the change of the gearing of the nuts so that without the aid of the workman's hand the shaft would always go forwards or backwards the same distance moreover the two screws correspond in size to that of the diameter of the metallic wire which it is desired to roll upon the soft iron armatures *i*. Several like armatures may be placed on the prolongation of the axis corresponding to the number of metallic wires intended to be rolled up. Thus the rolling of the cotton on the metallic wires and the completion of the helices are effected at the same time and with the greatest regularity.

And having now described the nature of the said invention and the manner in which the same is performed I declare that the improvements which I claim as constituting my said invention are as follows

First I claim the arrangement of four compound magnets in the manner represented in figure 1 and before described.

Second I claim the combination of four pairs of helices with armatures and other appliances in the manner represented in figures 1 & 2 and before described.

Third I claim the system of parallel multiplying spirals united in cylinders of indeterminate length and producing powerful and active induced currents by their combination as before described.

Fourth I claim the oscillating arrangement represented in figure 5 and before described.

Fifth I claim the rolling arrangement represented at figures 6 and 7 and before described.

Sixth I claim the flat helices employed as substitutes for the wires in the system of flat spirals represented in figure 4 and before described.

Seventh I claim the magneto-electric current condensers as before described.

Eighth I claim the application of dry piles and of secondary piles for the purpose of increasing the intensity both of the direct and of the induced currents.

Ninth I claim the electro-chemical motive power represented in figure 11 and before described but only in so far as regards the cylinder and its appendages.

4279 Tenth I claim the apparatus for lighting by the incandescence of prepared charcoal before described.

And eleventh I claim the lighting by hydrogen gas saturated with vapour of any hydrocarburet and burning in ordinary gas burners as before described.

In witness whereof I the said Edward Clarence Shepard have hereunto set my hand and seal this twenty-fourth day of April in the year of our Lord one thousand eight hundred and fifty-one.

E. CLARENCE (L. S.) SHEPARD.

And be it remembered that on the twenty-fourth day of April in the year of our Lord 1851 the aforesaid Edward Clarence Shepard came before our said lady the Queen in her chancery and acknowledged the specification aforesaid and all and every thing therein contained and specified in form above written.

Jefferson.

And also the specification aforesaid was stamped according to the tenor of the statute made for that purpose.

Enrolled the twenty-fourth day of April in the year of our Lord one thousand eight hundred and fifty-one.

London: Printed by Darling and Son. For her majesty's stationery office.

(G 38.—100.-5 | 87.)

(Here follow diagrams marked pp. 4280, 4281, 4282, and 4283.)

4284 DEF'T'S EXHIBIT SLATER & WATSON ENGLISH PATENT NO. 212 OF 1852. M'ch 13, 1889. W. T. F., N. P. & S. E.

A. D. 1852. No. 212.

Applying Electricity to Illuminating Purposes.

Letters patent to Thomas Slater, of Somers place, New road, Saint Pancras, in the county of Middlesex, optician, and Joseph John William Watson, of Old Kent road, in the county of Surrey, doctor of philosophy, for the invention of "improvements in the application of electricity to illuminating purposes."

Dated the 4th October, 1852.

Provisional specification left by the said Thomas Slater and Joseph John William Watson at the office of the commissioners of patents with their petition on the 4th October, 1852.

We, Thomas Slater, of Somers place, New road, Saint Pancras, in the county of Middlesex, optician, and Joseph John William Watson, of Old Kent road, in the county of Surrey, doctor of philosophy, do hereby declare the nature of the said invention for "improvements in the application of electricity to illuminating purposes" to be as follows:

Our improvements consist—

Firstly. In adjusting the distances between the parts of the electrodes by means of an induced magnet or magnets or by means of an electric current inducing magnetism in helices of wire.

4285 Secondly. The use of a chemically compounded electrode containing caustic substances and the introduction of a certain amount of non-conducting material to check the excess of convection or otherwise alter the mode in which the same is performed.

Thirdly. The use of a governor or governors for regulating the supply of electricity to the illuminating apparatus and thereby increasing or diminishing the intensity of the light.

Fourthly. The use of several electrodes in the same lamp.

Fifthly. The making the support or supports of the electrodes the armature of an induced magnet or magnets.

Specification in pursuance of the conditions of the letters patent filed by the said Thomas Slater and Joseph John William Watson in the Great Seal Patent Office on the 4th April, 1853.

To all to whom these presents shall come we, Thomas Slater, of Somers place, New road, Saint Pancras, in the county of Middlesex, optician, and Joseph John William Watson, of Old Kent road, in the county of Surrey, doctor of philosophy, send greeting:

Whereas her most excellent majesty, Queen Victoria, by her letters patent bearing date the fourth day of October, in the year of

our Lord one thousand eight hundred and fifty-two, in the sixteenth year of her reign, did, for herself, her heirs and successors, give and grant unto us, the said Thomas Slater and Joseph John William Watson, her special license
4286 that we, the said Thomas Slater and Joseph John William Watson, our executors, administrators, and assigns, or such other as we, the said Thomas Slater and Joseph John William Watson, our executors, administrators, and assigns, should at any time agree with, and no others, from time to time and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend within the United Kingdom of Great Britain and Ireland, the Channel islands, and Isle of Man an invention for "improvements in the application of electricity to illuminating purposes," upon the condition (amongst others) that we, the said Thomas Slater and Joseph John William Watson, by an instrument in writing, under our hands and seals or under the hand and seal of one of us, should particularly describe and ascertain the nature of the said invention and in what manner the same was to be performed and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said letters patent:

Now, know ye that we, the said Thomas Slater and Joseph John William Watson, do hereby declare the nature of our said invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement, reference being had to the accompanying drawings and to the letters and figures marked thereon—that is to say:

4287 Our invention- in improvements in the application of electricity to illuminating purposes consist—

First. In improvements in apparatus for employing electricity as an illuminating agent.

Second. In apparatus for governing electric currents so as to indicate the quantity and intensity of electricity and to increase or dimish the same when passing into any description of electrical illuminating apparatus.

Third. In a new mode of applying electric currents so as to cause an equable consumption of the electrodes.

Fourth. The nature and manufacture of the electrodes.

Fifth. The application of electricity to the purposes of signaling.

Our invention of improvements in apparatus for employing electricity as an illuminating agent consists, firstly, in using horizontal levers attached rigidly to a piece or pieces of soft iron, serving as the armature of an induced magnet, made magnetic by the same current, which by its rupture in the space between the poles affords the light by which a vertical rod or beam or other contrivance for holding the electrode is gripped and held in a fixed position, but which rod is free to slide downwards or take any other course obligatory on the effect of gravity or the elasticity of a spring, the said levers serving the further purpose by their forming the armatures of an
4288 induced magnet of elevating or giving other direct motion to the rod when gript by them, the simplicity of the above

arrangement allowing for its modification in an infinity of ways. We claim especially as our invention the use of levers attached to the armatures of an induced mag-et or magnets to act in the manner and for the purposes described. Of the forms advised by us as the most convenient on the above principle we select the following, and which plan we recommend for all lamps in which the apparatus is likely to receive rough usage and where ornamental appearance and beauty of design are not required: The current enters by the binding screw A, figure 1 on sheet 1 of our drawings, and passes up the body of the lamp B through the magnet C C, which is secured to a bracket fixed to the pillar B. A wire, C′, is connected with the rod D in order to ensure better contact. This rod is suspended at E by the chain F and counter-poise G, which works within the tubular support B, but which is by no means necessary for the successful working of the lamp. The armatures H H are attached to brass levers, H′ H′, which are fitted with eyes, through which the rod passes freely when induction ceases, but when the current passes through the magnet the outer extremities of the compound levers H′ H′ are raised, and their eyes simultaneously grasp the rod D, which
4289 is thus held at a proper elevation, but when the current is
broken the levers assume a horizontal position and allow the rod to drop down, which effects a re-establishment of contact between the electrodes. A series of anti-friction pulleys are fitted at I to surround the rod and allow it to descend freely. The lower portion of the lamp corresponds to that shown at figure 1, sheet 2, of the drawings. Our improvements for employing electricity as an illuminating agent embrace also the construction of electric lamps in the manner and on the principles next described. The lamps constructed as below differ in form and principle from those described above mainly by the induced magnet being situate in the base of the lamp and by connecting the armature with the electrode carriers by a system of levers. This form of lamp may be made exceedingly ornamental, and will occupy but little space. A A, figure 1 on sheet 2 of our drawings, is an electro-magnet, which may be constructed in the form hereinafter described and shown in detail at figure 2, sheet 2, fixed in the base of the lamp, and rendered magnetic by the wires which enters at A′, the other end of the magnet being in connection with the base of the lamp. The armature B of the magnet is attached to the lower extremity of the rod C, which is attached at its upper end to one extremity of the lever D. This lever works on the fixed centre E, and is terminated by a fork, *f*, shewn more
4290 clearly in the plan view of the lever shown detached
at figure 3, drawn full size. The helical spring G serves to keep the end D′ of the lever elevated when the magnet is not in action. This fork embraces the collar H, which consists of two semicylindrical pieces hinged together at I and made to grasp the vertical rod J by the action of the ascent of the fork on the conical sides of the collar. The rod J is fitted with a socket, K, and tightening screw for holding the electrode L, which should be fixed rigidly to it. The lower electrode L′ is inserted into the socket M. This

socket is fitted onto the top of the main stand N, which also carries a binding screw, by which it is connected with the other pole of the battery. The black portions of the drawings represents the insulated points of the apparatus. Two flexible wires, *o*, connect the top of the lamp with the upper end of the rod J, to which they are secured by a binding screw, P. As the correct working of the lamp depends on the adjustment of the arc or striking distance between the poles during the working of the lamp, we introduce an arrangement which is marked by the letter Q, and which consists of a boss capable of turning round in a grooved ledge encircling the upper portion of the pillar, through which passes the rod attached to the forked lever D and the armature of the magnet B. The in-
4291 ner portion of the boss is grooved with a female screw-thread, into which works a male screw. The turning of the boss raises the ma*il* screw, which consists merely of a tube grooved on the outside and carrying the lever, causes the armature of the magnet either to recede or approach the poles, and hence decreases or increases the inductive power. Moreover, the portion of the pillar above the boss, being slotted to allow of the lever passing through, restrains the play of the lever to certain limits. These two circumstances combined serve as the required means of adjustment of the striking distance, as will be obvious without further description. The action of the lower pole of the lamp is as follows: The current which makes the electro-magnet A makes also the electro-magnet R before it passes to the general body of the lamp. The electro-magnet R attracts the armature S, which is attached to a curved lever moving horizontally on the axis T, but kept from the magnet during the time induction is not taking place by the spring U. At the other extremity of the lever is a movable tooth, V, but which after turning the rack-wheel X, into which it fits by the induction of the magnet, is always made to resume its original position by the bow spring V′. Y is a screw, which is made to rise and so elevate W, the electrode-holder, by means of the rotation of the wheel X. It will be clear from this description of the apparatus that the
4292 same action which results from the magnetic operation of A will induce a similar consequence in the action of R, with the exception that in the latter case the motion is a rising one instead of a descending one. Moreover, by the simultaneous action of both poles the great desideratum of preserving the light in one place is successfully accomplished. In addition to the mode just described of raising the lower electrode we claim also the means of effecting this by an arrangement in which, instead of a screw traveling within a tube, we use a long rack into which fits a tooth attached to a lever of the same kind and construction as the last described, but working vertically instead of horizontally, the induction of the magnet being downwards instead of laterally. The action of this arrangement is very simple and consists merely in the keeper at one end of the lever being attracted and so causing on every such occasion the opposite and toothed end to raise the rack a tooth when the inductive action takes place. The action of this lamp is as follows: The electric current on its passage through the magnet A causes

the armature B to be attracted, thereby drawing down the end D′ of the lever D and consequently raising the collar H and rod J, the electrodes being thus retained at a proper distance asunder so long
as a sufficient amount of attraction exists between the magnet
4293 and armature to keep the latter down. Should any non-
conducting material obstruct the passage of the electricity through the arc the induction of the magnet instantly ceases and the helical spring G coming into action forces up the end of the lever D and at the same time the descent of the forked end of the lever releases the grasp of the collar upon the rod J, which consequently slides down and re-establishes contact between the electrodes, the requisite arc being instantly reformed by the attraction of the armature, as hereinbefore described. If, as in other arrangements for producing the electric light, the contact be made by two or more points on the electrode, which points are temporarily removed to admit of the electrode sliding down as it burns away, the light will for such time go out and spark passing between the points of the jaws will fuse them, and hence in time from the coat of oxide formed the lamp will cease to be of any use at all, since the principle does not admit of good conduction being always kept up. The contact in our lamp is always the same and continuous, since the descent of the rod to which the electrode is attached requires simply a diminution of the friction exercised on the rod by the lever-and-collar apparatus hereinbefore described, and this we claim as the substantive part of our invention. This action is accompanied by no diminution of
the light. In addition to the forms described we pre-
4294 fer for public lights, and, indeed, for all cases of illu-
mination where the light has to be sustained for a long time, the use of several electrodes, and also the use of separate lights in the same lamp, but in all such cases we strictly adhere to the same principles and differ only in the mode of arrangement of the electrodes. In arranging several electrodes we take great care to preserve them insulated one from the other and deriving their electricity by separate wires. We occasionally oppose several small electrodes forming the positive poles to one larger electrode forming the compound negative pole of the several batteries. We find that by combining several electrodes or sources of light in the same lamp that if near together they prevent the chances of flickering, going out, sparks, &c., and render the general illuminative effect constant. Figure 4 on sheet 2 of the drawings is a partial section and elevation of an arrangement for raising the lower electrode A, and figure 5 is a horizontal section of the same. This is effected by the screw B, which is secured to the pulley C. A traversing nut, D, works in a slot in the side of the cylindrical case E, being raised or lowered by the screw B. The electrode A is fitted into a socket in the top of the nut and passes through the piece E, which serves to guide it in its assent. This arrangement, which must be worked
by hand, we substitute for the magnetic arrangement in the
4295 bottom of the lamp in figure 1 in all cases where the lamps

are used in situations where personal attention is practicable and easily attainable.

The next portion of our invention relates to electrical governors, indicators, and alar*u*ms, and other minor apparatus connected therewith. Figure 2 on sheet 1 of our drawings show- an arrangement for indicating any variation in the current, and also to a certain extent a means of measuring its intensity. We have termed this the electric governor or indicator. It is shown half in section and half in elevation. A is the base of the apparatus, to which is attached the single magnet B. A helical spring, C, is interposed between the magnet and armature D. A rack, E, is attached to the armature and takes in to the pinion F on the arbor of the indicator G. A wire, H, connects the armature D with the arbor of the indicator, and another wire, I, passes thence to the outer pole of the battery. The action is as follows: The current on passing through the magnet attracts the armature, drawing it down, more or less, according to the strength of the current, and consequently turning the pinion and with it the indicator G, which shows on the graduated dial the strength of the current. The helical spring is for the purpose of raising the armature when the
4296 attraction diminishes. Figure 3 on the same sheet of our drawings is an alarm or means of indicating at the battery depot or at any other place through which the electric mains may pass any sudden or partial cessation in the continuity of the circuit. It may be termed generally an alarm. A is an electro-magnet made by the same current of electricity that supplies the lamp or other apparatus. B is the armature attached to a lever, C, which is bent at right angles and carries a tooth detent at D, which fits the teeth of the ratchet wheel E. Attached to the centre of E as a radial arm is the rod F. G is a toothed lever hammer, of which the head I plays within the bell H, and is constrained to the position represented in the drawing by a co*a*l spring in the axle on which it works. K is a weight attached to a spring passing round a drum attached to the back of the ratchet wheel E. The action of the alarm is as follows: When from any failure in the current the armature B ceases to be attracted by the electro-magnet, then falling from its own weight it relieves the detent tooth D and the weight descending causes the ratchet wheel to rotate and so turn the radial arm F, which, striking the hammer G, rings the bell H. It is easy to see that the re-establishment of the current will instantly arrest the descent of the weight and therefore the ringing of the alarm by the induction of the keeper of the
4297 magnet to its former and fixed position. In order to increase or decrease the amount of light in the lamp when the illuminating apparatus is large or in order to adjust a powerful battery to a delicate lamp, we check the current as it enters by causing it to pass through iron wires of different thicknesses imbedded in pipe clay or alumina or asbestos, the connection being made by means of a handle of peculiar construction, which by sliding on an axis on which it turns over the top of the pipe-clay bed with the surface of which the iron wires are arranged parallel and flush the

current is passed through any one of the wires at the pleasure of the operator, thereby diminis-ing or increasing the intensity of the light given off at the points of the electrodes. Figure 4 is an end view and figure 5 a corresponding plan of this apparatus. A is a lever composed of ivory or any other good non-conducting material working on the fixed centre B and turned in a horizontal plane by the small handle C, and having a small metal stud, D, at the movable extremity. E F G H I are iron wires of graduated thicknesses resting in a bed of pipe clay, J, which is fixed in the wooden stand K. The terminals of the wires are united by the cross-piece of metal L, which is fitted with a set-screw, M, for the attachment of the wire N. The action of the instrument is as follows: The lever being turned so as to bring the stud D onto any particular wire, the
4298 current passing in at L travels by D along the upper surface of the lever A, which is of brass, and thence by the bind screw forming the fixed centre of the lever to the lamp. Now, if the current be found too strong all that is necessary is to turn the lever so as to bring the metal stud onto a wire of smaller dimensions, and so by the increased resistance retard the surplus power. As it will be evident that the power of a battery must after a certain time of action decline, and as such an event would seriously effect what might be taking place in the apparatus to which the electricity might be passing, such as the lamp, we have to overcome the difficulty by using in practice a reserve battery, the power from which we can instantaneously transfer by the following contrivance shown in elevation at figure 6 and in corresponding plan at figure 7: A is a disc of wood which may be firmly attached to any suitable support. B B′ B″ B‴ are metallic plates embedded in the disc, all on the same level; and having attached in the manner shown screws $x\ x'\ x''\ x'''$. In the centre of the disc is a boss, G, which is extended above into a handle, F, by turning which the two metallic arms E E′ *which* are attached to the boss G, but insulated from each other by the introduction of a piece of ivory or other good non-conducting material. On the arms E E′ are two binding screws H H′. The action of the apparatus is very simple, and is as follows: The battery in action and the battery in reserve
4299 are attached by wires to the four metallic plates B B′ B″ B‴ by means of the binding screws. Thus to B B′ is attached the battery in action, which we will term a, and to B B′ accordingly are turned the metallic arms E E′, the current then passes by wires attached to the binding screws E E′ direct to the lamp or other apparatus. Now, supposing the power of a to be declining from the length of time the light has been burning without causing any cessation in the production of the light, all that is necessary is to turn, by means of the handle F, the metallic arms E E′ to the metallic plates B″ B‴ by sliding over and on to which the reserve battery, which we will call b, is immediately brought into play and the electricity from the fresh source instantaneously applied. The battery is then at liberty to be replenished and prepared for taking b's place when b shall have been exhausted. By such

means the light may be maintained with sufficient length of electrodes for a week in action without cessation. It is often desirable suddenly to change the poles when either from want of homogeneity in the electrodes or from any accidental cause one electrode has consumed much quicker than the other. This we effect by what we term the "brake," a small apparatus consisting of a sliding plate of brass or other metal, which being slid over 4 buttons of brass, each button forming the terminal of either the battery poles or the lamp
4300 poles, the current is made to proceed through the negative pole of the lamp or the positive pole, as the case may be. Let A and B, figure 8, be the positive and negative poles of a galvanic battery; a' b', the poles of the lamp; then let it be required to change the poles of the lamp. $x\,x'\,x''\,x'''$ are metallic plates well insulated from one another and arranged in a line in a wooden stand. L L′ is a slide consisting of wood and with two metallic ends and moved by the handle C. Now, when the ends of L L′ are on the plates $x\,x''$, then the current setting out from the positive pole of the battery (A) circulates by the wire 1 to the positive pole of the lamp a' by the wire n and returns by n' to x'' and thence by the wire 2 to the negative pole of the battery (B). To change the poles of the lamp the slide is slid back to $x'\,x'''$, and then the current from A circulates by 3 to x''', thence to b', and by 4 back from x' to B, by which b' becomes positive, a' negative; in other words, the poles of the lamp are reversed. Occasionally we employ electro-magnets of the following description, which we form as follows: A copper band 4 inches broad and about 25 feet long is insulated by coating with calico. A portion 3 inches long of this piece is then bent back, and between it and the main piece is inserted a plate of soft iron, the band 2 inches of which is next bent back in the opposite direction and a similar plate of soft iron inserted as before.

The rendering of this dry plate magnetic is effected by pass-
4301 ing the current in the direction indicated by the arrows in the drawing, by which double the opposite poles are obtained in the same plate. In the drawing, figure 2, sheet 2, A is a brass plate. B B′ are the copper plates. $x\,x'$ are the wires bringing the current which renders the pile or flat helix magnetic. The black spaces represent the iron plates. C is the keeper. It will be obvious to the practical man that the hereinbefore-described arrangements are equally applicable to signalising purposes.

Another portion of our invention relates to the use of two or more electrodes in the same or different planes and the arrangement of such electrodes so as to produce more than one point of illumination in the same lamp at the same time. Our improvements in the nature and manufacture of electrodes are as follows: Causing them to be homogeneous, moderately hard, of perfect conduct*a*bility, suffering moderate and perfectly uniform convection during ignition and non-absorbtive, as far as possible, of moisture. Under this head we have effected our improvement in the following manner: We have found that by taking 70 parts of finely powdered coke well boiled in nitro-muriatic acid to remove any metallic or earthly impurities with which it might be contaminated and afterwards wash-

ing it with caustic posash, that by taking this and washing it with 20 parts of red charcoal (we prefer it from the beech), or, as it is termed by French, charbon rouge or ani-
4302 mal charcoal, and 5 parts of gas pitch with 4 parts of
finely powdered Newcastle baking coal and 1 part of china clay, that by thoroughly incorporating the mass the desired end is obtained by subsequent careful heating in a mould of appropriate construction. We generally prepare a mass of about 1 foot 6 inches broad and 3 feet deep at a time, the gases which are reduced by distillation being allowed to escape by an induction pipe. The time occupied for the preparation of the mass we prefer to be nine to twelve hours, the heat being applied very gradually for the first two hours, after which the mass is tightly compressed by the ends of the mould being made to approximate by means of a screw. The furnace for heating the mould may be of any suitable description. After the mass is withdrawn from the mould and cooled, if the operation has properly been conducted, it may be sawn into pieces of the desired size, perfectly homogeneous in their structure. We have found that good electrodes giving a steady achromatic light may be prepared by the following process from well-burnt beech charcoal, selected from the small wood, or, as they are technically termed, "loppings;" boxwood will do as well: A piece of the charcoal sawn into required size for the electrodes is steeped in a solution of caustic lime for about a quarter of an hour; it is then taken out, dried, and placed into a crucible containing powdered
4303 charcoal, and, a lid being firmly and closely luted onto the
crucible, it is exposed to a white heat for about half an hour; it is then taken out after the crucible has cooled, placed into a saturated solution of alum, and after having soaked for about half an hour it is dried, and again brought to a white — as before. It is again removed and plunged whilst hot into treacle or any thick saccharine or carbonaceous fluid and finally once more ignited. If the operation- have been properly conducted it is now very hard, quite free from any traces of lignious structure, a perfect conductor, and burns moderately slowly, equally, and nois-lessly when forming the terminal of the voltaic arc. The electrodes which are formed by the first-described process burn at the rate of about a quarter of an inch an hour on an average, so that an electrode a foot in length would burn between twenty-four and twenty-eight hours. They consume evenly and are but little effected by the wind. Before using, the electrodes are pointed by a fine file in order that they may wear equally after being first ignited. For electrodes which are intended to be used in lamps where the arc will be great and the current passing very powerful we use instead of alum soluble glass, which is prepared in the following manner: 15 parts of powdered quartz or very fine sand are fused with 10 parts of potash and 1 part of charcoal in a crucible. When the fusing is complete the crucible is uncovered and the mass taken out and treated with cold water, by which the extraneous particles of carbon and foreign salts
4304 are removed. The residue is then heated with hot water
and thereby entirely dissolved. The electrodes are im-

mersed in this from five to ten minutes whilst the solution is hot. The other operations for preparing the electrodes are the same as in the preceding case. The object of adding the non-conducting substances, alum, china clay, soluble glass, and caustic potash, is to prevent the excessive convection which the otherwise great conductability of the carbon would occasion and thereby render the continuity and perfection of the light impossible from the excressences formed about the poles.

Having now described and particularly ascertained the nature of of our said invention and the manner in which the same is or may be used or carried into effect, we would observe, in conclusion, that we do not confine or restrict ourselves to the precise details or arrangements which we have had occasion to describe or refer to, as many variations may be made therefrom without deviating from the principles or main features of our invention, but what we consider to be novel and original and therefore claim as the invention secured to us by the hereinbefore in part recited letters patent is—

First. The general construction and arrangement of electric lamps as hereinbefore described.

Second. The application and use of a conical collar constructed of two semi-conical pieces of metal hinged at one of their extremities and acting as a grip upon a solid rod carrying the upper
4305 electrode of an electric lamp as hereinbefore described.

Third. The application and use of a lever forked at one of its extremities to act upon the conical collar in the manner and for the purposes hereinbefore described.

Fourth. The connection with one extremity of the aforesaid lever of the armature of an induced magnet to act in the manner and for the purposes hereinbefore set forth.

Fifth. The attachment of a spring in the manner hereinbefore described to the aforesaid lever to cause the forked extremity of the lever to leave the sides of the conical collar during the momentary cessation of the induction of the magnet in the manner hereinbefore described.

Sixth. The regulation of the striking distance by the slot and traveling screw-boss shown in figures 4 and 5, sheet 2 of the drawings, in the manner and for the purposes hereinbefore described.

Seventh. The construction and use of the screw for raising the lower electrode in the manner and for the purposes hereinbefore described and shewn in figure 1 on sheet 2 of the drawings.

Eighth. The use and construction of the horizontal levers forming the armature of an induced magnet or magnets for gripping the electrode holder in the manner and for the purposes hereinbefore described.

Ninth. The system or mode of raising the lower electrode in the manner and for the purposes hereinbefore described and
4306 shewn in figure 1 on sheet 2 of the drawings.

Tenth. The use and application of an electro-magnet for turning the ratchet wheel giving motion to the traveling screw holding the lower electrode in the manner hereinbefore described.

Eleventh. The system or mode of applying electric currents, so

A.D. 1852. Oct. 4. No. 212.
SLATER & WATSON'S Specification.
(2nd Edition)

(2 SHEETS)
SHEET 1

No. 286.
O.E. Light Co. } p. 4308
v.
McK. Light Co.

FIG. 1.

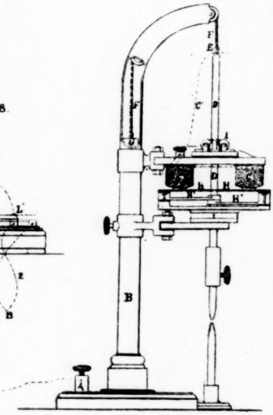
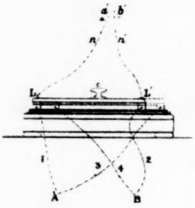


FIG. 8.



a b'
n n'
L L'
1
3
4
2
A
B

FIG. 2.

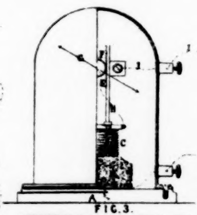


FIG. 6.

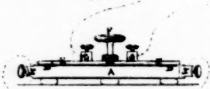
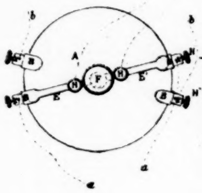


FIG. 7.



b
b
A
H
F
H
E
E'
B
H'
a
a

FIG. 3.

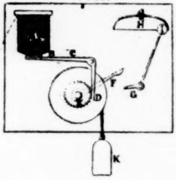


FIG. 4.

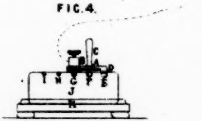
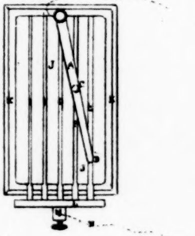


FIG. 5.



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A.D. 1852. Oct. 4. N° 212.
SLATER & WATSON'S Specification.
(2nd Edition)

(2 SHEETS)
SHEET 2

No. 286.
C.E. Light Co.
v.
McK Light Co. } p. 4309

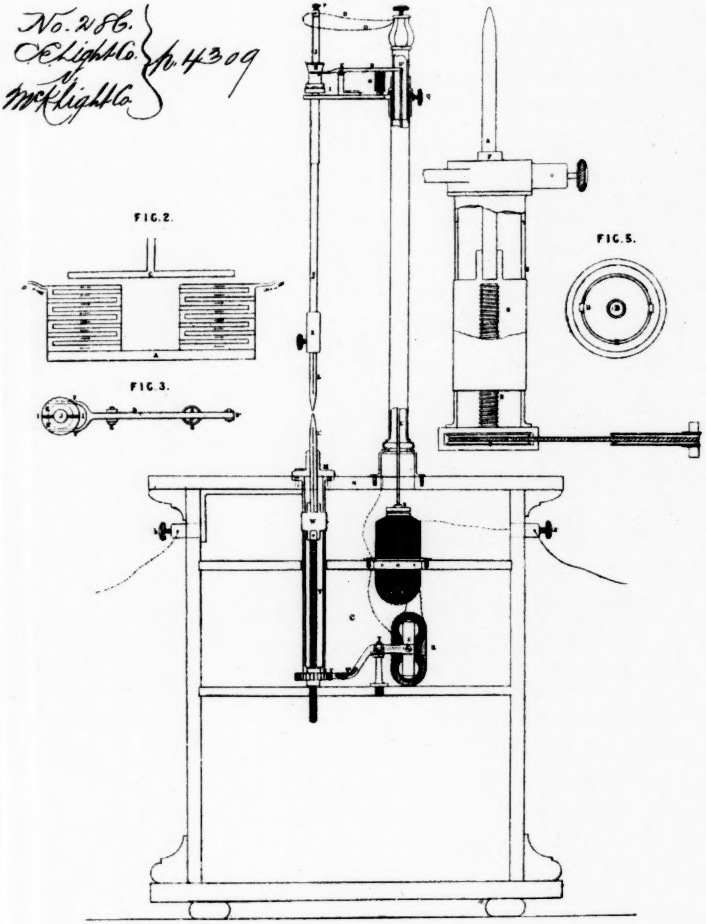

FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

FIG. 5.

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Printers to the Queen's most Excellent Majesty. 1886.

as to cause a more equable consumption of the electrodes, in the manner and for the purposes hereinbefore described.

Twelfth. The making of the two electro-magnets inductive at the same time and by the same current that supplies the light.

Thirteenth. The use of helices of copper or other wire in lieu of electro-magnets in the manner and for the purposes hereinbefore described.

Fourteenth. The application and use of several electrodes in the same lamp as arranged in the manner hereinbefore described.

Fifteenth. The construction of electro-magnets in the manner hereinbefore described and shewn in figure 2 on sheet 2 of the drawings.

Sixteenth. The construction of the governor and indicator for indicating the variation and strength of the current in the manner hereinbefore described and as shewn in figure 2, sheet 1 of the drawings.

Seventeenth. The use and construction of the alarum shewn in figure 3, sheet 1, in the manner and for the purposes hereinbefore described.

Eighteenth. The use and construction of the apparatus for retarding the passage of the current entering the lamp in the man-
4307 ner and for the purposes hereinbefore described and shewn in figures 4 and 5 on sheet 1 of the drawings.

Nineteenth. The construction and use of the apparatus for changing the passage of the current passing to the lamp or other apparatus, or as applied in any way practically from one battery to another, as hereinbefore described and as shewn in figures 6 and 7 on sheet 1 of the drawings.

Twentieth. The construction and use of the apparatus called "the brake" in the manner and for the purposes hereinbefore described and as shewn in figure 8 on sheet 1 of the drawings.

Twenty-first. The formation and use of electrodes of the materials and in the manner and for the purposes hereinbefore described.

Twenty-second. The introduction into the electrodes of a certain amount of non-conducting material to check the excess of convection and to render the light properly achromatic in the manner hereinbefore described.

Twenty-third. The introduction into the composition of the electrodes of a certain amount of caustic alkali or earth in the manner and for the purposes hereinbefore described.

Twenty-fourth. The application and use of the electric light for the purpose of signalizing.

In witness whereof we have hereunto set our hands and seals the fourth day of April, one thousand eight hundred and fifty-three.

THOMAS SLATER. [L. S.]
JOSEPH J. W. WATSON. [L. S.]

(Here follow diagrams marked pp. 4308 & 4309.)

4310 DEF'T'S EX. ROBERTS' ENGLISH PATENT NO. 14198 OF 1852.
Mar. 13, '89. W. T. F., N. P. & S. E.

(Fourth edition.)

[British coat of arms.]

A. D. 1852. No. 14198.

Specification of Martyn John Roberts.

Obtaining light, motion, &c., by the agency of electricity.

London: Published and sold at the patent office sale branch, 38 Cursitor street, Chancery lane, E. C. 1888. Price, 1s. 3d.

4311 (Fourth edition.)

A. D. 1852. No. 14198.

Obtaining Light, Motion, &c., by the Agency of Electricity.

Roberts' specification.

To all to whom these presents shall come I, Martyn John Roberts, of Gerrards Cross, in the county of Bucks, gentleman, send greeting:

Whereas her present most excellent majesty Queen Victoria by her royal letters patent under the great seal of the United Kingdom of Great Britain and Ireland bearing date at Westminster the sixth day of July one thousand eight hundred and fifty-two in the sixteenth year of her reign did for herself her heirs and successors give and grant unto me the said Martyn John Roberts my ex'ors adm'ors and assigns her especial license full power sole privilege and authority that I the said Martyn John Roberts my ex'ors adm'ors and assigns or such others as I the said Martyn John Roberts my ex'ors adm'ors or assigns should at any time agree with and no others from time to time and at all times during the term of years therein expressed should and lawfully might make use exercise and vend within England Wales and the town of Berwick-upon-Tweed my invention of "Improvements in the production of electric currents in obtaining light, motion and chemical products and effects by the agency of electricity, part or parts of which improvements are also applicable to the manufacture of certain acids and to the reduction of ores" In which said letters patent is contained a proviso that I the said Martyn John Roberts shall cause a particular description of the nature of my said invention and in what manner the same is to be performed by an instrument in writing 4312 under my hand and seal to be enrolled in her majesty's high court of chancery within six calendar months next and immediately after the date of the said in part recited letters patent as in and by the same reference being thereunto had will more fully and at large appear.

Now know ye that in compliance with the said proviso I the said Martyn John Roberts do hereby declare that the nature of my said invention and in what manner the same is to be performed are fully described and ascertained in and by the following specification reference being had to the drawings hereunto annexed for the purpose of illustrating the description of certain parts thereof (that is to say)

My improvements in the production of electric currents consists in a mode or modes of obtaining such currents at a cheaper rate or more economically than hitherto done by repeatedly used or applying certain materials in the production thereof For this purpose I take the products of a battery or batteries such as hereafter mentioned that is to say the products of the chemical action in the battery (such as hereinafter mentioned) by means of which an electric current has been produced and I convert such products into the materials from which they have been formed or into a state similar to that in which they existed when introduced into the battery The materials so obtained may then be again used or employed in a galvanic battery for the production of electric currents as before and so alternately may the materials be used in producing electric currents and the produce of the process reconverted into its original materials without further diminution than the waste which is necessarily occasioned by the performance of every process When I use a galvanic battery in which platina is the negative plate and iron the positive plate and excite these by nitric acid to generate currents of electricity part of the acid is itself decomposed yielding a portion of its oxygen to the iron so as to convert it into oxide of iron the other elements of the decomposed acid being given off in the shape of fumes of nitrous or hyponitrous gas or other combinations of oxygen and nitrogen Another part of the nitric acid will combine with the oxide of iron and form nitrate or pernitrate of iron. The fumes above mentioned I convey into any convenient vessel and convert them (with as little loss as possible) into nitric acid For this purpose I add to them such a quantity of oxygen or of atmospheric air containing the quantity of oxygen requisite to convert the fumes into nitric acid I then bring the combined gases into contact with as large a surface of water as practicable which will cause a chemical union of the gases so as to form nitric acid which will then be absorbed by the water. I also take the nitrate or pernitrate of iron the other product of the battery and place it in a retort and
4313 apply heat until the whole of the nitric acid has been distilled into a receiver containing water and the vessel used for combining the nitrous fumes and oxygen may conveniently be used as a receiver for that purpose. The residue left in the retort will be oxide of iron which I convert into metallic iron by smelting it with carbon in the usual way By these means the above mentioned products will be reconverted into the same materials as were originally introduced into the battery and those reconverted materials may be again applied in a battery for the production of electric currents and by these means a very considerable saving may be effected in the cost of producing the electric currents When any other metal

shall be used as the positive plate in conjunction with nitric acid as the exciting fluid I treat the products of the battery in a similar manner When I employ a battery consisting of the same plates as above mentioned using sulphuric acid as the exciting fluid the product obtained from the battery will be a sulphate of iron The sulphate of iron thus obtained I place in a retort and apply heat until the whole of the sulphuric acid shall be driven off into a receiver in the ordinary way The residue in the retort will be oxide of iron which I convert into metallic iron by smelting with carbon as above described.

This part of my invention is also applicable to the reduction of ores at a cheaper rate or more economically by repeatedly using or applying certain materials in the reduction thereof by means of electric currents Thus when nitric acid is applied to a copper ore so as to form a nitrate of copper and that nitrate is then decomposed by means of any other suitable metal and an electric current so as to obtain metallic copper nitrous fumes and a nitrate of the metal employed will be formed in like manner as above mentioned These products I treat in like manner as above described and thus regain the metal and the nitric acid to be again applied in like manner as before. So also if sulphuric acid be applied to copper ore so as to obtain a sulphate of copper and that sulphate be then decomposed by means of iron and an electric current for the purpose of obtaining metallic copper the resulting sulphate of iron may be treated in like manner as above described.

I have also invented an apparatus applicable to the purpose of causing the combination of nitrous acid gas and other compounds of nitrogen and oxygen with a further quantity of oxygen so as to form nitric acid and also for the purpose of causing the absorption of such nitric acid by water such apparatus is also applicable in the manufacture of such other acids as are formed by the union of two or more gases by promoting the union of such gases and causing the acids when formed to be absorbed by water This apparatus consists of a pipe or series of pipes opening freely
4314 from one into the other and filled with flints or some substances not easily acted on by the acid passing through them Through these pipes a current of water is made to flow so as to keep the surfaces of the flints or other substances covered with water and expose as large a surface of water as possible to the action of the gases passing through the tubes The water exposing so large a surface will thus be enabled more rapidly to absorb the gas or gases which it can take up and also more effectually to assist in the combination of gases in those cases in which water may be requisite for that purpose And when it shall be intended that the water shall contain a saturated or strong solution the same water may be caused repeatedly to pass through the tubes until the desired result has been attained When I employ this apparatus for the purpose of converting the fumes arising from a battery into nitric acid as above mentioned I convey these fumes by a tube into the pipes of the apparatus and into this tube and amongst the fumes I inject oxygen gas derived from any source but I prefer as most economical to in-

ject atmospheric air by bellows or other convenient apparatus this air is with the fumes driven along them into the pipes of an apparatus where it will come into contact with the moisture and a combination of the acid fumes with the oxygen will take place thus forming nitric acid the water absorbing the nitric acid will carry it down in a liquid form to a reservoir below the pipes figure 1 shows the apparatus A A A is a series of glass tubes opening at the bottom into one common reservoir R this reservoir is filled with water to above the mouth of the pipes as shewn by the dotted line and seals them air tight as regards these lower openings but the tubes have a free air or gas passage from one to the other at bottom as shewn by the small pipes *p p p* And at the top the large pipes open one into the other by their curved heads The intention being to have an air or gas passage from A × at the beginning of the set of pipes to A × the end of the pipes A. A. A. or orifice opening freely into the atmospheric air. Above the pipes A A A is another water or acid reservoir R X and from this small syphon tubes S S S convey acid or water into A A A and yet to prevent gases or air passing through them into the reservoir R × they being always filled to a certain height with liquid The end A × of the set of pipes A A A joins to the main pipe M leading to the battery and the battery being closed in on every other side the fumes must pass though M into A A A At B a pipe B × joins M. B × is in connection with a bellows or other apparatus for supplying atmospheric air A syphon pipe with water or a valve is interposed between B and the bellows to prevent any escape of the gases backwards through the bellows Let
us now suppose the two reservoirs R and R × to be filled
4315 with water to the dotted line the battery in action pouring
its fumes into M while the bellows through B × is injecting atmospheric air the fumes and the air mix and are driven into A A A here they meet with a very extensive wet surface of flints which causes the oxygen of the air to combine with the battery fumes and the current of water carries down the condensed fumes in the form of liquid acid into the reservoir R the nitrogen of the air and that part of its oxygen that did not combine with the fumes is driven out at the end of the pipes at A × × but in no case have I found any acid fumes lost at this opening when the series of pipes were long enough and the flow of water through the pipes continuous I have found that if the total length of the series of pipes exceed 35 or 40 feet long and 2 inches in diameter no loss of acid fumes was occasioned from want of condensing power The acidulous liquor in the reservoir R may either be removed of if wished to be made stronger may be raised by pump or otherwise to the reservoir R × from whence it may pass a second time through A A A and acquire a second dose of acid and this can be repeated until the desired strength of acid is obtained.

I desire it to be understood that I do not claim the elements or component parts of the apparatus which I have described separately or a part from the combination thereof in manner aforesaid and that what I do claim with reference to this part of my invention is, the combination of parts forming the apparatus hereinbefore described.

Another part of my said invention consists in a pecular mode of applying or using lead as a positive metal or plate in a galvanic battery When a plate of lead is used as the positive plate in the usual manner if the circuit or channel which leads from one pole of the battery to the other be broken for a short time when the circuit is again completed the current of electricity generated by the battery is found to be much diminished I have discovered that if a second or supplemental circuit or channel be opened or in other words if the current of electricity is allowed to flow through a second circuit while the main or principal circuit is broken the main current may be re-established without any material diminution of the electric current produced by the battery The secondary circuit which I prefer to use for the purpose of preventing the powers or currents produced by a leaden battery being diminished I form partly of a dilute acid (contained in any convenient vessel) and partly by a wire proceeding from each pole of the battery the termination of such wire (in the dilute acid) being composed of a platina plate in the ordinary way this secondary channel is in constant connection with the battery but the resistance which it is made to oppose to the electric current is so adjusted (by regulating
4316 the distance between the platina plates or otherwise) that it
shall always be greater than the resistance which the current meets with when flowing in the main channel or circuit so that when the main circuit is unbroken no current of electricity shall take place through the secondary channel, but immediately the main circuit is broken the electricity will flow through the secondary circuit which will thus maintain the current so that the battery may be ready for action in its full strength whenever the main circuit shall be made perfect With respect to this part of my invention I claim the use or addition to a battery in which lead is used to form the positive plate of a second or supplemental circuit or channel in manner and for the purpose hereinbefore described

My improvements in obtaining light by the agency of electricity consist firstly of a mode or modes of adjusting or regulating the distance between the points of the two electrodes used in the production of electric light so that the points of those electrodes shall be maintained or from time to time replaced at the proper distance from each other for the production of light which is usually called the striking distance The mode in which I effect this object is to arrange the apparatus carrying one of the electrodes so that such electrode shall be released from such apparatus and allowed to fall down or move forward until its point comes in contact with the other electrode and then be again taken hold of by the apparatus within which it is placed. This object having been effected I then by means of another arrangement of the apparatus either in connection with the same or the other electrode, draw back one of the electrodes until the points of the two electrodes shall be the proper and regulated distance from each other as above described The apparatus for producing these effects may be actuated either by an electric current or by mechanical means such as usually termed clock work And in the drawings hereunto annexed I have shown apparatus for effecting the above mentioned objects actuated or having motion given to it by an electric current and also apparatus for effecting the like objects worked by clock work

In figure 2 A A is a board or stand on which an upright pillar B of brass and about one inch in diameter and 18 inches high is firmly secured to the stand the pillar is bent at top into a right angle forming a projecting arm *c* of about 8 inches long to this is soldered the rod D about 6 inches long which forms a support and guide for the tube E which is $\frac{3}{8}$ inch internal diameter and about 12 inches long E is furnished with two pins × which slide in guide holes *o* and by these E is guided into a vertical motion when made to slide up and down E is in metallic connection with the pillar B by means of the flexible metallic strap F for the purpose of conveying electricity to it from a galvanic
battery which electricity traverses a wire that encircles
4317 an electro magnet M hereinafter to be described The tube
E contains a graphite or carbon electrode which electrode is from 8 to 12 inches in length or longer if convenient and of such a diameter as to slide freely within the tube E and yet not to fit so loosely as to fail to be pressed by the spring mouth piece S which mouth piece is a segment of the mouth of the tube E furnished with a long spring S × so far removed from the extremity of E that the heat of the incandescent graphite shall not injure it. The use of this spring mouth piece is to press against the electrode and give good metallic contact between it and the tube for the certain conveyance of electricity to the electrode and for further ensuring this the mouth piece is lined with platina but the mouth piece does not press against the electrode so forcibly as to prevent the graphite sliding through it either by its own weight or better by aid of a spring or small additional weight placed behind thus the electrode would always fall through the tube E were it not supported in it by the pressure of two jaws or clips F^1 F^1 working on joints or hinges G G The ends of these clips entering through two slits into the interior of the tube E and pressing so firmly (when in action) upon the electrode as to prevent its sliding and keep it securely in its place, these clips are actuated by two rods as handles *h h* reaching to the top of the tube E and there connected by a joint with a lever L if the other end of the lever be depressed it draws up the handles *h h* and the clips bite inwards upon the graphite or other electrode within the tube The lever L at the end Q is by a joint and rod N attached to a bell crank P the other limb of the bell crank is fixed to the piece of iron K that serves as a keeper to the electro magnet M This electro magnet is of the usual kind vizt a bar of soft iron in the horse shoe form wound round with a coil of covered copper wire and this wire forms part of the electric channel or circuit from one pole of a galvanic battery to the other, one end of this coil is soldered to the pillar B the other end has a binding screw for the purpose of attachment to the wire leading to the positive pole of a powerful galvanic battery On the base or stand A and vertically under the tube E is a socket R for the purpose of holding another graphite electrode T and the socket by means of a binding screw

can be put into good metallic connection with a wire from the negative pole of the galvanic battery by three slots and screws the socket and its electrode can be so adjusted as to bring the points of the electrodes in exact contact with each other Let us suppose the lamp now ready for action one graphite electrode in the socket R another dropped into the tube E the clips being open by reason of the balance weight W on the end of the lever L depressing the end of L and forcing the clips open the electrode in E slides through until its point comes into contact with that in the socket
4318 R if the lamp be now put into connection with the battery the
electricity circulates round M making this a powerful magnet attracting the keeper K this draws down the lever L raises the handles of the clips *h h* the clips seize on the electrode within the tube holding it firm while the further depression of the lever L lifts up the tube E until stopped by the adjusting screw *z* generally for the distance of $\frac{1}{32}$ of an inch while this is taking place the electricity circulates from the coil round M through the pillar B the strap F the metal of the tube E and to the electrode within it this electrode has now been raised by the lever L as described $\frac{1}{32}$ of an inch and consequently so far separated from the electrode in R and the electricity passes from the point of the electrode in E to that in R giving an intense light from R it circulates by means of a wire to the other end of the battery While this is taking place the electrodes gradually waste away until a time arrives when the distance between the points of the two electrodes is too great for the electricity to surmount or pass through immediately this occurs the current of electricity ceases M is no longer a magnet the keeper is released the lever L by means of the balance weight W is depressed at the end in connection with the clips of the tube E descends its allotted space the clips open and the electrode in E is free to slide downwards which it does until it comes into contact with the electrode in R the instant this contact takes place the circuit is complete again the current of electricity circulates and the same action as that first described with the evolution of a brilliant light takes place until by another wasting of the electrodes the same change ensues and this is repeated again and again until all the electrode is destroyed I find that with a moderately powerful battery about one and a quarter inch of electrode wastes per hour.

The construction of electric lamps may be modified in various ways so as to cause the distance between the two electrodes to be from time to time during the turning of the lamp adjusted or regulated in manner hereinbefore described In one modification of my lamp I cause the distance between the electrodes to be from time to time adjusted or regulated by an apparatus of a more simple description than that just described Figure 3 shows a side view or elevation of this machine A B and C are the stand pillars and arm similar to those of the lamp before described in figure 2 from C a rod D as before guides the motion of the tube E in the manner before described near the centre of the arm C is a fulcrum on which an electro magnet M can vibrate on its pivot the electrode in the tube E is provided with an iron holder or handle H which may be

attached to the electrode or merely rest on it as a weight which slides within the tube E but projects above it even when its lower
end is near the mouth of E The handle when thus in the
4319 tube E is close to the pole of M or to both poles if M be a
horseshoe magnet but it is prevented from coming into absolute metallic contact by a covering of some non-magnetic substance either on H or on the pole of M for the purpose of preventing it sticking by the residual magnetism in M The tube E is attached to M by a link or strap *a* and above the pole of M is fixed a piece of iron I so near as to attract and raise M when M is a magnet. E is in good electric connection with the battery by the wire coiled round the electro magnet and the strap or rod leading from it to the binding screw X and the arrangements for the lower electrode and the mouth-piece of the tube are the same as described in figure 2.

Now the action of the apparatus is as follows Suppose the lamp not in connection with the battery. M is not a magnet the handle or weight H is therefore free to slide downwards in the tube by its own weight and carries before and with it its electrode until the electrode comes into contact with the lower one Immediately contact is made with the battery M becomes a magnet seizes hold of H and at the same time attracting and being attracted by the iron I the end of the magnet and the tube E attached to it is thus lifted up until stopped by the regulating screw U the electrodes being thus separated a short distance from each other the electricity passing between them gives out brilliant light until the electrodes having so far wasted that the distance between them is too great, M ceases to be a magnet drops itself and the tube E at the same time releases the holder H which slides downwards until the two electrodes are once more in contact with each other the current of electricity is re-established when M becomes once more a magnet and the same series of operations as first described takes place

In all the modifications of my electric lamps if a single tube and pair of electrodes be used the quantity of light is apt to vary with the varying distance of the points of the electrodes caused by the wasting away of each until the striking distance becomes too great when as before described a fresh portion of electrode is protruded To avoid this inequality of light and obtain a fair average I (in some cases) use two or more sets of electrodes combined within the same lamp and either worked by one battery or by more This arrangement permits one pair of electrodes to be at their maximum production of light while another pair is at their minimum production and thus between the two a good and equal average quantity of light may be obtained and if two such lamps or pairs of electrodes be used in connection with one battery as the light produced from one pair of the electrodes diminishes in consequence of the increased distance between their points that pair of electrodes obtains a less
quantity of electricity from the battery and the surplus or re-
4320 mainder is sent through the second pair of electrodes thus
increasing the light which they produce.

In figure 4 I have shewn an arrangement of clock-work apparatus by means of which I cause the distance between the two electrodes

of a lamp to be from time to time adjusted or regulated A stand A has a pillar B to which a tube C of about twelve inches long and three eighths of an inch bore is screwed this tube is also furnished with a spring mouth piece C^1 as described in figure 2 a slot or opening of about an inch long is made in the tube about an inch above its mouth, through this slot the short arm X of a bell crank lever L can enter for the purpose of pressing upon and arresting the descent of an electrode withine the tube the lever L works upon pivots *p p* and the end L^1 (being heavy) when free to move falls downwards pressing its short arm through the slot in C On the same stand and turning on proper supports or pillars H is a wheel *w* of about four or five inches diameter a segment of this wheel is cut off as shewn at *a a* upon the axle of the wheel is an arm F which when the wheel axle is turned strikes against the lever L and raises it of course at the same time causing the bent arm X of the lever to come out of the slot by this action the electrode within the tube before supported by X falls by its own weight or assisted by any spring or weight behind it Above the wheel is another lever R working on pivots at I and pillar T and the end of this lever immediately over the wheel rests upon its periphery. Now if the wheel be turned the lever (if the wheel be round) remains at rest until that part of the wheel which is reduced or cut off comes below the lever when the lever follows this irregularity in the wheel and consequently becomes depressed at that end raising the other Now to the end Q of the lever R is attached by a link or strap P a socket S which is free to slide perpendicularly up and down upon a proper guide or support z this socket contains the lower electrode E × and is in metallic connection by a flexible strap with a binding screw K to connect it with one end of the battery. the electrode within the tube is also in connection by means of the tube and pillar with the battery which can be joined on to it by the screw K × a carbon electrode is put into the socket S and another into the tube C and if the wheel is turned until the depression in the periphery of the wheel is under the lever R this falls and raises the lower electrode to its normal place at the same time the arm on the axle raises the end of L which frees the electrode in the tube C and this electrode falls into contact with the lower electrode. The apparatus being put into connection with the battery and the wheel turned by proper clock work attached to its axle the arm F passes the lever L which drops and secures the electrode within C the periphery of the wheel
4321 now raises the lever R depressing the lower electrode until
a proper striking distance is obtained the wheel revolves until the lower electrode is again raised to its normal place the arm strikes the lever L liberates the electrode in C and a repetition of the described operation takes place at every separation of the electrodes a vivid light takes place between these points and the duration of the light is while the wheel maintains them apart (of course if not so long as to waste the electrode too far) and the duration of darkness while the points of the electrodes are in contact.

This apparatus I deem to be applicable as a light for lighthouses by causing the electrodes to remain a longer or shorter time in contact with each other the light may be made intermittent and the intermission regulated at pleasure so as to have the desired durations of light and darkness respectively for indicating the particular light house to which it belongs

With respect to machines or apparatus for producing light as hereinbefore described I claim as of my invention the construction of electric lamps with apparatus attached thereto whereby the points of the electrodes shall be from time to time brought into contact with each other and then removed to a proper or striking distance apart in manner and for the purposes hereinbefore described.

Another part of my invention consists of a mode of obtaining electric light by passing a current of electricity through a thin piece of graphite coke or charcoal or other infusible body being a conductor of electricity while it is enclosed in a vacuum or space not containing any oxygen or other matter which can cause the combustion or destruction of it when brought into an incandescent state by the action of the current of electricity.

In figure 5 I have shewn an elevation or side view of an apparatus which may be used for this purpose but I desire it to be understood that I do not claim any of the elements or parts of which this apparatus is composed apart from the combination thereof In this figure A is a stand upon which a hollow pillar or tube B can be screwed this tube is furnished with a stop cock S by which its passage can be closed air tight on the top of the pillar is a screw C about one and a half inch in diameter which receives the neck of the globe G also furnished with a cap and screw to allow it to be screwed air tight down upon the tube B The tube B has a binding screw F soldered to it for the purpose of making connection with a galvanic battery and the tube is also in metallic connection with a rod R having at the end of it a clip H for the purpose of holding a piece of graphite or other substance through which I wish to pass the electricity another rod R^1 also furnished with a similar clip H × passes through the head of the pillar or tube B but
4322 is preserved from coming into metallic contact with it by
having the rod enveloped in ivory at D or other non-conductor of electricity At the bottom of the rod R^1 is another binding screw F × for the purpose of connecting it with the other pole of the battery Now the mode of operation with this apparatus is as follows—a piece of very thin graphite about half an inch long half an inch wide and as thin as conveniently can be made is fastened at each end into the clips H and H^1 and firmly secured, the globe G is screwed air tight upon the pillar B the stop cock S is opened and the whole apparatus by a screw at the botton of B screwed down upon an air pump or exhausting syringe by this the air is drawn out of G and as perfect a vacuum as can conveniently be made obtained, when this is done the stop cock is shut and the apparatus is then removed from the pump to its stand A and a galvanic battery is put into connection with it by the binding screws F F × the electricity passes through the rods and thin piece of graphite J which becomes white hot from the passage of the electric current and no combustion will ensue if the vacuum be perfect

and no matter within the globe to cause combustion of the graphite or if the graphite be not otherwise destroyed the light continues as long as the electricity flows through the graphite in sufficient strength.

And with respect to this part of my invention I claim the production of light by passing electricity through a thin infusible body being a conductor of electricity in manner hereinbefore described.

Another part of my invention consists of a mode or modes of giving increased brilliancy to the light produced by electric lamps.

I have discovered that flame or the combustion or volatilization of some substances between or on the points of the electrodes will very much increase the light produced by an electric lamp Thus if a candle or lamp be placed so that its flame shall pass between the points of the electrodes the brilliancy of the light evolved between the electrodes will be increased And if lime or any other alkaline earth be interposed between the points of the electrodes when the lamp is in action the brilliancy of the light evolved will be very greatly increased When I intend lime to be interposed between the electrodes in this manner I prefer to effect that object in the same manner as lime is introduced between two jets in what is usually called the Drummond light I prefer however to produce the same or nearly the same effect by a new description of electrode which I make by mixing the material of which the electrodes may be composed with a portion of lime or other alkaline earth (I have used about five per cent of lime with success) taking care not to introduce as much as will materially diminish the power of
4323 the electrodes to conduct electricity When electrodes thus
made are brought into action in the lamp they produce a light very much more brilliant than electrodes made without any such admixture.

Another part of my said invention consists of a mode of diminishing the spark produced upon the breaking of a circuit for conducting currents of electricity It has been found that when a current of any great power has been employed the points or parts at which the circuit is broken are rapidly destroyed by the spark produced by breaking circuit For the purpose of avoiding or preventing this evil immediately before the breaking of the circuit I furnish the current of electricity with another circuit which is shorter so as to destroy or greatly diminish the electric action by which the spark is created at the place where contact is broken The formation of such a secondary circuit will of course carry off the greater portion at least of the electricity which would otherwise pass along what may be called the primary or working circuit or channel And in some cases this diversion of the current of electricity from the primary or working circuit or channel may be a sufficient substitute for the breaking of the primary circuit If the primary circuit be broken I cause it to be again made before breaking the secondary circuit so that upon breaking the secondary circuit there shall always be another circuit for conducting the current of electricity and so preventing the production of a spark or greatly diminishing it The making and breaking of this secondary and short circuit may be effected by means of any ordinary contact breaker used in electro-galvanic apparatus care being taken to construct or regulate it in such a manner that it shall make and break the secondary circuit at the proper times or intervals

I will now describe my apparatus for making and breaking contact when the primary or working channel is also made and broken

A stand A figure 6 supports a pillar B of metal having a binding screw E^1 to connect it with one pole of a battery To the top of this pillar a metallic spring P is soldered and at the end of this a piece of iron I to act as keeper to the small electro-magnet M another metal pillar D is fixed to the stand and can by its binding screw be put into connection with the electro-magnet M a third pillar E on the same stand can also by its binding screw be put in connection with the other pole of the battery the N°s 1. 2 shewing the poles to which all are to be connected On the pillar E a lever L in metallic connection with E moves on a pivot *p* and is so arranged as to press by its spring × its end onto the top of D. A wire from D is coiled round and forms the coil of the electro-magnet M and the wire passing from this to the working or primary channel 2^x when M is a magnet it attracts I
4324 depresses P and comes into good contact with L depresses
that end and raising the other out of contact with D, if the pillars be in connection with the battery as described and further shown by the figures 1. 2. 2^x in figure 6 it will be seen that while L rests upon D the current of electricity flows from the battery through 2, through E through L through D through the wire to the electro-magnet M round the magnet and away through the working channel back to the battery But while this is taking place M becomes a magnet, draws down I breaks contact between L and D and makes contact between P and L The electricity now flows from the battery through 2 to E through L to P and away through B and 1 to the battery. it will be clear that the current at D and L being broken the current cannot flow through the primary or working channel or round the electro-magnet which ceases to be a magnet and does not attract I The spring P flies up, contact between L and P is broken and contact is made as before between D and L and the same phenomenon again ensues The apparatus by which I cause a cessation or great diminution of electricity in the primary or working channel by means of giving the electricity a better and shorter channel than it would find in the primary one is as follows and is shewn in figure 7 A stand A has a pillar B of brass and spring C of brass with iron head I as before in figure 6 the pillar B is in connection with one pole of the battery and a pillar D of brass in connection with the other pole of the battery is fixed on the stand with its head under the spring C An electro-magnet M to which the iron I would form a keeper forms part of the main working or primary channel that is to say a wire in constant connection with one pole of the battery forms the coil of this magnet and is continued onwards to the apparatus which I call the main working apparatus and from thence back to the other pole of the battery and

is maintained in constant connection with it Now while the keeper I is up that is not drawn down by the attraction of M the electricity of the battery has but one channel to travel through videlicet the primary or working channel but if M draws down I so that E comes into contact with D and if the channel or circuit from the battery through B. C. D. and back to the battery is much shorter and far more easily traversed by the electricity than that of the primary or working channel then will the current of electricity forsake in a great measure the primary channel or circuit and flow in preference through the secondary channel B. C. D. for example suppose the resistance offered by the primary channel to the circulation of the electric current through it to equal one thousand, and suppose the resistance offered by the secondary channel to equal only ten then if both these channels were at one time fully in connection with
4325 the battery then would one thousand parts of electricity flow through the secondary or better conducting channel and only ten parts circulate through the primary or working channel which in effect would be practically to annihilate its effective power Thus to stop the action of the electricity in the working or primary channel I have only to offer to it an infinitely better secondary channel and the object is effected without breaking contact in primary channel and consequently no destructive spark is elicited Again when M has drawn C into contact with D and thus as described practically destroyed the current in the primary channel M ceases to have any attractive power as its coil forms part of the primary channel When this happens I is released and contact between C and D is broken the secondary channel is thus interrupted and the primary channel being still in good connection with the battery the electricity flows through it and does its work A very trifling and harmless spark is elicited at the head of D when contact is broken with C because the electricity has a free channel open to it through the primary channel and therefore does not follow C through any striking distance so as to be destructive The above descriptions and figure- 6 and figure 7 shew how contact is made and broken or the electric force annihilated or reduced in the primary channel by the agency of the electric current itself, but if it be desired to effect this at certain regular and defined intervals then the electro-magnets M M in figure- 6 and 7 are removed and levers or springs P C are brought into contact with D and D and removed from it by any convenient application of machinery to effect the motion at the proper intervals of time for example a cam wheel may rotate in front of the spring C and lift up the head I in the manner a cam wheel works a tilt hammer.

Another of the improvements forming part of my said invention consists in obtaining electric currents by causing a permanent magnet or combination of permanent magnets to rotate through a helix or helices of insulated wire If I use one magnet only for this purpose I make it of a circular form resembling a ring or hoop a portion of which has been cut out of it and between the ends or poles of the magnet I fix a piece of some non-magnetic body of the same breadth and thickness as the magnet so that with the

magnet it may form one continuous circle or ring I prefer however to use a combination of several magnets each of which I make in the form of a segment of a circle of the size which I intend the combination to assume when they are combined together and I make the magnets of such a size or sizes that when put together with pieces of non-magnetic material between their ends they shall form a circular hoop or ring of the intended dimensions
4326 Each of the segmental magnets just mentioned may be a
compound magnet that is to say may be composed of several magnets or magnetized steel plates placed one upon the other in the usual way I support a magnetic ring such as above described (whether composed of one or several magnets) upon the peripheries of three or more supporting or guiding wheels which I place within the interior of the magnetic ring as shewn in figures 8 and 9 These wheels I prefer to make with some soft or elastic material upon their peripheries so as to hold the ring more steadily during its rotation I mount the axes or spindles of these wheels in suitable bearings and I communicate motion to the ring either through the medium of one or more of these guide wheels or by means of a strap or belt applied to the exterior of the ring as shewn in figure 8 I cause a magnetic ring made in any of the ways above mentioned to rotate through the middle of one helix or several helices of insulated wire the interior or bore of each helix being made sufficiently large to permit the continuous rotation of the ring through it without touching the interior of it In figure 8 I have shewn an elevation or side view of a magnetic ring composed of two magnets supported upon three guide wheels rotating through a single helix of insulated wire and having motion given to it by means of a strap or belt applied to its periphery Figure 9 is an edge view of the same and in each of these figures similar parts are marked with similar letters of reference. A A and Z Z are the two magnets united together by two connecting pieces C C.—B B B are three guide or supporting wheels having flanges at their edges, and round the peripheries of which between the flanges are fixed coverings of vulcanized India rubber and the wheels are placed in such positions that they shall hold the ring securely in its proper position during its rotation D is the helix or coil made of insulated wire fixed upon the support G and with two projecting ends *x x* of the wire which may be connected with the connecting wires or other part of any apparatus in conjunction with which the machine is to be used F F is the strap or belt by means of which the ring is caused to rotate through the helix When a magnetic ring of any of the above descriptions is put together it must be introduced within each of the helices through which it will have to rotate before fixing the last segment or piece of the circle of which the ring shall be composed Although I have only shewn one helix or coil in these figures the magnetic ring may be caused to rotate through two or more such helices And if motion be given to the magnetic ring through the medium of one or more of the guide wheels in lieu of a strap or belt the ring may be made to rotate through a greater number of helices or coils I claim as this part of my in-

vention the obtaining of electric currents by causing such
4327 magnetic rings as aforesaid to rotate through a helix or
helices of insulated wire in manner aforesaid.

A farther part of my said invention consists in a mode of obtaining motion by the agency of electricity by means of a permanent or electro magnet fixed in one position and in front of the poles of this magnet a wheel rotates. On the periphery of this wheel are fixed small electro magnets in connection with a battery which on the revolution of the wheel pass close to the poles of the fixed magnet but do not touch them and the novelty of my invention consists in making these small electro-magnets neutral or feebly repulsive of the large fixed magnet immediately they come opposite to its pole.

Another part of my said invention consists in the use or application of wheels similar to an apparatus called Barlow's rotating wheel for producing motion For this purpose I mount several of such wheels upon the same spindle or axis causing each of them to work in a separate trough or reservoir of mercury or quicksilver I cause a current of electricity to pass successively through each of these wheels and in the same direction in each wheel that is to say from the centre to the periphery of each wheel or *vice versa* By the combined action of several of these wheels motive power may be communicated through the spindle on which they are fixed and the extent of the power will depend upon the number of wheels mounted on the spindle and the strength of the current of electricity employed

Another part of my said invention consists of the combined use or application of a plate or plates of lead as the positive plate or plates of a galvanic battery with a plate or plates composed of any metal which is electro-negative in relation to lead together also with a mixture of dilute nitric and sulphuric acid as the exciting fluid.

Another improvement forming part of my said invention consists in the combined use or application of tin as the positive plate or plates in a galvanic battery with a plate or plates composed of any metal which is electro-negative in relation to tin together also with a caustic alkaline solution as the exciting fluid.

Another improvement consists of a mode of obtaining electricity from a thermo-electric battery this improvement consists in the application of heat to the plates of the battery by means of a current or currents of dry air or any fluid which is not a good conductor of electricity The same effect may be produced by protecting the plates at the place or places where the heat is applied by any non-conducting body such as glass or varnish through which the heat may be conveyed to the plate or plates.

4328 My improvements in chemical decomposition by the aid of electric currents consists firstly in the use of a U tube in cases where it may be desirable that the products eliminated shall not be mixed The same effect may also be produced by a vessel divided into two parts by a partition which has an aperture therein from one division to the other below the surface of the liquid acted on The positive wire from this battery is to be introduced into one leg of the tube or compartment of the vessel and the negative wire into the other leg or compartment When it is desired to prevent the admixture of any gas evolved from a pole with the liquor under action I carry off such gas by putting a pipe open at each end over the pole mentioned and in the decomposition of bodies take chloride of sodium and reconvert it into other substance When it is desired to maintain the liberated chlorine or other matter as long as possible in contact with the liquor I cause the pole at which the chlorine or other matter is liberated to be sunk deeply into the liquid and I make the passage for the escape of the evolved gas &c. as long and as tortuous as possible

Another of my said improvements consists of a mode of purifying sugar in solution by the action of electric currents For this purpose I immerse two platina plates in connection with a galvanic battery in the solution of sugar to be purified and I pass currents of electricity through these plates and the solution in which they are placed for the purpose of causing the impurities contained in the sugar to be separable by filtration

In witness whereof I the said Martyn John Roberts have hereunto set my hand and seal this third day of January in the year of our Lord one thousand eight hundred and fifty three.

MARTYN JOHN (L. S.) ROBERTS.

Drew.

And be it remembered that on the third day of January in the year of our Lord 1853 the aforesaid Martyn John Roberts came before our said lady the Queen in her chancery and acknowledged the specification aforesaid and all and every thing therein contained and specified in form above written and also the specification aforesaid was stamped according to the tenor of the statute made for that purpose.

Enrolled the sixth day of January in the year of our Lord one thousand eight hundred and fifty three.

London: Printed for her majesty's stationery office, by Darling and Son.
(G 157.—100.—1 | 88.)

(Here follow diagrams marked pp. 4329 & 4330.)

4330*a* Def't's Exhibit Binks English Patent No. 119 of 1853.

No. 119.

Electric Lights.

Provisional specification left by Christopher Binks at the office of the commissioners of patents with his petition on the 18th January, 1853.

(Void by reason of notice to proceed not having been given within the time prescribed by the act.)

I, Christopher Binks, of Albert Villa, North Woolwich, in the county of Kent, do hereby declare the nature of the said invention for "improvements in producing electric light" to be as follows:

My invention relates to the forms, arrangements, and modes of working the electrodes and to the materials of which to construct the electrodes for producing light by electricity.

First part. In the ordinary arrangements of the carbon electrodes for producing light by a current of voltaic electricity two rods or pencils of solid charcoal are used, being placed end to end, and describing a straight vertical line, broken only at the point of juxtaposition of the two ends, between which is left a minute intervening space measuring ordinarily from about $\frac{1}{50}$th to $\frac{1}{4}$ of an inch, according to the strength of the passing current of electricity.
4330*b* These rods, though not in actual contact at their points of juxtaposition, form part of the circuit, connecting together the two poles of the battery, for the (so called) current of electricity passes through this intervening space, giving rise in its passage to the evolution of the electric light, but the quantity of light so evolved is in all such arrangements perpetually varying, for the quantity of light varies according to the distance one from the other of the carbon ends or points, and this distance is continually altering through possible alterations in the power of the battery, through the burning of the carbon, the disintegrating action upon it of the current of electricity, and the transference which takes place of particles of carbon from the one electrode to the other. The result is an intermittent light, the effects of a perpetual fluctuation in the amount evolved, which no contrivance hitherto applied with a view to the maintaining of the carbon points at a fixed distance under all the existing conditions of change has yet been able to obviate. Now, this first part of my invention consists in so constructing and arranging the electrodes that the unavoidable changes arising, as just described, in the material structure and in the relative distance of the electrodes are, in their inevitable effects upon the evolved quantity of light and upon the manner of its evolution, rendered either entirely impercept*a*ble or less percept-
4330*c* *a*ble than under the methods hitherto followed; whereby, consequently, by my invention a more uniform light or one less variable and intermittent is obtained; and my plan is

as follows: In place of forming each electrode (whether made of carbon or of other material) of a single rod or pencil (as heretofore) I form it of two, three, four, or more separate rods or pencils, and consequently have as many light-emanating points as there are separate rods; and these rods are placed close together and all act together as a common centre of emanation for the production of one light, so that the chances of perceptable variations in the amount and effects of the light evolved are reduced in proportion to the number of points into which the electrode is divided and that are brought into action at one time. This kind of arrangement I call the "compound electrode." A negative "compound electrode" may consist, for example, of two or three or four or more solid cylinders or rods of charcoal or other material placed side by side close together, but without actual contact, and having as many points (as there are rods) to be brought in juxtaposition (for the light-giving points) with the other or positive electrode, and the oppositive or positive electrode in this arrangement may consist of several cylinders or rods placed and acting side by side, or of only one cylinder or rod with its extremity
4330d brought into close juxtaposition with the ends or points of
the opposite compound electrode. The bundle or group of separate cylinders forming such a compound electrode may have one common connection with the battery or each cylinder may constitute an independent conductor. In all arrangements of light-giving electrodes where the material forming them is destructible under the action of electric current, as carbon is, one of them is more rapidly worn away than the other, and the one least acted on is called the "non-consuming" and the other "wasting" electrode. In the practical use of my invention of the several and various arrangements it is obviously capable of assuming, I prefer to employ a single rod of charcoal or other material for the non-consuming electrode and to place this undermost, and to use as the wasting electrode a combination of three separate rods connected by one common conductor to the battery. But I do not confine my invention to the use of this arrangement only; both electrodes may be "compound" and may be collectively connected with the battery or each of its rods may have an independent communication with the battery, and the "non-consuming" electrode may be a "compound" one, whilst the "wasting" electrode is made to consist of only a single rod, &c., &c. But, howsoever varied in detail, the nature of my invention is the same, namely, in place of one point of emination only, as hitherto, to have several points for each light. In an arrangement, for example, in which three rods of charcoal form a compound wasting electrode, should one of the three
4330e points become removed beyond the maximum light distance
by waste or transfer, &c., in quantity of the electricity that would otherwise pass through, this one point is thereupon transferred to the other two points still within full acting distance, and this transference serves immediately to increase the action, and, consequently, the quantity of light given out by these two or more active points. In the same way it results if two of the points be

thrown out of action fully or comparatively and only one remains in full activity, a more active current passes through this one remaining active point and the light it gives out increased in proportion. After the same manner it occurs when, in place of a "compound electrode" of three points, one consisting of four or five or of any other greater number is used. The wasting and shifting in distance of all the points in such compound electrodes can seldom if ever take place exactly to the same extent and at exactly the same moment of time, consequently a failure in any one point to give out light or its full quantity of light is comparatively unimportant, and those points least wasted or shifted compensate for or reduce the effects of such a deficiency to an extent that no contrivance, when applied to the old or single rod electrodes, has yet been able to secure.

I claim as my invention the forming of the electrode of two, three, or more rods or pencils or points of charcoal or other material instead only of one rod or pencil, as heretofore, or of so
4330*f* constructing the electrode that it shall have two, three, or
more light-em*i*nating points for each light in place of only one light-em*i*nating point, as heretofore.

The second part of my invention consists in using for the carbon electrodes the charcoal obtained by subjecting lignite to destructive distillation in close vessels—that is, I fully carbonize lignite and employ the hard close-grained charcoal thus obtained as the light-giving electrodes, for which it is admirably adapted and has not hitherto been used.

Third part. I form carbon electrodes by covering metal with a coating of carbon obtained by painting over the surface of the metal with tar or melted pitch or other like material or mixtures of any materials which on being strongly heated in close vessels yield a residue of solid carbon. Of such materials I prefer to use tar, pitch, bitumen, asphaltum, and rosin, or mixtures of finely pulverized charcoal or lamp-black with some adhesive vehicle which on being dried or strongly heated leaves a residue of solid or compact carbon. In this way I cover wires (platinum, copper, &c., &c.), narrow slips of metal rods, bars, plates, or other forms with carbon, leaving or not (at option) one portion of the metal uncovered, by which portion to connect the electrode with the battery. The portion coated with the carbon is that used as the electrodes proper, or parts
4330*g* brought in juxtaposition as the striking points for the pro-
duction of the light. By this means I obtain good conducting carbon electrodes, economise the power of the battery, and have power of electrodes more available than the fragile and imperfectly conducting long and thick rods or cylinders of carbon in use, or in place of coating metal in the manner above described I drill holes or cut grooves in solid pieces of charcoal for insertion of the wire or rod or other shaped metal intended to act as the conductor, or I affix thin slips or cuttings of charcoal or charcoal veneer by some adhesive material to the surfaces of slips, bars, plates, or other forms of metal to act as the conductor and to obtain improved forms and kinds of electrodes for production of the electric light.

I do not claim as my invention the use of carbon obtained by the destructive distillation of tar or of a mixture of such carbon and of lamp-black, for such carbon and mixture of carbon have long been known and used for electrodes, but I claim the use of lignite carbon for electrodes and the improved electrodes formed by coating or covering metal with carbon or charcoal as above described.

The fourth part of my invention consists in attaching one or both of the electrodes to a floating stem or stems, placed and working in some liquid (as water, mercury, oil, &c.) in order to obtain a 4330*h* simple and convenient power for moving the electrodes in order to maintain them at their proper relative distance or to replace them in their proper positions for producing the light when shifted out of it by the disintegrating action of the electric current on the charcoal, and for this purpose I balance the stem carrying the electrode in the liquid, so that as the carbon is burnt away the stem*s* becomes lighter and rises out of the liquid, and, in so doing, readjusts the distance or presents a fresh point or surface of carbon to the action of the opposite electrode.

Fifth part. In place of bringing (as heretofore generally done in such arrangements) the carbon electrodes together, end to end, in order to obtain the striking or light-em*i*nating points (as when two cylindrical rods are, as usual, brought in juxtaposition, end to end), I so form the electrodes that they can be placed and act concentrically, as, for example, a long cylindrical rod or pencil of charcoal placed and acting partly within a hollow cylinder or ring or truncated cone o*r* charcoal, the latter being a little longer in diameter than that necessary to merely admit the rod, so that the inner surface or edge at the end of the hollow cylinder or ring or cone will be close to but not in actual contact with the nearest portion of the side or exterior surface of the rod, and that the space between them at this point shall constitute the striking or light-em*i*nating point—that is, a narrow zone or belt on the exterior surface of 4330*i* the cylindrical rod at the point of it in closest juxtaposition with the inner edge of the end of the hollow cylinder or cone are the points through which the current of electricity passes and from which consequently the light is emitted. By any convenient mechanical contrivance the rod is made progressively to move within and through cylinder or cone through the entire length of the rod, in order to replace by a fresh surface that wasted from time to time by the action of the electric current. I prefer to make the hollow cylinder or cone the " non-consuming " electrode, and as the solid rod moves into and through it the fresh surface that is thus continually being presented by such movement is that which necessarily is the nearest to the opposite electrode, and through which consequently the current passes, and from which the light is obtained. The solid rods may be cylindrical or angular, being inserted in and moving through ap*p*ertures of corresponding shapes, so that the solid electrodes may be inserted and move within the other without actual contact. I vary this part of my invention when desirable by using " compound electrodes "—that is, in place, for example, of one solid charcoal rod moving within a solid cylinder I

employ two or more rods within one cylinder, or each of the two or more rods may be placed within its own corresponding hollow cylinder, but the two or more such sets are to be placed close
4330*j* together and act for the production of one light.

Again, in place of entirely encircling the rod of charcoal at the striking point on its exterior surface with the charcoal forming the opposite electrode, as above described, I make the latter to come in juxtaposition with only one side or face or part of the rod; as, for example, if the rod be a long, narrow slip of charcoal I cause another slip of charcoal to be placed close and parallel to it, but without actual contact, and the long slip to slide gradually past the other in a parallel direction so that the point of the side or face of the long slip that is nearest to the end of the shorter slip and the end of the shorter slip itself shall form the striking points, or I place the long slip between two other slips so that both sides or faces of it shall be in action, giving out light at the points nearest to the ends of the two other slips constituting together the opposite electrode.

I claim as my invention the using of carbon electrodes placed and acting concentrically or so that the end of one electrode and a point or points of the side nearest to it of the other electrode shall be the striking or light-em*i*nating points.

The sixth part of my invention consists in using the metal mercury for the electrodes in producing light, and for this purpose I employ two separate reservoirs of mercury, one connected with the positive and the other with the negative pole of the voltaic
4330*k* battery, and I cause the mercury from one reservoir to drop
into or upon the mercury in the other reservoir or a thin stream of metal to flow through a minute aperture from the one reservoir to the other, the quantity so flowing in a given time being so regulated in proportion to the quantity of current electricity in use that the stream of mercury at the point of contact or when in the act of coming into contact with the surface of the other mass of metal it falls into is partially or fully vaporized by the heat generated by the electric current, whereby a continuous and brilliant emission and light applicable to many important purposes is obtained. I vary this part of my invention by causing the drops or streams of mercury (in place of falling into the mass of mercury *in place of falling into the mass of mercury*) to fall upon charcoal or upon another metal or other conducting and light-giving material. With charcoal for one electrode and mercury for the other a combination is obtained which yields a most brilliant and valuable light. I confine the mercury so employed in a vessel or lamp so arranged that the vaporized portion of the metal is condensed, collected, and again applied to the same purpose.

I claim the use of mercurial electrodes for producing light by electricity and of one electrode formed of mercury and the other of carbon or of some other material for the same purpose and whether two electrodes or a greater number tha*t* two be used in such arrangements.

4330*l* The seventh part of my invention is as follows: I cause the light-giving electrodes of voltaic circuit intended to produce light successively to approach to (but without actual contact) and to recede from each other by such movement imparted to one or to both or to all the electrodes that the distance or the space between them shall — certain limits be continually changing and this so rapidly that the eye shall be unable to detect the different intensities of the light evolved under the different distances of the electrodes or when they are the nearest to and when the farthest apart from each other.

There is a certain point in the space between the electrodes in action in all such arrangements at which the maximum amount of light is obtained, but which point is not that of actual contact nor, perhaps, that the most immediately preceding actual contact, in the act of approaching to it. But this maximum-light point or the exact distance corresponding with it is the distance which inventors have hitherto attempted to secure and maintain by a fixture of the electrodes at it or by contrivances for replacing the electrodes in it when shifted by changes in the structure of the carbon through disintegration or transfer. But by my invention I do not fix or attempt to fix the distance of the electrodes at this point or to replace them in any fixed position when accidentally shifted from it
4330*m* or attempt (when the maximum-light point itself has shifted through any accidental change in the power of the battery) to make a corresponding shift for the time being of the position of the electrodes, but, on the contrary, I employ the conver*t* of all such methods—that is, I cause the electrodes (one or both *of* all of them, if there be more than two in the arrangement) to be continually changing their position and in doing so to travel thro' a certain space within the limits of which is embraced or lies the said maximum-light point, and the total or effective quantity or intensity of light that I do obtain is the mean of all the quantities evolved within this space, and the steadiness of the resulting light is due to the rapidity of the movement and in the capacity of the eye to detect the differences that really occur. In this way I obtain a light the quantity of which is the mean of the two extreme quantities obtained respectively when the electrodes are at the shortest and at the longest distance; and in consequence of the rapidity with which the changes in distance are made and by reason of a well-known law of vision the different quantities or degrees of intensity of the light are imperceptible, and consequently a steady or apparently uniform emanation of light or one free from any sudden fluctuation or fluctuations that are discern*a*ble *as* obtained. I obtain these changes in position or distance and the consequent results by impart-
4330*n* ing, by any convenient mechanical contrivance, a vibratory, an oscillating, a rotary, or other movement to one of the electrodes whilst the other remained stationary, or by such motion given to both the electrodes or to any set or number of electrodes, and I either employ a single arrangement of electrodes (that is, a single negative and a single positive electrode, constituting together

a set) as the source of the light, or I combine together for one light the effects of two or more sets of electrodes.

This peculiar movement or method of working the electrodes I obtain by the vibration of a wire or wires carrying the charcoal points, and which points, in the act of —, successively approach to — recede from each other within limits that may be adjusted and regulated according to the power of the current of electricity in use, or the movement can be given by the vibration of a metallic fork carrying the carbon on each branch, by an eccentric-wheel movement carrying the electrodes within the required limits rapidly towards and then away from each other on each revolution, by the revolution of two di-cs on a common axis, but revolving in contrary directions, carrying carbon arms or radiating on the electrodes and crossing each other scissorwise, but without actual contact at any time, and in this way causing the emanat-ry points or edges successively and continually to close upon and to separate from each other; by the rapid revolution of two carbon wheels with serrated 4330*o* edges placed and acting edge to edge, by the revolution of two wheels or rings placed concentrically with the proximate or light-emanating positions s*u*rrated or made angular, or the same general results may be obtained by a variety of other forms and arrangements of the electrodes, and the requisite motive power can be obtained by clock-work, by magneto-electric action, or otherwise; but, howsoever arranged or accomplished mechanically, I claim as my invention the causing the electrodes for producing light by electricity or the light-emanating points in a broken voltaic circuit alternately to approach to and to recede from each other by a movement imparted to one or both or to all the electrodes by any mechanical agency so that their distance shall be continually changing, but by so rapid a movement that the eye cannot detect the differences in the amount of light emitted that correspond with the difference in distance by which a light free from any sudden or apparently sudden fluctuations is produced.

(This method of producing a steady light I call the vibratory system to distinguish it from the others in this specification.)

The eighth part of my invention is as follows: When the two lights-giving electrodes in a voltaic circuit are brought into actual contact there is a point in the act of bringing them together at which the light is the most intense that 4330*p* the elements engaged are capable under any conditions of producing. It is a sudden flash of brilliant light; and this part of my invention consists in obtaining a steady light by causing those flashes to follow other in such rapid succession that the eye can distinguish no interval between them. By any convenient mechanism I bring the electrodes (whether two, as usual, or any other number) together and into actual contact, and again immediately separate them; and I repeat this making and breaking of contact a number of times in such rapid succession that an apparently uniform emission of light is obtained. I vary this part of my invention by giving to an arrangement of electrodes (whether consisting of two electrodes, as usual, or of several electrodes combined together for producing one light), yielding flashes of light by the successive and rapid making and breaking of contact between the opposite electrodes, a rotary motion by which the several independent flashes are blended together into an apparently uniform ring or disc or circlet of light (according to the form of the arrangement used), and in this way I obtain a steady light, or one free from any disagreeable or sudden fluctuations.

4330q The several arrangements of and contrivances for working the electrodes by causing them to vibrate or move between each other that are given under the seventh or immediately preceding part of my invention are applicable also to the carrying into practice of this the eighth part of my invention, with this difference only, namely, that whilst under the former or vibratory system the movement of the electrodes towards each other stop short of actual contact, in this (which I call the "blending" system) the contact is completed, though immediately broken again, on each vibration or movement of the electrodes.

I claim as my invention, in order to produce a steady or apparently non-intermittent electric light, by whatsoever mechanical contrivance it may be accomplished, the blending together of independent flashes of light emitted between two or more carbon or other electrodes on making and on breaking contact between them, by causing, by any convenient mechanical contrivance, such contact to be made and broken repeatedly in such rapid succession that no interval can be perceived between the flashes so produced; and I claim the blending together for one uniform light independent flashes of light obtained by making and breaking contact between the electrodes by causing the electrodes producing such flashes to rotate or move so rapidly as to blend the flashes together, and give the impression of an apparently uniform light.

4330r DEFENDANT'S EXHIBIT ENGLISH PATENT NO. 2547 OF 1856. W. T. F., S. E.

A. D. 1856. No. 2547.

Electric Lights.

Letters patent to John Thomas Way, of Welbeck street, in the county of Middlesex, for the invention of "improvements in obtaining light by electricity."

Sealed the 28th April, 1857, and dated the 29th October, 1856.

Provisional specification left by the said John Thomas Way at the office of the commissioner of patents with his petition on the 29th October, 1856.

I, John Thomas Way, of Welbeck street, in the county of Middlesex, do hereby declare the nature of the invention for "improvements in obtaining light by electricity" to be as follows:

Heretofore in obtaining light by means of electricity electrodes a set) as the source of the light, or I combine together for one light the effects of two or more sets of electrodes.

This peculiar movement or method of working the electrodes I obtain by the vibration of a wire or wires carrying the charcoal points, and which points, in the act of —, successively approach to — recede from each other within limits that may be adjusted and regulated according to the power of the current of electricity in use, or the movement can be given by the vibration of a metallic fork carrying the carbon on each branch, by an eccentric-wheel movement carrying the electrodes within the required limits rapidly towards and then away from each other on each revolution, by the revolution of two di-cs on a common axis, but revolving in contrary directions, carrying carbon arms or radiating on the electrodes and crossing each other scissorwise, but without actual contact at any time, and in this way causing the emanat-ry points or edges successively and continually to close upon and to separate from each other; by the rapid revolution of two carbon wheels with serrated
4330*o* edges placed and acting edge to edge, by the revolution of
two wheels or rings placed concentrically with the proximate or light-emanating positions s*u*rrated or made angular, or the same general results may be obtained by a variety of other forms and arrangements of the electrodes, and the requisite motive power can be obtained by clock-work, by magneto-electric action, or otherwise; but, howsoever arranged or accomplished mechanically, I claim as my invention the causing the electrodes for producing light by electricity or the light-emanating points in a broken voltaic circuit alternately to approach to and to recede from each other by a movement imparted to one or both or to all the electrodes by any mechanical agency so that their distance shall be continually changing, but by so rapid a movement that the eye cannot detect the differences in the amount of light emitted that correspond with the difference in distance by which a light free from any sudden or apparently sudden fluctuations is produced.

(This method of producing a steady light I call the vibratory system to distinguish it from the others in this specification.)

The eighth part of my invention is as follows: When the two light*s*-giving electrodes in a voltaic circuit are brought into actual contact there is a point in the act of bringing them together at which the light is the most intense that
4330*p* the elements engaged are capable under any condi-
tions of producing. It is a sudden flash of brilliant light; and this part of my invention consists in obtaining a steady light by causing those flashes to follow other in such rapid succession that the eye can distinguish no interval between them. By any convenient mechanism I bring the electrodes (whether two, as usual, or any other number) together and into actual contact, and again immediately separate them; and I repeat this making and breaking of contact a number of times in such rapid succession that an apparently uniform emission of light is obtained. I vary this part of my invention by giving to an arrangement of electrodes (whether consisting of two electrodes, as usual, or of

several electrodes combined together for producing one light), yielding flashes of light by the successive and rapid making and breaking of contact between the opposite electrodes, a rotary motion by which the several independent flashes are blended together into an apparently uniform ring or disc or circlet of light (according to the form of the arrangement used), and in this way I obtain a steady light, or one free from any disagreeable or sudden fluctuations.

4330*q* The several arrangements of and contrivances for working the electrodes by causing them to vibrate or move between each other that are given under the seventh or immediately preceding part of my invention are applicable also to the carrying into practice of this the eighth part of my invention, with this difference only, namely, that whilst under the former or vibratory system the movement of the electrodes towards each other stop short of actual contact, in this (which I call the "blending" system) the contact is completed, though immediately broken again, on each vibration or movement of the electrodes.

I claim as my invention, in order to produce a steady or apparently non-intermittent electric light, by whatsoever mechanical contrivance it may be accomplished, the blending together of independent flashes of light emitted between two or more carbon or other electrodes on making and on breaking contact between them, by causing, by any convenient mechanical contrivance, such contact to be made and broken repeatedly in such rapid succession that no interval can be perceived between the flashes so produced; and I claim the blending together for one uniform light independent flashes of light obtained by making and breaking contact between the electrodes by causing the electrodes producing such flashes to rotate or move so rapidly as to blend the flashes together, and give the impression of an apparently uniform light.

4330*r* DEFENDANT'S EXHIBIT ENGLISH PATENT NO. 2547 OF 1856. W. T. F., S. E.

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Electric Lights.

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Provisional specification left by the said John Thomas Way at the office of the commissioner of patents with his petition on the 29th October, 1856.

I, John Thomas Way, of Welbeck street, in the county of Middlesex, do hereby declare the nature of the invention for "improvements in obtaining light by electricity" to be as follows:

Heretofore in obtaining light by means of electricity electrodes of charcoal have usually been employed, and motion has commonly been given to such electrodes by clock-work or otherwise, so as constantly to change their acting points; but even with this precaution it has been very difficult to obtain a constant light, in consequence of the want of uniformity in the electrodes. Now, this invention consists in the use for one of the electrodes of a substance such as mercury, which is caused to flow through an orifice or orifices on to a point or points of steel or other material. The mercury 4330s is in connection with one of the poles of the battery, and the points are in connection with the other pole of the battery, and they are so arranged that the distance between them and the orifices from which the mercury escapes can be adjusted so as to bring the points to the level, at which the streams of mercury break into drops. In place of using points of steel or other material for the lower electrode, a regulated surface of mercury may be employed, if desired, and the apparatus may be surrounded by a glass to prevent the escape of mercurial fumes; means also may be provided for raising the mercury from the lower receiver into which it falls from the orifices to the upper receiver or cistern which supplies the jets.

Specification in pursuance of the conditions of the letters patent filed by the said John Thomas Way in the Great Seal Patent Office on the 29th April, 1857.

To all to whom these presents shall come I, John Thomas Way, of Welbeck street, in the county of Middlesex, send greeting:

Whereas her most excellent majesty Queen Victoria, by her letters patent bearing date the 29th day of October, in the year of our Lord one thousand eight hundred and fifty-six, in the twentieth year of her reign, did, for herself, her heirs and successors, give and grant unto me, the said John Thomas Way, her special li- 4330t cense, that I, the said John Thomas Way, my executors, administrators, and assigns, or such others as I, the said John Thomas Way, my executors, administrators, and assigns, should at any time agree with, and no others, from time to time and at all times thereafter during the term therein expressed should and lawfully might make, use, exercise, and vend within the United Kingdom of Great Britain and Ireland, the Channel islands, and Isle of Man an invention for "improvements in obtaining light by electricity" upon the condition (amongst others) that I, the said John Thomas Way, my executors or administrators, by an instrument in writing under my or their or one of their hands and seals, should particularly describe and ascertain the nature of the said invention and in what manner the same was to be performed and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said letters patent:

Now, know ye that I, the said John Thomas Way, do hereby declare the nature of the invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement thereof—that is to say:

Heretofore in obtaining light by electricity electrodes of charcoal
have usually been employed, and motion has commonly been
4331 given to such electrodes by clock-work or otherwise, so as
constantly to change their acting points, but even with this
precaution it has been very difficult to obtain a constant light in
consequence of the want of uniformity in the electrodes.

Now, this invention consists in the use for one of the electrodes of a substance such as mercury, which is caused to flow through an orifice or orifices onto a point or points of steel or other material. The mercury is in connection with one of the poles of the battery, and the points are in connection with the other pole of the battery, and they are so arranged that the distance between them and the orifices from which the mercury escapes can be adjusted so as to bring the points to the level at which the streams of mercury break into drops. In place of using points of steel or other material for the lower electrode a regulated surface of mercury may be employed if desired, and the apparatus may be surrounded by a glass to prevent the escape of mercurial fumes; means also may be provided for raising the mercury from the lower receiver, into which it falls from the orifices, to the upper receiver or cistern which supplies the jets.

Having thus stated the nature of my said invention, I will proceed more fully to describe the manner of performing the same:

I use a cistern of iron, slate, or other suitable material, in which
the mercury is led by a pipe (with a stop-cock) to a jet, with
4332 as small an orifice as I can conveniently make, from which
by its own weight the mercury will flow in a constant
stream. I find a height of from two to four feet to give a suitable pressure, but I do not confine myself to a particular pressure. It is obvious also that the jet or jets may be thrown upwards or in any other direction that may be desirable, but I prefer that it should descend from the orifice by gravity. The necessary pressure may be obtained by mechanical means. When a small power only is employed the mercury may descend onto a point of steel, platinum, charcoal, or other conductor in connection with one pole of the battery, the mercury itself being connected with the other pole, and it is important that the second electrode (or one of the electrodes) should be capable of ready adjustment to insure its being at the point where the stream of mercury breaks in order that there may be a space between the stream and the second electrode. When the electric power is great I find that a point electrode is liable to be destroyed, and in such cases I employ a small cup of mercury made of infusible material, such as fire-clay or other matter, so arranged that the mercury therein shall be in connection with one pole of the battery, and I find that it is desirable that the mercury should flow off only on one side from the small cup, for which reason I make
the cup cylindrical and about half an inch in diameter, with
4333 the upper edge higher on one side than the other, so that the
edge is formed to an inclination or angle of forty-five de-

grees. The use of a small cup of mercury for the second electrode is important, as on the one hand it does not materially interfere with the light passing downwards, and at the same the quantity of mercury subject to the heat is small as compared with the quantity which would be present if the mass of mercury formed the second electrode. The mercury flows away by a pipe from below the small cup into any convenient re*ci*ptacle, from which it may be returned by hand, by a pump, or other means to the upper cistern. Finally, a glass is used to retain the fumes of mercury. The glass is cemented into the two cast-iron cylinders which form the upper and lower parts of the apparatus. This glass is to be as infusible as may be, and its size may vary from an inch in diameter to two inches or more, according to the size of the light to be produced. Instead of being a cylinder the glass may be fixed in segments in a frame of metal, but in that case means must be taken to isolate one or other of the electrodes. Whether a metal or other conducting point or a cup of mercury be used it is essential that means should be employed to adjust the distance between the two electrodes. For this purpose a screw or rack and pinion or other equivalent mechanism is to be used in combination with one or other of the electrodes in order that the distance apart of the electrodes may be regulated thereby, and that they may be retained at a distance apart corresponding with the breaking point of the stream of mercury. 4334

I would remark that I am aware that it is not new to employ a stream of mercury as an electrode in apparatus for obtaining light by electricity. I do not, therefore, claim the same, neither do I claim the adjusting of an electrode by a screw or other mechanical apparatus when separately considered; but what I claim is the use of a flowing electrode of mercury in combination with apparatus for regulating the distance apart of the two electrodes, and I also claim the combination of a small overflowing cup or regulated surface of mercury as a second electrode with a flowing electrode of mercury in apparatus for obtaining light by electricity.

In witness whereof I, the said John Thomas Way, have hereunto set my hand and seal this twenty-seventh day of April, in the year of our Lord one thousand eight hundred and fifty-seven.

JOHN THOMAS WAY. [L. S.]

Witness:

JNO. ALCOCK.

4335 DEF'T'S EX. HARRISON ENGLISH PATENT NO. 588 OF 1857.
Mar. 13, '89. W. T. F., N. P. & S. E.

(Fourth edition.)

[British coat of arms.]

A. D. 1857. No. 588.

Specification of Charles Weightman Harrison.

Electric light.

London: Published and sold at the patent office sale branch, 38 Cursitor street, Chancery lane, E. C. 1888. Price 1s. 1d.

4336 (Fourth edition.)

A. D. 1857. No. 588.

Electric Light.

Letters patent to Charles Weightman Harrison, of Woolwich, in the county of Kent, civil engineer, for the invention of "improvements in obtaining light by electricity."

Sealed the 28th August, 1857, and dated the 28th February, 1857.

Provisional specification left by the said Charles Weightman Harrison at the office of the commissioners of Patents with his peti tion on the 28th February, 1857.

I Charles Weightman Harrison of Woolwich in the county of Kent, civil engineer, do hereby declare the nature of the said invention for "improvements in obtaining light by electricity," to be as follows:—

My invention relates firstly to the preparation of electrodes.

It is well known that condensed gas carbon from its great purity and density is the best and most durable form of charcoal for the display of electric light.

Now one of my improvements under this head of my invention consists in placing pieces of metal or other material in gas retorts or in tubes connected therewith, for the purpose of receiving a deposit of gas carbon. I allow the pieces to remain exposed to the action of the gas until they are coated to a desired thickness and I then cut or grind them down to any required form of electrode.

4337 Another of my improvements under this head of my invention consists in the use of electrodes of spongy or powdered metals prepared by means of compression into any determinate shape or cut to a required form from blocks or masses of such compressed metals. In the employment of these electrodes I produce lights of various colors according to the kind of metal or combinations of metals used.

My invention relates secondly to an arrangement of electrodes.

In every apparatus employed up to the present time it is necessary in order to obtain a continuous light that the electrodes should approach each other as fast as diminution takes place, but by my improvements this necessity is obviated. I employ a cylindrical electrode and placing it on an axis in the direction of its length, I impart to it by suitable arrangements, a rotary as well as horizontal or onward motion in the line of its axis. Opposite to the periphery or circumference of this electrode I place another electrode and by preference I use one that is in the form of a point or pencil, the apex being in contact with the circumference of the cylindrical electrode and near to one of its ends. If motion be now given as herein-before stated to the cylindrical electrode, the opposide electrode will trace a spiral path over its surface from one end to the other, the contiguity of the convolutions being determined by the rate of its onward progression. In order to obtain the light I connect the opposite or pointed electrode with the armature of an electro-magnet or with a coil of conducting medium in such manner that on the transmission of a current of electricity this electrode is drawn or moved away to a suitable distance from the other and then retains a fixed position until on breaking the electric circuit it again renews the contact. I form the circuit of the current so as to render the rotary cylinder an electrode of positive electricity, and the point or pencil an electrode of negative electricity. The light being by these arrangements produced on the circumference of the cylindrical electrode and its motion continuously bringing fresh surface to the operation of the luminous portion of the current, an uniform amount of resistance is offered to its passage and the light is generated with a steady constancy due to that of the current itself.

The third part of my invention relates to a mode of maintaining a very uniform distance between a rotary disc positive electrode and a point or pencil negative electrode. The said mode consisting principally in keeping in contact with the periphery of a rotary disc electrode a roller or pulley or other contrivance which is connected by a chain or band or by levers with a pendant or sliding point or pencil electrode, whereby as the positive electrode diminishes the negative electrode is permitted continuously to advance without causing sudden fluctuations in the light.

4338 The fourth part of my invention refers to improvements in producing a succession of flashes or streams of light.

It has already been proposed to obtain electric light by a rapid succession of flashes resulting from the vibration, produced by mechanical agency, of electrodes. I do not therefore claim as new that which has been done before but I adopt the use of one or more electro-magnets to give rise to or effect a reciprocative or vibrative motion in electrodes. I sometimes employ a steel armature in connection with the electro-magnets so that its residual magnetism shall serve to retain the electrode or electrodes in the position assumed during the passage of the last current. On the arrival of each succeeding current, the transmission of which is regulated by a suitable electrotome, the electrodes are moved away one from another by the force originated by the current, a flash or stream of light is produced and the residual magnetism holds the electrodes in position for another electric impulse.

Another mode whereby I produce successive flashes or streams of light consists in the employment of a coil of conducting medium, and by means of an axial bar or magnet used in connection therewith a vibratory motion is given on the passage of the current to one or more electrodes. In those arrangements of electrodes where contact is made between them I prefer to introduce therein a spring or some compressible body in such a manner and position that it will break the force of concussion. In any arrangement of a vibratory system of electrodes I employ an electrotome by which the current is so directed that it shall at every impulse impart a negative nature to the vibrating electrode.

This part of my invention is very suitable for lighting marine buoys, the electricity being conveyed through insulated submarine conducting medium.

The fifth part of my invention relates to the introduction of an inductive coil (formed either with or without a condensing arrangement) to be used in connection with a primary current, and one of my improvements herein consists in given any required motion to electrodes by the operation of the primary current and producing light by means of the induced current alone.

The sixth part of my invention consists in combining the current generated in an inductive coil with a current of magneto-electricity produced by the motion of a conductor within the action of permanent magnets.

The seventh part of my invention consists in a peculiar mode of obtaining the electric light by which signals are effected. It comprises the application and use of an electrotome or an arrangement of electrotomes by which the current shall be let on both at
4339 rapid and at long intervals, or both at rapid, at short and at
long intervals. At each passage of the current a distinct flash of light is produced and this may be taken to denote an unit, the short intervals the end of a number and the long intervals to signify either the termination of the signals, as when a repetition of it is desired, or the end of a combination of numbers. This system may be made to represent words or sentences as well as numerals and being easily understood it is well adapted to lighthouses.

I also propose to indicate to vessels by flashes of electric light the depth of water in harbours or on banks, and to effect this by means of a float within a tube, which, by suitable mechanical contrivances, as it rises and falls calls into operation different electrotomes and these by completing the circuit of the current give rise to flashes of light, in number according to the depth of water in feet. To distinguish this from other marine lights I make it a colored light by placing a colored glass before it, or by the use of my improved metal electrodes described in the first part of this my provisional specification.

Specification in pursuance of the conditions of the letters patent filed by the said Charles Weightman Harrison in the Great Seal Patent Office on the 28th August, 1857.

To all to whom these presents shall come I, Charles Weightman Harrison, of Woolwich, in the county of Kent, civil engineer, send greeting:

Whereas her most excellent majesty Queen Victoria by her letters patent bearing date the twenty-eighth day of February in the year of our Lord one thousand eight hundred and fifty-seven in the twentieth year of her reign did for herself her heirs and successors give and grant unto me the said Charles Weightman Harrison her special licence that I the said Charles Weightman Harrison my executors administrators and assigns or such others as I the said Charles Weightman Harrison my executors administrators and assigns should at any time agree with and no others from time to time and at all times thereafter during the term therein expressed should and lawfully might make use exercise and vend, within the United Kingdom of Great Britain and Ireland the Channel islands and Isle of Man an invention for "improvements in obtaining light by electricity" upon the condition (amongst others) that I the said Charles Weightman Harrison my executors or administrators by an instrument in writing under my or their or one of their
4340 hands and seals should particularly describe and ascertain the nature of the said invention and in what manner the same was to be performed and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said letters patent.

Now know ye, that I the said Charles Weightman Harrison do hereby declare the nature of my said invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement thereof reference being had to the accompanying drawings and to the figures and letters marked thereon that is to say,

My said invention relates firstly to the preparation of electrodes for producing light.

It is well known that condensed gas carbon from its great purity and density is the best and most durable form of charcoal for the display of electric light.

Now one of my improvements under this head of my invention consists in placing pieces of metal or other material in gas retorts, or in tubes connected therewith for the purpose of receiving a deposit of gas carbon. I form hollow cylinders of carbon or barrel electrodes by passing a current of coal gas through a chamber which is traversed by metal tubes joined with a furnace the flame and heated air of which are drawn through the tubes. When these attain a red heat they gradually become coated with a dense form of carbon. I form pencil or solid carbon electrodes by suspending small rods or pencils of wood charcoal upon a frame of iron, which I place within a heated gas chamber or retort, where it will be subjected to a high degree of heat. By this process the charcoal is rendered hard and lasting. I allow the tubes and pieces to remain exposed to the action of the gas until they are coated to a desired thickness and I then cut or grind them down to any required form of electrode.

Another of my improvements under this head of my invention consists in the use of electrodes of spongy or powdered metals prepared by means of compression into any determinate shape or cut to a required form from blocks or masses of such compressed metals. I first slightly moisten the metallic powder and having placed it in an iron mould of any suitable shape, I apply hydraulic or other pressure to a piston which accurately fits the aperture of the mould. In this way the pulverulent matter is solidified and made suitable for use in electric light apparatus. In the employment of these electrodes I produce lights of various colors according to the kind of metal or combination of metals used. The metallic dust 4341 may be mixed in various proportions with carbon or other substance. I obtain a brilliant white light by using a positive electrode formed of a combination of zinc powder and plumbago and consisting of three parts of plumbago with one of zinc.

My invention relates secondly to an arrangement of electrodes.

In every electric light apparatus employed up to the present time it is necessary in order to obtain a continuous light that the electrodes should approach each other as fast as diminution takes place, but by my improvements this necessity is obviated. I employ a cylindrical electrode and placing it on an axis in the direction of its length. I impart to it by suitable arrangements a rotary as well as horizontal or onward motion in the line of its axis. Opposite to the periphery or circumference of this electrode I place another electrode and by preference I use one that is in the form of a point or pencil the apex being in contact with the circumference of the cylindrical electrode and near to one of its ends. If motion be now given as herein-before stated to the cylindrical electrode the opposite electrode will trace a spiral path over its surface from one end to the other, the contiguity of the convolutions being determined by the rate of its onward progression. In order to obtain the light I connect the opposite or pointed electrode with the armature of an electro-magnet or with a coil of conducting medium in such a manner that on the transmission of a current of electricity this electrode is drawn or moved away to a suitable distance from the other and then retains a fixed position until on breaking the electric circuit it again renews the contact. I form the circuit of the current so as to render the rotary cylinder an electrode of positive electricity, and the point or pencil an electrode of negative electricity. The light being by these arrangements produced on the circumference of the cylindrical electrode, and its motion continuously bringing fresh surface to the operation of the luminous portion of the current an uniform amount of resistance is offered to its passage, and the light is generated with a steady constancy due to that of the current itself. To obtain the maximum amount of light it is necessary to proportion the distance between the electrodes to the intensity of the electricity employed. I provide means for effecting this object by placing the electro-magnet or its armature on a movable support which will admit of the distance between them being increased or diminished at pleasure. The duration of the light will of course depend upon the size of the rotary barrel electrode and as by its motion which is derived from clockwork or other suitable means it maintains a steady and permanent light I have in contradistinction to other electric lights called this arrangement the electric constant light apparatus.

In order that this part of my invention should be fully as-
4342 certained and in what manner it may be performed I will
now proceed to describe and refer to the several figures on the first sheet of drawings hereunto annexed.

Figure 1 is a front elevation of one of my electric light apparatuses complete. Figure 2 is a side elevation of the same, parts being removed to shew the interior. Figure 3 is a plan of apparatus fixed on a base board. In each of these figures the same letters refer to like parts.

a is a hollow cylinder or barrel positive electrode of which a cross section is shewn in figure 13. *b* is the central rotary axis shewn separate in figure 7. *c* is a fixed hollow screw within which the central axis works shewn detached in figures 8 and 9. *d d* are clamp circular plates or discs having an interior rim fitting the aperture in the barrel electrode, one of the plates is fixed on the end of a hollow axis, the other end being formed with a screw, by which to connect the second plate and thus clamp or hold the electrode in position these are shewn separately in figures 10 and 11. Within this hollow axis the fixed hollow screw containing the central axis is placed. One end of the central axis carries a pulley which is connected by the chain or cord *e* with the driving pulley *f* actuated by clockwork apparatus held by the frame *g g* *h h* are hollow standards supporting the barrel electrode *i* is the negative electrode held by the pendant socket *j* in which is a projection fitting in a recess or groove *k* in the electrode to prevent its falling out. For the purpose of affording a convenient means of fixing the electrode, the socket is made to open in two parts, one of which is removed in this figure but they are shewn together in figures 5 and 6. *l* is part of the mouthpiece of the standard *m*; the other part being fixed on the slide or door which is here removed. To facilitate the passage of the current I line the inside of the mouthpiece with platinum. The negative electrode passes freely through this mouthpiece without lateral deviation when drawn upwards. *n* is a cord carried over the pullies *o o* one end being hooked to a ring in the socket and the other end to the bar *p* *q* is an electro-magnet fixed by the bracket *r* to the plate *s* which moves on another or bed plate *t*, secured on the block or bridge of wood t^1 *u* is a screw working through the bracket *r* and employed to adjust the distance apart of the magnet *q* and armature *w* this armature is attached to a short arm *x* of the lever *y* which is supported on the axis *z*. The long arm of the lever passes under the bed plate *t*, and terminates in a forked end; to this fork a pair of spring nippers a^1 a^1 is attached and these are so regulated by the screws b^1 b^1 working in the

bracket c^1 c^1 that at the moment the armature is attracted by the electro-magnet they take hold of the bar *p*, fixed to the end of the chain, and carry it down with the lever d^1 is a bent rod fixed to the
armature which as it is drawn to the magnet causes the rod
4343 to depress a short ivory stud secured on the end of the axis
e^1 carrying an arm furnished with a pin at the end that drops in between the teeth of the wheel f^1 and thus stop the motion of the clockwork when the current is cut off g^1 is an adjustment acting on a balance wheel for the purpose of varying the rate of motion h^1 is a spring regulated by a screw and serving to withdraw the armature from the magnet on the occurrence of a break or loss of power in the current k^1 k^1 k^1 k^1 are screws to fasten down the base board l^1 to the bottom of the case m^1.

Still further to make plain the connection and general operation of the several parts of the apparatus I shall now state the direction traversed by the current. The screw P being brought into contact with a conductor from the positive pole to the screw N with another conductor from the negative pole of a voltaic battery or other suitable source of electricity, the circuit will be from N to the standard *h* thence through the central axis and screw clamp plate to the rotary barrel electrode. From this it passes to the opposite point or pencil electrode and it is in so doing that the great resistance to the passage of the current gives rise to heat and light the amount of which is proportionate to the power of the current and to the nature of the electrodes. From the pencil electrode the circuit is through the mouthpiece *l* and socket *j* down the standard *m* to a wire by which it is carried around the electro-magnet to the screw P.

Of the remaining figures in the first sheet of drawings figure 4 represents a back elevation of the mechanism by which the negative electrode is withdrawn *n* is a cord attached to the socket *j* *p* is a bar a^1 a^1 are spring nippers fixed on the fork of lever *y* *y* b^1 b^1 adjusting screws working through brackets fixed to the under side of case *m*. Figure 5 is a front view of socket figure 6 cross section of the same *a* the part which opens or may be detached *b* aperture to contain electrode and *n* the chain or cord. Figure 7 central axis which for the purpose of giving a rotary motion to the electrode is made flat on one side for half of its length the hole in the screw clamp plate being made of a similar form to receive it; *a*, chain pulley. Figure 8 hollow screw to contain central axis, one end terminates in a shoulder plate by which it is fixed in a recess formed in its bearing standard. Figure 9 is an end view of this shoulder plate, *a* being the aperture in which the central axis revolves. Figure 10 shews the hollow clamp axis; an end view of the fixed clamp plate is shewn in figure 11. *a*, clip or tongue which being held by the pressure of the spring *b*, between the thread of the screw carries the electrode as it revolves along the line of its axis. *c* loose clamp
plate screwing on to the end of the hollow axis when passed
4344 through the electrode. Figure 12 is a front view of a barrel
screw electrode, the apex of the thread when in motion in the apparatus being continuously brought under the point of another electrode placed at right angles to it. Figure 13 is a cross section

of a barrel electrode *a*, tube of iron *b*, deposit of gas or other carbon.

The third part of my invention relates to a mode of maintaining a very uniform distance between a rotary disc positive electrode and a point or pencil negative electrode, this mode consists principally in keeping in contact with the periphery of a rotary disc electrode a roller or pulley or other contrivance which is connected by a chain or band or by levers with a pendant or sliding point or pencil electrode, whereby as the positive electrode diminishes, the negative electrode is permitted continuously to advance without causing sudden fluctuations in the light.

The manner in which this part of my invention may be carried into effect will be understood by reference to the figures in the second sheet of the accompanying drawings and to the following description.

Figure 1 is a front elevation of the complete apparatus and figure 2 is a side elevation, part of the case and of one of the standards supporting the disc electrode being removed to shew the mechanism. *a* positive disc electrode to which a rotary motion is imparted by a pulley fixed on one end of its axis being connected with another pulley driven by clockwork held in the frame *b*—*c* negative electrode fixed in a socket sliding in the standard *d* where it is held pendant by the cord *e* passing over pulleys placed therein—*f* sliding frame carrying a pulley around which the cord is conveyed—*g* spring nippers attached to the lever *h*—*i* screws for regulating the pressure of the nippers on the sliding frame—*j* axis of lever—*k* armature borne on the end of the adjusting screw *l* which passes through the short elbow of the lever—*m* is an electro-magnet supported on the bed *n*, and held by the bracket *o*—*p* pulley over which the cord is conveyed and made fast to a cross pin at the lower end of the sliding frame *q*—*r* is a pulley fixed in this frame and held against the disc electrode by the weight of the pendant socket and negative electrode—*s s* are hollow standards supporting the disc.

Upon connecting the binding screws P and N with a suitable voltaic battery, the electricity will pass from N around the electromagnet, and up a standard *s* to the disc electrode on the periphery of which the light is produced. Through the negative electrode the electricity is carried to the standard *s* and thence to the second binding screw P—The action of the apparatus is as follows—upon the soft iron or armature at one end of the lever being attracted by the electro-magnet, the nippers attached to the other end of the lever are drawn down carrying with them the pulley frame
4345 through which the cord connected with the negative electrode
is passed the extent of this movement is restrained by an adjusting screw. As the rotary positive disc is consumed the pulley in contact with its edge will be raised thereby lowering in exact proportion the other electrode. Upon the current ceasing to pass, the nippers liberate the frame, and the negative electrode rests upon the disc ready for further use.

The fourth part of my invention refers to improvements in producing a succession of flashes or streams of light.

It has already been proposed to obtain electric light by a rapid succession of flashes resulting from the vibration produced by mechanical agency of electrodes. I do not therefore intend to claim as new the obtaining of electric light by a succession of flashes. I employ however for the purpose one or more electro-magnets to give rise to or effect a reciprocative or vibrative motion in electrodes and prefer to use the metal mercury for the positive electrode in producing flashes or streams of light.

In sheet 3 of the annexed drawings, figure 1 is a plan and figure 2 a side elevation partly in section of an arrangement by which this part of my invention may be carried out, as a lamp suitable for vessels at sea, or locomotives on land, there being no liability to the light ceasing, and as the flashes of light are produced with exceeding rapidity they appear almost as one sparkling light—*a*, is a frame or case provided with suitable slides or doors for gaining access to the interior—*b* lens—*c* bent glass vessel having a close fitting lid *s*, at the elbow—*d*, *d*, sockets or hollow pistons working through the lid *s*, and connected by short rods with the beams *f*, *f*, supported on the standards *g g*—*h h*, rods which unite the short end of each beam with the balance *i* working on the axis *j*,—*k*, *k*, are adjusting screws passing through the balance and holding the soft iron armatures *l*, *l*. m, m^1 are electro-magnets—*n* is a reservoir or supply vessel with an opening *u* at the top to admit the open end of the glass vessel *c*, and also connected near the bottom with the glass vessel by a small tube or pipe *p*—*t* is a reflector—*e*, *e*, are two hollow pencil negative electrodes securely fastened in their sockets—*s* is an aperture to admit mercury into the reservoir—the various parts of the apparatus are securely fixed to the base board *q*, which slides within the lamp and is held down by the screws *r*, *r*. The path of the current is from the binding screw N fixed in the iron reservoir containing the supply of mercury which forms the positive electrode in the glass *c*, thence alternately through each of the negative electrodes e, e^1 and around its electro-magnet to the binding screw P. In this way the lamp continues in operation, as the electro-magnets are excited they successively attract their armature which drawing down the 4346 balance connected to the beams raises a negative electrode from the mercury and produces a flash of light. At the same time the short end of the other lever being raised by the balance causes the other negative electrode in its turn to complete and then break the circuit and thus give another flash of light. As mercury when used for the positive electrode in the production of light undergoes a rapid evaporation, I provide means, by carrying the bent glass vessel over into the supply reservoir for its condensation therein, and to facilitate this I sometimes cover the mercury therein with water. I find it of great advantage to employ hollow negative electrodes in connection with a positive electrode of mercury.

I sometimes employ steel armatures in connection with the electro-magnet in place of soft iron, so that its residual magnetism shall serve to retain the electrode or electrodes in the position assumed during the passage of the last current. On the arrival of each succeeding current the transmission of which is regulated by a suitable electrotome, the electrodes are moved or drawn away one from another by the force originated by the current, a flash or stream of light is produced, and the residual magnetism holds the electrodes in position for another electric impulse.

Another mode whereby I produce successive flashes or streams of light consists in the employment of a coil of conducting medium and by means of an axial bar or magnet used in connection therewith a vibratory motion is given on the passage of the current to one or more electrodes which may be arranged as herein last before described. In any arrangement of a vibratory system of electrodes, I so direct the current that it shall at every impulse impart a negative nature to the vibrating electrode.

This part of my invention is very suitable for lighting marine buoys the electricity being conveyed through insulated submarine conducting medium. Figure 3 in sheet 3 of the drawings represents the plan of an arrangement by which I propose to light up any number of marine buoys or beacons one after another successively by the same electric current; the buoys being moored around shoals or sand beds, as for instance the Goodwin, would by the continuous running of the light completely surround them with a belt of fire and thus afford a valuable means of preventing shipwreck—*a* is a submarine electric cable, communicating through a flow and return insulated conductor with the light producing electrodes placed under a strong bell glass or frame on each buoy. The two ends of the submarine cable are placed in connection with an electrotome formed as shewn in the figure. One end of each insulated conductor is joined to a binding screw numbered in the figure similar to the buoy it is in communication with, and this by means
4347 of a spring a^1 forms contact with a projecting tooth of the barrel *b*, the axis of this barrel carries a toothed wheel *c*, which is drawn round a distance of one tooth by a claw in the end of the arm *d*, each time that the armature *h*, is released from the electro-magnet—*e* is the lever borne on an upright axis *f*, and connected, one end with the upright *g*, working on an axis and carrying the armature, the other end is joined to the arm *d*,—*i* is a spring regulated by a screw and pressing back the armature when the current is broken—N binding screw from which the current passes around the electro-magnet to the screw *m*, thence to the spring *n* in permanent contact with the barrel. As each tooth of the barrel during its rotary motion is brought into contact with a spring the current passes to one pair of electrodes which are ignited and drawn away to a distance that will break the current, the electro-magnet then ceasing to hold the armature its support is forced back by the spring which causes the arm to draw on the toothed wheel and bring the adjoining spring in contact with the next tooth upon the barrel thus igniting the electrodes in advance and in this way the light continuously runs the round of the buoys.

The fifth part of my invention relates to the introduction of an induction coil (formed either with or without a condensing arrangement) to be used in connection with a primary current, and one of my improvements herein consists in giving any required motion to electrodes by the operation of the primary current, and producing light by means of the induced current alone. I effect this operation by passing a primary current of voltaic or other electricity through one or more induction coils and at the same time move or regulate electrodes or their apparatus in any desired way. To produce the light I connect the electrodes with the secondary circuit of the coils, so that that current only shall pass through them and cause ignition. I prefer not to cut off or suspend the primary current but simply to change its direction by means of an electric reversing apparatus the construction of which is well understood. While therefore the light is developed by the secondary current the primary current does not cease to regulate the motion of the electrodes.

I perform the sixth part of my invention by combining the currents generated in an inductive coil with currents of magneto-electricity, produced by the motion of a conductor within the action of permanent magnets, so as to increase its effect in producing light.

The seventh part of my invention consists in a peculiar mode of obtaining the electric light by which signals are effected. It comprises the application and use of an electrotome or an arrangement of electrotomes, by which the current shall be let on both at rapid and at long intervals, or at rapid at short and at long intervals.
At each passage. of the current a distinct flash of light
4348 is produced, and this may be taken to denote an unit, the
short intervals the end of a number, and the long intervals to signify either the termination of the signal, as when a repetition of it is desired, or the end of a combination of numbers. This system may be made to represent words or sentences as well as numerals and being easily understood is well adapted to lighthouses.

Figure 4 represents a side view of an electrotome suitable for signalling the number three hundred and fifty-seven. It is placed on an axis which forms part of the circuit of the current and as it revolves in the direction of the arrows, by means of clockwork or other suitable power, the successive projecting teeth are brought at intervals according to their distance apart, in contact with a spring or moveable stud, thus closing the circuit and producing light between the electrodes with which it is in connection, as the distance to which the electrodes are separated breaks the current the light is extinguished until by the motion of the electrotome it is again renewed.

Lastly I propose to indicate to vessels by flashes of electric light, the depth of water in harbours or on banks and to effect this by means of a float within a tube, which by suitable mechanical contrivances as it rises and falls, calls into operation different electrotomes, and these by completing the circuit of the current give rise to flashes of light in number according to the depth of water in feet.

The manner in which I carry out this part of my invention will be understood on reference to the drawings numbered 5 and 6 sheet 3, *a* is a hollow pillar or tube, on the top of which the cap *b* is screwed—*c, c* are separate rows of insulated plates each plate being one foot long and connected by an insulated conductor to a rotary electrotome which corresponds by the number of flashes it is capable of calling forth, to the height in feet that the float *d*, will be from the bottom of the water when the brace spring *f* unites opposite plates. The electrotome is connected with one pole of a battery and one of the rows of insulated plates with the other pole. The pressure of the spring on the plates is regulated by the nut *g*. It will be evident that the post should be fixed sufficiently high above high-water mark to effect the required signals. Figure 6 represents a section of a revolving electrotome which would shew a depth of eleven feet.

To distinguish this from other marine lights I make it a colored light, by placing a colored glass before it, or by the use of my improved metal electrodes described in the first part of this my specification.

Having now described and particularly ascertained the nature of my said invention of improvements in obtaining light by electricity, and the manner in which the same is or may be used or carried into effect, I declare that I do not confine or restrict 4349 myself to the precise details or arrangements which I have described or referred to, as many variations may be made therefrom without deviating from the main features of my invention but I claim

First, the mode described of forming condensed gas-carbon electrodes for obtaining electric light.

Second, the use of the electrodes formed of compressed spongy or powdered metals, or of a combination of metal powder and plumbago or other form of carbon.

Third, the arrangement of electrodes and combination of mechanism or means for the production of a constant electric light as herein-before described in relation to the second part of this my said invention, reference being had to the figures on the annexed first sheet of drawings.

Fourth, the arrangements described of maintaining an uniform distance between a rotary disc electrode and a point or pencil electrode.

Fifth, the arrangements described relating to the fourth part of my said invention for producing a succession of flashes or streams of light, as well as the use of two or more negative electrodes in combination with a single positive electrode of mercury and the use of hollow negative electrodes in combination with a positive electrode of mercury.

Sixth, the plan described herein, by which any number of marine buoys or beacons may be successively illuminated.

Seventh, the arrangements or means for the production of electric light by the use of a secondary or induced current as described.

Eighth, the combination of magneto-electric with secondary currents for the production of light.

Ninth, the system or mode herein described in reference to the seventh part of my said invention for effecting signals by electric light.

And tenth, the arrangements described for indicating the depth of water by electric light.

In witness whereof I the said Charles Weightman Harrison have hereunto set my hand and seal this twenty-eighth day of August, one thousand eight hundred and fifty-seven.

CHAS. W. HARRISON. [L. S.]

London: Printed for her majesty's stationery office, by Darling and Son.
(G. 161.—100.—1 | 88.)

(Here follow diagrams marked pp. 4350, 4351, & 4352.)

4353 DEF'T'S EXHIBIT BURLEIGH & DANCHELL'S ENGLISH PATENT NO 3164 OF 1837. March 13, 1889. W. T. F., S. E. & N. P.

A. D. 1857, 24th December. No. 3164.

Manufacture of Articles from Plastic and other Materials.

Letters patent to Benjamin Burleigh, of 26 Great George street, Westminster, and Frederick Ludwig Danchell, of No. 452 Oxford street, in the county of Middlesex, for the invention of "certain improvements in the manufacture of vessels, plates, or utensils used for domestic, sanitary, electric, and manufacturing purposes."

Sealed the 18th June, 1858, and dated the 24th December, 1857.

Provisional specification left by the said Benjamin Burleigh and Frederick Ludwig Danchell at the office of the commissioners of patents with their petition on the 24th December, 1857.

We, Benjamin Burleigh, of 26 Great George street, Westminster, and Frederick Ludwig Danchell, of No. 452 Oxford street, in the county of Middlesex, do hereby declare the nature of the said invention for "certain improvements in the manufacture of vessels, plates, or utensils used for domestic, sanitary, electric, and manufacturing purposes" to be as follows:

4354 This invention has for its object the formation of articles of utility from various plastic and other material to be rendered solid by means of percussive force, stamping or hammering, and afterwards submitted to the action of heat in inclosed vessels.

It is proposed to take carbonaceous matter, such as coke, animal or vegetable charcoal, boghead ash, gas carbon, soot, lamp-black, clay, porcelain, sand, or other suitable material, each by itself or mixed, and rendered plastic by means of moist bituminous, resin-

ous, gummy, sac-harine, or glutinous substances, and to force the said materials into moulds suited for the object to be constructed by stamping or beating with suitable tools, by means of hand power or machinery, to the required degree of consistency or solidity. I propose to apply the above process in manufacturing articles of the following kinds, vizt: Meat safes, tanks, cisterns, casks, and other hollow vessels or receptacles for the purpose of preserving or purifying culinary or other substances, as well as water and other fluids; crucibles, retorts, assayers' muffles, muffle plates, cupolas; also cells, cyl*l*inders, plates, and el*l*ectrodes for electric purposes; receptacles and other articles for photographists; screens, respirators, and plates in general for purifying air; tubes, hollow or solid cyl*l*inders,
4355 columns, blocks, and similar objects for conducting fluids or
for building purposes; filtering mediums, charcoal pencils, tobacco pipes, moulds for casting metals, or articles used for manufacturing glass.

To render crucibles and other objects made of carbon proof against the action of oxygen when used in a fire, I cause the said articles to be coated outside with s*e*licious or other substance not liable to be acted upon by oxygen. To render vessels and other objects proposed to be manufactured impermeable to fluids and gases, I glaze or coat them with a varnish outside or inside, or both, when required.

Specification in pursuance of the conditions of the letters patent filed by the said Benjamin Burleigh and Frederick Ludwig Danchell in the Great Seal Patent Office on the 24th June, 1858.

To all — whom these presents shall come we, Benjamin Burleigh, of 26 Great George street. Westminster, and Frederick Ludwig Danchell, of No. 452 Oxford street, in the county of Middlesex, send greeting:

Whereas her most excellent majesty Queen Victoria, by her letters patent bearing date the twenty-fourth day of December, in the year of our Lord one thousand eight hundred and fifty-seven, in the twenty-first year of her reign, did, for herself, her heirs
4356 and successors, give and grant unto us, the said Benjamin
Burleigh and Frederick Lugwig Danchell, her special license that we, the said Benjamin Burleigh and Frederick Ludwig Danchell, our executors, administrators, and assigns, or such others as we, the said Benjamin Burleigh and Frederick Ludwig Danchell, our executors, administrators, and assigns, should at any time agree with and no others, from time to time and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man an invention for "certain improvements in the manufacture of vessels, plates, or utensils used for domestic, sanitary, electric, and manufacturing purposes," upon the condition (amongst others) that we, the said Benjamin Burleigh and Frederick Ludwig Danchell, our

executors or administrators, by an instrument in writing under our or their or one of their hands and seals, should particularly describe and ascertain the nature of the said invention and in what manner the same was to be performed and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said letters patent:

4357 Now know ye that we, the said Benjamin Burleigh and Frederick Ludwig Danchell, do hereby declare the nature of our said invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement—that is to say:

This invention has for its object the formation of articles of utility from various plastic and other materials to be rendered solid by means of percussion force and afterwards submitted to the action of heat in closed vessels.

It is proposed to take carbonaceous matter, such as coke, animal or vegetable charcoal, boghead ash, gas carbon, lamp-black, or other suitable material, each by itself or mixed or rendered plastic by means of moist bituminous, resinous, gummy, oleaginous, saccharine, glutinous, or other suitable cementing medium, and to force the said materials into moulds suitable for the objects to be constructed by stamping or beating with suitable tools by means of machine or other power to the required degree of consistency or solidity, after which the objects are baked or burned in closed vessels.

We propose to apply the above process in manufacturing articles of the following kinds, viz: Meat safes, tanks, cisterns, casks, and other hollow vessels or receptacles for the purpose of preserving or purifying culinary and other substances, as well as water and
4358 other fluids, crucibles, retorts, assayers' muffles, muffle plates, cupolas; also cells, cylinders, plates for batteries, and electrodes for electro or galvanic purposes; receptacles and other articles for photographists, screens, respirators, and plates in general for purifying air, tubes, hollow or solid blocks, cylinders, columns, and similar objects for conducting fluids; filters, charcoal pencils, tobacco pipes, moulds for casting metals; also articles used in the manufacture or casting of glass.

To render crucibles and other objects made of solidified carbon proof against the action of oxygen when exposed to fire we cause the said articles to be coated outside with silicious glaze or other substance not liable to be acted upon by oxygen or atmospheric air.

To render vessels and other objects impermeable to fluids and gases we glaze them or coat them, either on the outside or inside, or on both sides, when required, with a varnish or lacker insoluble in the particular fluid or gas intended to be contained in the vessel.

Referring to the method of treating the carbonaceous substances herein described, it is further necessary to explain that either moist, bituminous, resinous, gummy, oleaginous, saccharine, or glutinous matters are mixed with pulverized carbonaceous substances, in order to make the particles thereof adhere together; but we cannot state the exact proportions of 4359 such mixture, as they differ according to degree of density of the object required to be produced. Generally, however, the proportion which the carbon bears to the plastic or cementing medium is about fifty per cent., and with regard to the mode of solidifying the material when placed in the mould we find the action of a steam hammer the most effective for the purpose, but we do not limit ourselves to this method, as the percussive action produced by another body accellerated by machine or other power may answer the purposes in many instances, and in some cases even hydraulic or screw pressure may be used. Any of the hollow vessels, receptacles, or other objects herein described may be made in one or in several parts, which parts may be joined together by means of suitable cement, screws, bolts, hoops, iron, wood, or other suitable casing.

Having thus described the nature of our invention and the manner of performing the same, we would have it understood that what we claim is—

Firstly. The mode of treating the materials by the use of percussive force produced by the steam hammer or other power as described for the production of the articles of utility herein specified.

Secondly. The application of solidified carbon to the manufacture of the articles of utility herein specified.

4360 Thirdly. The coating of objects of solidified carbon with glaze, as described, for the purpose of protecting them against the action of oxygen or atmospheric air when exposed to heat.

Fourthly. The coating of articles of solidified carbon with a suitable varnish, lacker, or glaze for the purpose of retaining fluids or gases.

In witness whereof we, the said Benjamin Burleigh and Frederick Ludwig Danchell, have hereunto set our hands and seals this twenty-fourth day of June, in the year of our Lord one thousand eight hundred and fifty-eight.

BENJ'N BURLEIGH. [L. S.]
FREDERICK LUDWIG DANCHELL. [L. S.]

4361 DEF'T'S EXHIBIT WAY ENGLISH PATENT NO. 2841 OF 1857.
Mar. 13, 1889. W. T. F., N. P. & S. E.

A. D. 1857, 10th November. No. 2841.

Obtaining Light by Electricity.

Letters patent to John Thomas Way, of Welbeck street, Cavendish square, in the county of Middlesex, for the invention of "improvements in obtaining light by electricity."

Sealed the 12th March, 1858, and dated the 10th November, 1857.

Provisional specification left by the said John Thomas Way at the office of the commissioners of patents with his petition on the 10th November, 1857.

I, John Thomas Way, of Welbeck street, Cavendish square, in the county of Middlesex, do hereby declare the nature of the invention for "improvements in obtaining light by electricity" to be as follows:

When a jet or jets of mercury connected with one pole of the battery is directed upon a point of charcoal or other conducting substance in connection with the other pole of the battery the charcoal or other conducting substance is liable to be consumed, in which case the focal distance is altered and the brilliancy of the light is impaired.

Now, one part of my invention consists in so arranging the charcoal of other conducting substance forming the solid electrode that it shall be continually renewed and presented to the steam of the flowing electrode at a constant distance from the orifice of
4362 the jet from which the latter issues. This may be effected in one or other of the following ways or otherwise: I arrange cylinders or rods of charcoal or other conducting material opposite to each other and cause them to be pressed together by springs or other convenient mechanism. Upon the point where the ends of the rods meet I direct the jet or jets of mercury, which, by proper means of adjustment, as described in my former patents, may be fixed at the focal distance or breaking point of the stream.

It is important that the pressure applied to the different rods of charcoal or other conducting material should be as nearly as possible the same. I sometimes employ for this purpose in place of springs the following arrangement: Cylinders of iron or steel or other suitable material are fitted with pistons, which in moving press the conducting rods against each other. At the back of these pistons mercury is introduced by pipes leading from a cistern above, and by this column of mercury the rods of charcoal or other conducting material are pressed forward with great equality. Instead of pressing rods of charcoal or other conducting substance against each other one such rod may be pressed against a piece of lime, phosphate of lime, or other comparatively infusible material, the flowing electrode being directed against the point of junction. A surface of charcoal or other conducting material, forming one electrode, may be presented at a constant distance from the ori- 4363 fice from which the flowing electrode issues by causing a cylinder or rod of each conductor upon which the flowing electrode is thrown to move forwards and on its axis, the required motion being given by suitable self-acting mechanism, or a rod of charcoal or other conducting material forming one of the electrodes may be projected by a spring or otherwise through a ring of iridium, so that as the end of the charcoal is consumed a fresh portion is pushed forwards in a similar manner to that in which the candle in Palmer's candle lamp is forced forwards as its end is consumed.

Another part of my invention consists in heating the material forming the flowing electrode before it is supplied to the jets.

Another part of my invention consists in adjusting the focal distance or breaking point of the flowing electrode by increasing or diminishing the pressure which causes it to issue from the jet.

Another part of my invention consists in a method of maintaining at a constant height above the jet the column of mercury or other flowing electrode. For this purpose, in conjunction with the open cistern from which the mercury flows, I employ a close cistern, from which the mercury is led by a pipe to the open cistern; this pipe dips slightly below the surface of the mercury in the open cistern. So soon, therefore, as the level of the mercury in the lower cistern is reduced the mercury will flow from the upper cistern, so that the pressure of mercury remains practically constant.

4364 Specification in pursuance of the conditions of the letters patent filed by the said John Thomas Way in the Great Seal Patent Office on the 10 May, 1858.

To all to whom these presents shall come I, John Thomas Way, of Welbeck street, Cavendish square, in the county of Middlesex, send greeting:

Whereas her most excellent majesty Queen Victoria, by her letters patent bearing date the tenth day of November, in the year of our Lord one thousand eight hundred and fifty-seven, in the twenty-first year of her reign, did, for herself, her heirs and successors, give and grant unto me, the said John Thomas Way, her special license that I, the said John Thomas Way, my executors, administrators, and assigns, or such others as I, the said John Thomas Way, my executors, administrators, and assigns, should at any time agree with, and no others, from time to time and at all times hereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend within the United Kingdom of Great Britain and Ireland, the Channel islands, and Isle of Man an invention for "improvements in obtaining light by electricity," upon the condition (amongst others) that I, the said John Thomas Way, my executors or administrators, by an instrument in writing under my or their or one of their hands and seals, should particularly describe and ascertain the nature of the said invention and in what manner the same was to be performed and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said letters patent:

Now, know ye that I, the said John Thomas Way, do
4365 hereby declare the nature of the said invention and in what
manner the same is to be performed to be particularly described and ascertained in and by the following statement thereof—that is to say:

When a jet or jets of mercury connected with one pole of the battery is directed upon a point of charcoal or other conducting substance in connection with the other pole of the battery, the charcoal or other conducting substance is liable to be consumed, in which case the focal distance is altered and the brilliancy of the light is impaired.

Now, one part of my invention consists in so arranging the charcoal or other conducting substance forming the solid electrode that it shall be continually renewed and presented to the stream of the flowing electrode at a constant distance from the orifice of the jet from which the latter issues. This object may be effected in one or other of the following ways or otherwise: I arrange cylinders or rods of charcoal or other conducting material opposite to each other and cause them to be pressed together by springs or other convenient mechanism. Upon the point where the ends of the rods meet I direct the jet or jets of mercury, which, by proper means of adjustment as described in my former patents, may be fixed at the focal distance or breaking points of the stream.

Figure 1 is a longitudinal section of part of an electric lamp constructed in this manner. A A, tubes of iron; B B, pistons ground in, say, an inch long; C C, springs; D D, screw-nuts to open the
tube for charging; E, junction of the rods of charcoal; F,
4366 the jet; G, the stream of mercury.

It is important that the pressure applied to the different rods of charcoal or other conducting material should be as nearly as possible the same. I sometimes employ for this purpose in place of springs the following arrangement: Cylinders of iron or steel or other suitable material are fitted with pistons, which, in moving, press conducting rods against each other. At the back of these pistons mercury is introduced by pipes leading from a cistern above, and by this column of mercury the rods of charcoal or other conducting material are pressed forward with great equality. This arrangement is clearly shown at figure 2, which is also a longitudinal section of part of an electric light. A A, tubes of iron; B B, pistons ground in; C C, tubes connecting the tubes A A with a mercury cistern above; D D, screw-nuts to open the tubes A A for charging; E, junction of the rods of charcoal; F, the jet; G, the stream of mercury. The size (diameter) of the charcoals is dependent upon the strength of the battery, and the mercury current, about that of an ordinary le-d pencil or goose quil- or somewhat

smaller, is found to answer with a battery power of forty-eight cells of a Maynooth's battery, the zinc plates of which expose a surface of 60 inches each and a mercury stream of from 15 to 20 fluid ounc*h*es per hour, with a pressure of 18 to 24 inches. The lamp may be of the shape shewn in the drawings of my specification (No. 1258, 1856), the charcoals being introduced at the sides
4367 and the jet of mercury coming from the top and adjusted in
the manner shewn at figure 3, which is hereinafter described. Instead of pressing rods of charcoal or other conducting substances against each other, one such rod may be pressed against a piece of lime, phosphate of lime, or other comparatively infusible material, the flowing electrode being directed against the point of junction. In this case, when phosphate of lime is employed, it is prepared by precipitating phosphate of lime, moulding into a cylindrical form similar in size to the charcoal employed, and burning it. The cylinder of phosphate of lime is fixed in a suitable cup or boss of iron at the end of a rod or tube carried by the frame of the lamp.

A surface of charcoal or other conducting material forming one electrode may be presented at a constant distance from the orifice from which the flowing electrode issues by causing a cylinder or rod of such conductor, upon which the flowing electrode is thrown, to move forwards and on its axis, the required motion being given by suitable self-acting mechanism. For this purpose a rod or axis is mounted horizontally at the bottom of the lamp, and on this axis a cylinder of charcoal about 1½ to 2 inches in diameter is mounted, a hole being formed through the centre of the charcoal cylinder for the purpose. Motion is given to the axis by clock-work so that it may make about one-sixth of a revolution per minute, and on one end of the axis a screw is cut having about 10 threads to the
4368 inch, and this end of the axis passes through a fixed screw-
nut so that as the axis revolves it is constrained also to move forwards endwise; thus a fresh surface is constantly offered to the flowing electrode; or a rod of charcoal or other conducting material forming one of the electrodes may be projected by a spring or otherwise through a ring of iridium, so that as the end of the charcoal is consumed a fresh portion is pushed forwards in a similar manner to that in which the candle in Palmer's candle lamp is forced forwards as its end is consumed. Figure 3 is a vertical section of a lamp constructed in this manner. *a* is an iron tube communicating at its upper end with a reservoir of mercury and carrying at its lower end a jet of fire-clay, *b*, cemented into it. On the exterior of the tube *a* a screw-thread is cut, and it has on it the nut *c*, by turning which the jet at the end of the tube is raised and lowered to adjust the focus. *d* is an exterior tube, through which the tube *a* can slide freely. A cap, *e*, screws onto the upper end of the tube *d*, and by nipping the flange at the lower part of the nut *c* clamps the tube *a* and the tube *d* together. On the lower end of the tube *d* a ball, *f*, is formed, which fits into a socket formed at the upper part of the cap *g*, and it can be clamped in any position in this socket by screwing down the piece *h* upon it; thus facility is afforded for the horizontal adjustment of the position of the jet. *i* is

a glass cemented at its upper end into the cap *g* and at its lower end into the metal ring *j*, which screws onto
4369 the bottom *k*. Through the centre of this piece a hole is
drilled of sufficient size to receive the charcoal rod *l*, which is pressed constantly upward by the spiral spring *m*, contained in a metal tube screwed into the pieces *k*, and the upper end of the charcoal rod *l* is prevented from rising above its proper position by a cap of fire-clay, *m'*, carrying a ring of irid-um of smaller diameter than the charcoal rod. This ring of irid-um is shown separately at figures 4. It will be seen that it is furnished with four projections, which are embedded in the fire-clay of the cap *m'* before it is burnt. I would remark that it is not necessary that the irid-um ring should be formed in one piece of metal; a series of points of that metal embedded in the fire-clay cap and ranged in a circle round the central ap*p*erture and projecting inwards, so as to come in contact with the upper end of the charcoal, succeeds equally well. It is only necessary that the metal should abut*t* on the cylinder of charcoal at a sufficient number of points in a circle round its axis to retain it truly in its place. Figure 5 is a plan of a cap, *m'*, in which three only of such points are employed, and a cap formed in this manner I find to succeed well in practice. The mercury from the jet escapes by the pipe *n* and is received into a vessel, *o*. At the end of the metal tube containing the spiral spring is a screw-cap, *p*, by removing which access may be obtained to the spring. *q q* are strengthening wires passing from the ring *j* to the cap *g;* they are
4370 insulated from the cap *g* by passing through collars of ivory
r r.

When the lamp is in use the wires from the two poles of the battery are clamped to the apparatus at *s* and *t*, and the mercury jet is adjusted so that the stream of metal falls on the end of the charcoal rod *l* before or about the point where it breaks into drops.

Another part of my invention consists in heating the material forming the electrode before it is supplied to the jets. For this purpose I arrange, under the iron cistern from which the jet is supplied, a gas or other lamp, and I so regulate the lamp as to heat the mercury as much as possible without producing an injurious amount of evaporation.

Another part of my invention consists in adjusting the focal distance or breaking point of the flowing electrode by increasing or diminishing the pressure which causes it to issue from the jet. For this purpose I connect the cistern with a jet by means of jointed iron or flexible tubes, and in place of fixing the cistern in its position with respect to the lamp I suspend the cistern from a standard by means of a cord passing over a pulley at the upper part of the standard and descending to a barrel, on which the cord can be wound so as to lift the cistern to a greater or less height, and by so raising or lowering the cistern the breaking point of the jet can be adjusted. The bar'l can be fixed in any position by means of a click dropping into the teeth of a ratchet wheel fixed on the
4371 axis of the barrel.

Another part of my invention consists in a method of maintaining at a constant height above the jet the column of mercury or other flowing electrode. For this purpose, in conjunction with the open cistern from which the mercury flows, I employ a close cistern, from which the mercury is led by a pipe to the open cistern. This pipe dips slightly below the surface of the mercury in the open cistern. So soon, therefore, as the level of the mercury in the lower cistern is reduced the mercury will flow from the upper cistern, so that the pressure of mercury remains practically constant. This arrangement is shown at figure 6. A is the cistern, having well-ground stop-cocks at D and E. Mercury is introduced into the cistern C by the funnel F. The stop-cock D is then closed, and upon opening the stop-cock E mercury flows till the cistern A is filled up to the mouth of the tube. As the mercury in the cistern is drawn off through B it will be regularly replaced from the upper cistern. The cisterns may be of any convenient size, but the cistern C, with the pipe leading from it, cannot, of course, exceed 30 inches in height. It has been assumed in the present specification that the source of electricity employed in the mercurial light is a battery. Any arrangement by which current electricity is obtained, such, for instance, as a magneto-electric machine, is equally applicable to this form of light.

4372 In witness whereof I, the said John Thomas Way, have hereunto set my hand and seal this eighth day of May, in the year of our Lord one thousand eight hundred and fifty-eight.

J. THOMAS WAY. [L. S.]

Witness:

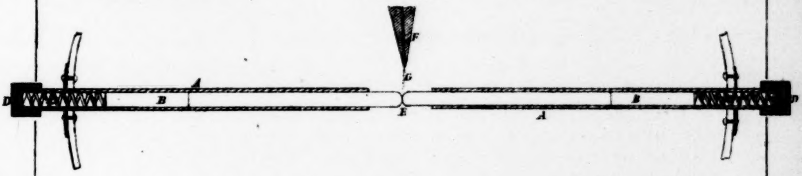
JNO. ALCOCK.

(Here follow diagrams marked pp. 4373, 4374, & 4375.)

A.D. 1857, Nov. 10. No. 2841.
WAY'S SPECIFICATION.

(2 SHEETS)
SHEET 1

FIG. 1.



No. 286.
C.E. Light Co.
v.
M.K. Light Co.
p. 4373

FIG. 2.

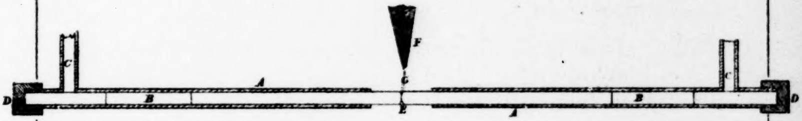
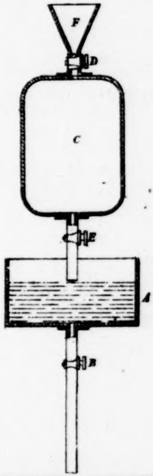

C
A
F
G
B
D
E
C
B
A
D

FIG. 6.



The filed drawing is partly colored.

LONDON: Printed by George Edward Eyre and William Spottiswoode,
Printers to the Queen's most Excellent Majesty. 1858.

A. D. 1857. Nov 10. No 2841.
WAY'S. SPECIFICATION.

(2 SHEETS)
SHEET 2.

No. 286.
C. G. Light Co.
v.
McK Light Co.
} p. 4374

FIG. 3.

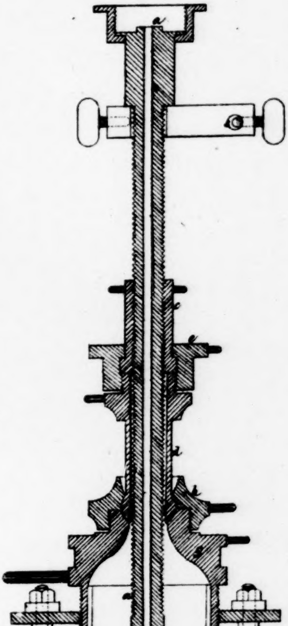

a
c
e
d
h
g
a
r
r
b
i
q
q
m
m

FIG. 4.

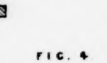
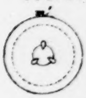
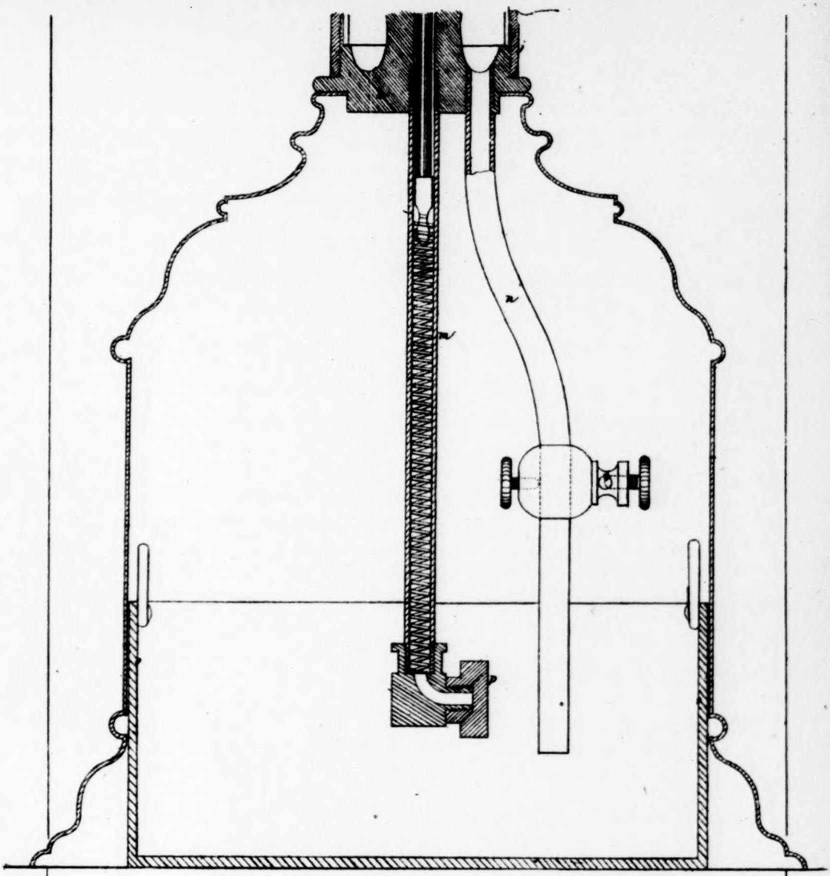


FIG. 5.





No. 286.
C.E. Light Co.
v.
MCK. Light Co.
p 4375

The filed drawing is partly colored.

London: Printed by George Edward Eyre and William Spottiswoode,
Printers to the Queen's most Excellent Majesty. 1858.

4376 DEF'T'S EX. KONN'S ENGLISH PATENT NO. 3809 OF 1872.
Mar. 13, '89. W. T. F., N. P. & S. E.

(Third edition.)

[British coat of arms.]

A. D. 1872, 16th December. No. 3809.

Specification of Stanislas Wikentjevitsch Konn.

Electric light.

London: Published and sold at the patent office sale branch, 38 Cursitor street, Chancery lane, E. C. 1886. Price, 8d.

4377 (Third edition.)

A. D. 1872, 16th December. No. 3809.

Electric Light.

Letters patent to Stanislas Wikentjevitsch Konn, of the firm of S. A. Kosloff and Company, of Great Winchester Street buildings, in the city of London, and of St. Petersburgh, in the Empire of Russia, for the invention of "improvements in the means and appliances for the production and maintaining of light by electricity." A communication from abroad by Alexandre Nicolaevitsch Ladiguine, of St. Petersburgh.

Sealed the 4th February, 1873, and dated the 16th December, 1872.

Provisional specification left by the said Stanislas Wikentjevitsch Konn at the office of the commissioners of patents with his petition on the 16th December, 1872.

I Stanislas Wikentjevitsch Konn of the firm of S. A. Kosloff and Company of Great Winchester Street buildings in the city of London and of St. Petersburgh in the Empire of Russia do hereby declare the nature of the said invention for "improvements in the means and appliances for the production and maintaining of light by electricity" to be as follows:—

Hitherto the ordinary manner of producing the electric light has been to bring the points of two bad conductors of electricity
4378 into proximity with each other when the intense heat produced by the chemical reaction caused by the contact of the electricity with the oxygen of the atmosphere brought about the ignition of the carbon and the production of an intense light.

This invention consists in a novel method of producing the electric light by taking advantage of the property possessed by the electric current of pumping so to speak the conductors whereby many of the disadvantages of the former method are avoided. The current instead of by a chemical reaction causing the ignition of the conductor points, merely carries a portion of the conductor to a red heat by the simple action of caloric.

One or more of the conductors which are preferably of graphite are enclosed in a species of lantern hermetically closed and filled with nitrogen or other gas that does not support combustion and are maintained therein by any convenient method of support. To produce the electric current an ordinary magneto-electric machine such as those of Wild Noble and others is employed and the current is led into the lantern by means of a wire to one of the graphite conductors (when the lantern contains more than one) and in passing through the conductor the electricity heats it to redness and causes it to give out a brilliant light. The current is then led to the second graphite conductor and passing through that producing a similar effect is led to a third and so on until all the conductors in the particular lamp have been illuminated when the current is led to those in the next lamp and so *on* to the end of the series which may consist of hundreds of conductors or lamps.

If it should be desired not to illuminate some of the lanterns of the series an arrangement is provided to each of them whereby this can be effected.

By this method of producing the electric illumination a continuous and steady lighting in one or more lamps is effected, a great economy is produced by the non-consumption of the conductor and a flame which is not injurious to the eyes is obtained.

4379 Specification in pursuance of the conditions of the letters patent filed by the said Stanislas Wikentjevitsch Konn in the Great Seal Patent Office on the 16th June, 1873.

To all to whom these presents shall come I, Stanislas Wikentjevitsch Konn, of the firm of S. A. Kosloff and Company, of Great Winchester Street buildings, in the city of London, and of Saint Petersburgh, in the Empire of Russia, send greeting:

Whereas her most excellent majesty Queen Victoria by her letters patent bearing date the sixteenth day of December in the year of our Lord one thousand eight hundred and seventy-two in the thirty-sixth year of her reign did for herself her heirs and successors give and grant unto me the said Stanislas Wikentjevitsch Konn her special licence that I the said Stanislas Wikentjevitsch Konn my executors administrators and assigns or such others as I the said Stanislas Wikentjevitsch Konn my executors administrators and assigns should at any time agree with and no others from time to time and at all times thereafter during the term therein expressed should and lawfully might make, use, exercise, and vend, within the United Kingdom, of Great Britain and Ireland, the Channel islands, and Isle of Man, an invention for "improvements in the means and appliances for the production and maintaining of light by electricity," communicated to me from abroad by Alexandre Nicolaevitsch Ladiguine of Saint Petersburgh upon the condition (amongst others) that I the said Stanislas Wikentjevitsch Konn my executors or administrators by an instrument in writing under my, or their, or one of their hands and seals, should particularly describe and ascertain the nature of the said invention and in what manner the same was to be performed and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said letters patent.

Now know ye that I the said Stanislas Wikentjevitsch Konn do hereby declare the nature of my said invention, and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement thereof reference being had to the drawings hereunto annexed that is to say.

Hitherto the ordinary manner of producing the electric light has
been to bring the points of two bad conductors of electrcity
4380 into proximity with each other when the intense heat produced by the chemical reaction caused by the contact of the electricity with the oxygen of the atmosphere brought about the ignition of the carbon and the production of intense light.

This invention consists in a novel method of producing the electric light by taking advantage of the property possessed by the electric current of pumping so to speak the conductors whereby many of the disadvantages of the former method are avoided. The current instead of by a chemical reaction causing the ignition of the conductor points merely carries a portion of the conductor to a red heat by the simple action of caloric.

One or more conductors which are preferably graphite are enclosed in a species of lantern hermetically closed and filled with nitrogen or other gas that does not support combustion and are maintained therein by any convenient method of support. To produce the electric current an ordinary magneto-electric machine such as those of Wild Noble and others is employed and the current is led into the lantern by means of a wire to one of the graphite conductors (when the lantern contains more than one), and in passing through the conductor the electricity heats it to redness and causes it to give out a brilliant light. The current is then led to the second graphite conductor, and passing through that producing a similar effect is led to a third and so on until all the conductors in the particular lamp have been illuminated when the current is led to those in the next lamp and so on to the end of the series which may consist of hundreds of conductors or lamps.

If it should be desired not to illuminate some of the lanterns of the series an arrangement is provided to each of them whereby this can be effected.

By this method of producing the electric light a continuous and steady illumination in one or any number of lamps is effected a great economy is produced by the non-consumption of the conductor, and a flame which is not injurious to the eyes is obtained.

The invention will be understood by reference to the accompanying drawings, and by the following detailed description thereof.

Figures 1 and 2 are views of a lantern, with respectively one and
two of the carbon stems arranged in the interior. Figure 3 is
4381 an outside view of the lantern with two stems, figure 4 is a
plan view of the same, figure 5 is a plan view taken through

the line A, B, of figure 2, figure 6 is a plan view taken through the line C D of figure 1, while figure 7 is a separate view of the carbon stem which I prefer to use for these sorts of lanterns. The stem is composed of graphite or a composition of the usual description compressed or formed with a reduced diameter at or near its central part as at *b* the ends *c c* being of larger diameter and clipped or held in socket frames *d d* which pass through the lantern ends *e e* and are connected to the circuit wires from the magnets or from the battery. Any number of the carbon stems can be employed in the same lantern and the current of electricity may be made to pass from one stem to another until the whole or any two or more of them are charged for lighting as desired. The lanterns are composed of the two ends *e e* the lips of which receive the glass *f* of the required shape and in such a manner that the whole can be hermetically closed for preventing electrical contact with the atmosphere, which is essential for the purposes of practically carrying the invention in effect and in order to fulfil this object more completely the lanterns are charged with nitrogen or other gas which does not support combustion.

In some cases I connect the two wires or frames of neighbouring stems by a claw attachment *g* (figures 2 and 3) which is free to be turned on its pin or stud *h* for its claw to engage over or upon the pin or stud *i* of the other and I establish the continuity of the electric current from one frame to the next by that means.

In other cases if desirable I fit a metallic strip or wire *k* to the two ends of the lanterns as in figure 1 to put the two ends in connection.

To ensure the passage of the electric current in the proper direction I insulate the lantern ends by means of glass or other non-conductable body arranged upon the socket frames so as to close the openings through which the stems are inserted as will be understood.

Figure 8 is a section, and figure 9 a plan view with the top cap removed of another form of lamp or lantern. In this lamp the carbon stem is V shaped, the electric current passing down one side and up the other side of the V the light being formed at the angle at the bottom. This stem is suitably supported and enclosed
4382 in a glass lamp or case filled with nitrogen or gas incapable
of supporting combustion as before and the current of electricity is applied as in the first instance or in any convenient manner.

And having now described the nature of the said invention and in what manner the same is to be performed I declare that I claim,—

Firstly, the production of light by electricity from carbon stems enclosed in a case charged with a non-supporter of combustion and hermetically closed substantially in the manner hereinbefore described.

Secondly, the apparatus shewn in figures 1 to 7 of the accompanying drawings in which light is produced by electricity from carbon stems hermetically closed in a vessel charged with a non-supporter of combustion as described and

Thirdly I claim the modified arrangement of carbon stem described and shown with reference to figures 8 and 9 of the accompanying drawings.

In witness whereof I the said Stanislas Wikentjevitsch Konn, have hereunto set my hand and seal this fifth day of June one thousand eight hundred and seventy-three.

STANISLAS WIKENTJEVITSCH KONN. [L. S.]

London: Printed by Eyre and Spottiswoode, printers to the Queen's most excellent majesty. For her majesty's stationery office.
(26665.—50.—3 | 86.)

(Here follows diagram marked p. 4383.)

4384 DEF'T'S EXHIBIT KONN'S ENGLISH PATENT NO. 91 OF 1873.
Mar. 31, '89. W. T. F., S. E.

A. D. 1873, 8th January. No. 91.

Producing Heat by Electricity.

Letters patent to Stanislas Wikentjevitch Konn, of the firm of S. A. Kosloff and Company, of Great Winchester Street buildings, and of St. Petersburgh, in the Empire of Russia, for the invention of "improvements in producing heat by electricity." A communication from abroad by Alexandre Nicolaevitch Ladighin, of St. Petersburgh, in the Empire of Russia.

Sealed the 25th February, 1873, and dated the 8th January, 1873.

Provisional specification left by the said Stanislas Wikentjevitch Konn at the office of the commissioners of patents with his petition on the 8th January, 1873.

I, Stanislas Wikentjevitch Konn, of the firm of S. A. Kosloff and Company, of Great Winchester Street buildings, and of St. Petersburgh, in the Empire of Russia, do hereby declare the nature of the said invention for "improvements in producing heat by electricity" to be as follows:

This invention relates to the production of heat by electricity by the employment of solid stems of carbon within hermetically closed vessels in which azotic or other gas is present.

The stems of carbon are of varied diameters in their length,
4385 and the heat is thrown off from them at their smaller parts,
preferably at about their centres, the contact or circuit being established between them by claws or pins, the removal of which breaks the contact when desired. The electric current is produced by an electro-magnetic apparatus such as that known as Wild's or Noble's, and the heat is maintained so long as the current is kept up. The azotic gas employed is of such a nature when hermetically enclosed in a vessel that the carbon stems are not decomposed

by it. Consequently they do not burn away, as is known to be the case where two carbon points have been used for the purpose.

Several apparatus can be enclosed in an outer casing into which atmospheric air can be forced and which after being heated to the desired degree can be spread or distributed into apartments, factories, or into ovens, drying sheds, or places in which the heat is required.

Specification in pursuance of the conditions of the letters patent filed by the said Stanislas Wikentjevitch Konn in the Great Seal Patent Office on the 8th July, 1873.

To all to whom these presents shall come I, Stanislas Wikentjevitch Konn, of the firm of S. A. Kosloff and Company, of Great Winchester Street buildings, and of Saint Petersburgh, in the Empire of Russia, send greeting:

4386 Whereas her most excellent majesty Queen Victoria, by her letters patent bearing date the eighth day of January, in the year of our Lord one thousand eight hundred and seventy-three, in the thirty-sixth year of her reign, did, for herself, her heirs and successors, give and grant unto me, the said Stanislas Wikentjevitch Konn, her special license that I, the said Stanislas Wikentjevitch Konn, my executors, administrators, and assigns, or such others as I, the said Stanislas Wikentjevitch Konn, my executors, administrators, and assigns, should at any time agree with and no others, from time to time and at all times thereafter during the term therein expressed should and lawfully might make, use, exercise, and vend within the United Kingdom of Great Britain and Ireland, the Channel islands, and Isle of Man an invention for "improvements in producing heat by electricity," communicated to me from abroad by Alexandre Nicolaievitch Ladighin, of Saint Petersburgh, in the Empire of Russia, upon the condition (amongst others) that I, the said Stanislas Wikentjevitch Konn, my executors or administrators, by an instrument in writing under my or their or one of their hands and seals, should particularly describe and ascertain the nature of the said invention and in what manner the same was to be performed and cause the same to be filed in the Great Seal
4387 Patent Office within six calendar months next and immediately after the date of the said letters patent:

Now know ye that I, the said Stanislas Wikentjevitch Konn, do hereby declare the nature of my said invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement thereof, reference being had to the drawings hereunto annexed, that is to say—

This invention relates to the production of heat by electricity by the employment of solid stems of carbon within hermetically closed vessels, charged with azotic or other gas, which does not support combustion.

The stems of carbon may be of varied diameters in their length, and the heat is thrown off from them, preferably, at about their centres, the contact or circuit being established between them by claws on pins, the removal of which breaks the contact when desired. The electric current is produced by an electro-magnetic apparatus, those known as Wilde's or Noble's being preferred, and the heat is maintained so long as the current is kept up. The azotic gas hermetically enclosed in the vessel in which the carbon stems are prevents their decomposition, and consequently they do not burn away, as is the case where two carbon points in contact with the atmosphere have been used for production of light.

4388 Several apparatus can be enclosed in an outer casing, into which atmospheric air can be forced and which after being heated to the desired degree can be spread or distributed into apartments, factories, or into ovens, drying sheds, or places in which the heat is required or into boilers for heating the water direct.

The invention will be well understood on reference to the accompanying drawings, in which figure 1 is a section of a carbon steam enclosed in its case.

Figure 2 is a plan view of a vessel or box, in which are placed several stems or apparatus in electrical connection with one another, while figure 3 is a side view of the same, showing a portion of the case removed.

The carbon stem *a* of smaller diameter in its middle is fixed firmly in the metal case *b* in any convenient manner, the case being filled with azotic gas (nitrogen) or other gas which does not support combustion and hermetically closed. Several of the carbon stems and their cases are enclosed in a metal vessel or box, *d*, and the electrical circuit is established between them by the claws *e*, which turn freely upon pins *f*, so that the circuit can be interrupted when desired. The electricity is led into the box or case by means of the first claw *f′*, to which is attached the wire from the battery or magneto machine. At each side of the vessel *d* is a cylin-
4389 drical aperture, *g h*, the one *g* for the entry of air and the other *h* for its exit. On the electric current being caused to pass continuously from the battery into the claw *f′* and thence successively through all the carbon stems, the latter, becoming incandescent or red hot, develop an enormous heat, so that the air entering through the aperture *g*, after circulating among all the cases *b*, becomes warmed and, proceeding out through the aperture *h*, is led away to any place where it may be required. In consequence of the carbon stems being surrounded by a non-supporter of combustion it is impossible for them to consume, however long or however often may be the passage of the electric fluid through them and their consequent incandescence.

Figures 4 and 5 show the invention as applied to the heating of water in steam boilers, being respectively a longitudinal and transverse section of a steam boiler with the invention applied to it. In this case a tube or tubes, *i*, is fitted in the boiler above the water level, and along its whole length from these tubes *i* proceed other tubes *j* into the boiler, to the ends of which the cases *b*, hermetically closed and containing the carbon stems surrounded by a gas which does not support combustion, are suspended. The wire from the electric battery is led into this tube *i* and down each of the tubes *j* to the carbon stems and up again to the next carbon stem, so 4390 that upon the current being sent continuously it passes through all the stems and keeps them in a state of incandescence, and by the intense heat developed the water in the boiler is rapidly raised to the boiling point.

In figure 5 the method in which it is preferred to support the tubes *i* is shown. To the top of the boiler is secured an arm, *k*, which ends in each side in a semicircular holding clip and cap with flanges at the side through which bolt-holes are made, and the tube *i* being passed between the semicircular clip and cap, they are then bolted together and thus the tube *i* is firmly held.

Figure 6 is a transverse section of a boiler showing another form of case containing the carbon stem.

Figures 7 and 8 show a section and plan view — a heating apparatus in which the carbon stem is of V shape. In this case the electric current passes down one side of the V and up the other, and in other respects the apparatus is precisely similar to those already explained; it is evident that stems of other shapes may be used.

Having now described the nature of the said invention and in what manner the same is to be performed, I declare that I claim:

Firstly. The production of heat by electricity by means of single solid carbon stems enclosed in a vessel charged with a non-4391 supporter of combustion and hermetically closed, substantially as described and shown.

Secondly. The arrangement of apparatus, shown in figures 1, 2, and 3 of the drawings, whereby air is heated, substantially as described and shown.

Thirdly. The arrangements of apparatus, shown in figures 4, 5, and 6, for heating the water on steam boilers, substantially as described and shown.

And lastly. I claim heating liquids by electrical heaters immerced or submerged therein, substantially as described.

In witness whereof I, the said Stanislas Wikentjevitch Konn, have hereunto set my hand and seal this fourth day of July, one thousand eight hundred and seventy-three.

S. W. KONN. [L. S.]

(Here follow diagrams marked pp. 4392 and 4393.)

FIG. 1.

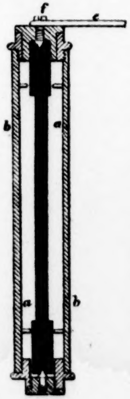


FIG. 2.

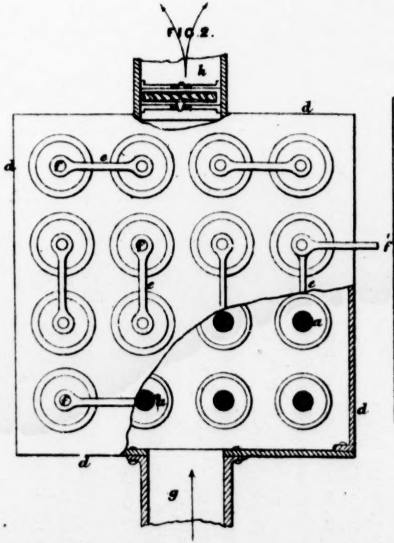

h
d
d
e
f
f'
e
e
a
a
d
d
g

FIG. 3.

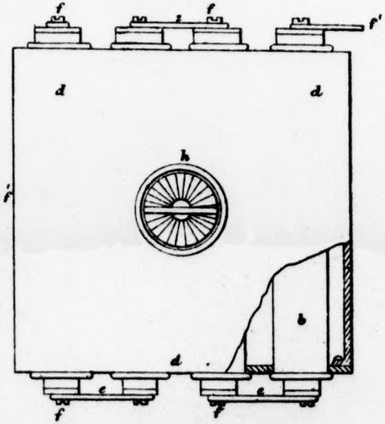
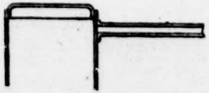
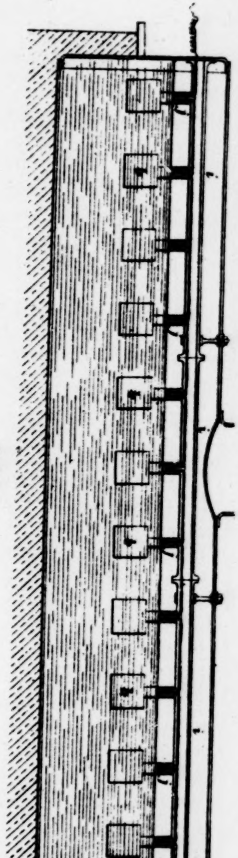

f
i
f
f'
d
d
h
b
d
c
c
f
f

FIG. 4.



No. 286
C.E. Light Co.
v.
W.C.K. Light Co.
} p. 4392



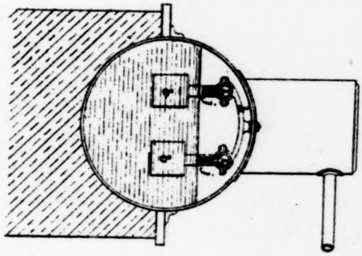


FIG. 5.

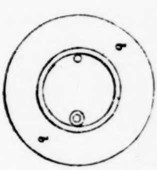


FIG. 8.

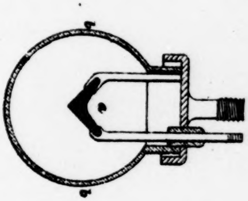


FIG. 7.

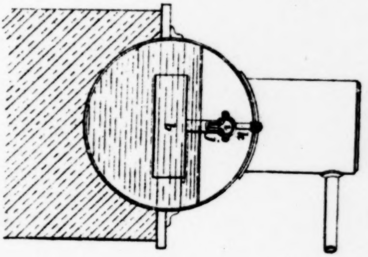


FIG. 6.

No. 286.
C.E. Light Co } p4393
McK. Light Co

4394 DEF'T'S EXHIBIT KOSLOFF'S ENGLISH PATENT NO. 441 OF 1875. W. T. F., S. E.

A. D. 1875, 5th February. No. 441.

Production of Electric Light.

Letters patent to Stephen Alexandrovitch Kosloff, of St. Petersburg, in the Empire of Russia, but at present of the city of London, for the invention of "improvements in the production of electric light and in apparatus therefor."

Sealed the 2nd April, 1875, and dated the 5th February, 1875.

Provisional specification left by the said Stephen Alexandrovitch Kosloff at the office of the commissioner of patents with his petition on the 5th February, 1875.

I, Stephen Alexandrovitch Kosloff, of St. Petersburg, in the Empire of Russia, but at present of the city of London, do hereby declare the nature of the said invention for "improvements in the production of electric light and in apparatus therefor" to be as follows:

These improvements consist essentially in the subdivision of the electric light which is produced by means of an electric current heating to a white heat sticks of carbon placed in the circuit and being hermetically enclosed in a globe filled with nitrogen gas, all as hereinafter set forth.

1st. The unequal expansion by heat of different substances
4395 employed in electric light apparatus has not been hitherto
sufficiently considered by other inventors. They therefore placed their carbons on metal conductors which served as supports and fix- them firmly thereto, either by pinchers or by being screwed to the same or by other means. This way of joining together two different substances subject to different temperatures produced the breakage of the carbon, the latter not expanding in the same ratio as the metal, or because, the expansion of the metal being greater than that of the carbon, the metal in heating detaches itself gradually from the carbon and produced electric sparks. In my system the carbon is placed between two insulating supports, either of china, clay, crystal, calcined magnesia, or other insulating substances, the carbon fitting in and being allowed to move a little in the hollow of the said supports.

2d. Every metal which is outwardly attached, screwed, or fixed in any other way to the carbon detaches itself in heating and produces electric sparks and consequently the melting of the metal. In my system I introduce the metal wires into the carbon, which gives me a better contact when the carbon is heated by the current and does not produce electric sparks; but in order not to put the
metal into direct contact with the white-hot carbon, thicker
4396 end pieces of carbon with holes crosswise (that is to say,
through the length and the thickness) serve as communi-

cators of the electric current, and these thicker pieces of carbon, not being such bad conductors as the thinner sticks of carbon which are destined to give the light and fit into the thicker pieces of carbon, heat to a lesser degree the metal introduced into them.

3rd. The connection of the principal conductors with the metallic —, which are introduced into the thick end pieces of carbon, I effect by means of hinges or fastenings of fine twisted metallic wire, leaving a little space to move about in case of dilatation, and resting thereon with their own weight. I thus obtain a sufficient contact without producing electric sparks. My connections cannot increase the loss of electric current, because the heat produced by an electric current passing through two pieces of metal not firmly attached to each other, but closely touching each other, is much smaller than the heat caused to my connections by the contact with a white-hot body in a high temperature.

4th. In order to avoid the inconvenience of the preparation of nitrogen gas and its introduction into the lamp after the air has been withdrawn from it, I, according to my invention, produce the gas by rar*i*fying the air in the globe in which the apparatus
4397 is placed by means of the carbon itself, which is heated by
the electric current, and which at the same time is to give me the light. By dilating the air, which could not occupy the same space in the globe, it is caused to escape out of the globe through a valve or valves, and then cannot re-enter the globe. The small quantity of oxygen remaining in the rar*i*fied air in the globe is transformed into oxide of carbon. In order to have as little air as possible in my lamps I fill the superfluous space in the globe with massive pieces or pieces in the shape of tubes closed at one end of china, clay, calcined magnesia, crystal, or any other insulating substance, with a hollow through their whole length for their metallic conductors or even with carbons, with insulators, instead of employing metallic conductors. I also make use of these massive pieces as supports for the carbon bearers of the sticks of carbon which are destined to give the light. If I make the said filling pieces as insulated pieces of carbon, carbon connections may be employed for connecting with the thin carbon sticks. The globe and the said massive pieces must be of sufficient length, according to the strength of the light which it is intended to produce, in order that the valve or valves may not be exposed to too great a heat and
4398 in order that by employing a hydraulic joint or closing of
any liquid which, being exposed to a certain heat, does not produce vapors which would consume the carbon. I altogether avoid mercury as being dangerous to the health. The said massive pieces may also be of metal, but in that case I introduce insulators in order that the currents may meet in the sticks of carbon.

5th. When I have not at my disposal a stronger electric source to enable me to light thicker sticks of carbon, then I place several thin sticks of carbon in the same lamp, and I light them successively the one after the other, and in order to cause the electric current to pass automatically from one carbon to another I employ the following system: I introduce the metallic wires which traverse

the thick pieces of carbon, not at the same height, but gradually a little lower than in the preceding piece of carbon. In case of breakage of one of the lighted carbons the thick piece of carbon, being fastened on one side only, will incline through its weight toward the wire extending in the shape of a ring from the second carbon, and, having a wire in the form of a hook or a plate, place itself into the ring of the second carbon. The current being interrupted in the first carbon is communicated to the second carbon, and
4399 from the second to the third, and so forth.

In lamps with several carbons the insulators between which the thick pieces of carbon repose are of a round shape, with a small opening to allow guards to be placed into them, which prevent the thicker pieces of carbon from descending lower than they ought. After having *out* the carbon into its place the opening is shut up by means of a bolt or hook.

In lamps with several carbons one pole is in communication with one end of all the carbons, while the other pole is put into communication with all the carbons which are to be lighted first—that is to say, with the carbons where the aforesaid metallic wire is highest.

If I do not want to make use of the automatic mechanism in the lamps with several carbons I employ a commutator, where one pole is in communication with the one end of all the carbons, whilst the other pole may be put into connection with each series of carbons in the different lamps having separate conductors.

The system of placing the lamps into the circuit may be effected in two ways, namely, either by placing one series of lamps united by a metallic wire in such a way that the current traverses
4400 all the carbons, the conductor of one pole being in communication with the first lamp and the conductor of the other pole in communication with the last lamp, or by subdividing the current—that is to say, the current of one pole is subdivided from one point and conducts the current by separate conductors to each lamp. The current of the other pole, subdivided in the same way, meets the current of the first pole in each lamp.

Specification filed in pursuance of the conditions of the letters patent and of an order of the lord chancellor by the said Stephen Alexandrovitch Kosloff in the Great Seal Patent Office on the 26th August, 1875.

To all to whom these presents shall come I, Stephen Alexandrovitch Kosloff, of St. Petersburg, in the Empire of Russia, but at present of the city of London, send greeting:

Whereas her most excellent majesty Queen Victoria, by her letters patent bearing date the fifth day of February, in the year of our Lord one thousand eight hundred and seventy-five, in the thirty-eighth year of her reign, did, for herself, her heirs and successors, give and grant unto me, the said Stephen Alexandrovitch Kosloff, her special license that I, the said Stephen Alexandrovitch Kosloff,

my executors, administrators, and assigns, or such others as
4401 I, the said Stephen Alexandrovitch Kosloff, my executors, administrators, and assigns, should at any time agree with, and no others, from time to time and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend within the United Kindom of Great Britain and Ireland, the Lamel islands, the Isle of Man an invention for "improvements in the production of electric light and in apparatus therefor," upon the condition (amongst others) that I, the said Stephen Alexandrovitch Kosloff, my executors or administrators, by an instrument in writing under my or their or one of their hands and seals, should particularly describe and ascertain the nature of the said invention and in what manner the same was to be performed and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said letters patent:

Now, know ye that I, the said Stephen Alexandrovitch Kosloff, do hereby declare the nature of my said invention and in what manner the samé is to be performed to be particularly described and ascertained in and by the following statement, reference being had to the accompanying drawings and to the letters of reference marked thereon—that is to say:

4402 These improvements consist essentially in the subdivision of the electric light, which is produced by means of an electric current heating to a white heat sticks of carbon placed in the circuit and being hermetically enclosed in a globe filled with nitrogen gas, all as hereinafter set forth.

First. The unequal expansion by heat of different substances employed in electric light apparatus has not been hitherto sufficiently considered by other inventors. They therefore place- their carbons on metal conductors, which serve as supports, and fixed them firmly thereto either by pinchers or by being screwed to the same or by other means. This way of joining together two different substances subject to different temperatures produced the breakage of the carbon, the latter not expanding in the same ratio as the metal, or because the expansion of the metal being greater than that of the carbon the metal in heating detached itself gradually from the carbon and produced electric sparks. In my system, as illustrated upon the appended sheet of drawings at figure 1, the carbon A and B are placed between two insulating supports C D, either of china, clay, crystal, calcined magnesia, or other insulating substances, the carbons *a* fitting in and being allowed to move a little in the hollow of the said supports C D.

4403 Second. Every metal which is outwardly attached, screwed, or fixed in any other way to the carbon detaches itself in heating and produces electric sparks, and consequently the melting of the metal. In my system I introduce the metal wires E E′ (see figure 2) into the carbon A, which gives me a better contact when the carbon is heated by the current and does not produce electric sparks. In order not to put the metal into direct contact with the white-hot carbon I employ the thicker end pieces A of carbon with holes crosswise, which serve as communicators of the electric current to the smaller carbon sticks B, and these thicker pieces of carbon A not being such bad conductors as the thinner sticks of carbon B, which are destined to give the light and which fit into the thicker pieces of carbon A, heat to a lesser degree the metal introduced into them. These insulators C D are secured to a screwed support or standard F by means of the nuts G G′ and H, the whole being placed upon a seat I.

Third. The connection of the principal conductors with the metallic wires E E′, which are introduced into the thick end pieces of carbon, is illustrated at figure 3, and consists of hinges or fastenings J J′ of fine twisted metallic wires, which are placed upon the metallic conductors K K′ from the different poles and held there at
the required height by nuts M, their other ends being
4404 placed upon the wires E E′, nuts N preventing them from
coming off, but leaving a little space to move about in case of dilatation, the hinges resting on the wires with their own weight. I thus obtain a sufficient contact without producing electric sparks. My connections cannot increase the loss of electric current, because the heat produced by an electric current passing through two pieces of metal not firmly attached to each other, but closely touching each other, is much smaller than the heat caused by any connections by the contact with a white-hot body in a high temperature.

Fourth. In order to avoid the inconvenience of the preparation of nitrogen gas and its introduction into the lamp after the air has been withdrawn from it according to my invention I produce the gas by rar*i*fying the air in the globe in which the apparatus is placed by means of the carbon itself, which is heated by the electric current and which at the same time is to give the light. This part of my invention is shown at figure 4. By dilating the air, which could not occupy the same space in the globe O, it is caused to escape out of the globe O through a valve or valves, P, so arranged as to admit of the passage of air out of, but not into, the globe O. The small quantity of oxygen remaining in the rar*i*fied air in the
globe is transformed into oxide of carbon. In order to have
4405 as little air as possible in my lamp I fill the superfluous space
in the globe with massive pieces Q or pieces in the shape of tubes, closed at one end, of china clay, calcined magnesia, crystal, or any other insulating substance, with a hollow through their whole length for their metallic conductors or even with carbon with insulators instead of employing metallic conductors. I also make use of these massive pieces as supports for the carbon bearers of the sticks of carbon which are destined to give the light. If I make the said filling pieces as insulated pieces of carbon, carbon connections may be employed for connecting with the thin carbon sticks. The globe O and the said massive pieces Q must be of sufficient length, according to the strength of the light which it is intended to produce, in order that the valve or valves P may not be exposed to too great a heat and in order to avoid vaporization when I employ a hydraulic seal joint or closing of any liquid which being exposed to a certain heat does not produce vapors which would con-

sume the carbon. I altogether avoid mercury as being dangerous to the health. The said massive piece or pieces Q may also be of metal, but in that case I introduce insulators in order that the current may meet in the sticks of the carbon. The lower part of the globe O is situated in a reservoir, R. A lid, S, is provided, and springs T attached thereto hold the globe in position; *u u′* 4406 are conductors in the form of an incrusted metallic piece, and are put in communication with external conductors by means of metallic buttons V.

Figure 5 shows an arrangement which I employ when I have not at my disposal a sufficiently strong electric source to enable me to light thicker sticks of carbon; then I place several thin sticks of carbon into the same lamp, and I light them successively the one after the other, and in order to cause the electric current to pass automatically from one carbon to another I employ the following system: I introduce the metallic wires E E′, which traverse the stick pieces of carbon A, not at the same height, but gradually a little lower than in the preceding piece of carbon. In case of breakage of one of the lighted carbons B, the thick piece of carbon A, being fastened on one side only, will incline through its own weight towards the wire E^2 (extending in the shape of a ring from the second carbon), and having a wire in the form of a hook or a plate and place itself into the ring of the second carbon. The current, being interrupted in the first carbon, is communicated to the second carbon, and from the second to the third, and so forth.

In lamps with several carbons the insulators between which the thick pieces of carbon repose are of a round shape, with a small opening to allow guards to be placed into them, which prevent the thicker pieces of carbon from descending lower than they ought.

After having put the carbon into its place the opening is shut
4407 up by means of a bolt or hook.

In lamps with several carbons one pole is in communication with one end of all the carbons, whilst the other pole is put into communication with all the carbons which are to be lighted first—that is to say, with the carbons where the aforesaid metallic wire is highest.

If I do not want to make use of the automatic mechanism in the lamps with several carbons, as described with reference to figure 5, I employ a commutator where one pole is in communication with the one end of all the carbons, whilst the other pole may be put into connection with each series of carbons in the different lamps, having separate conductors.

The system of placing the lamp into the circuit may be effected in two ways, namely, either by placing one series of lamps united by a metallic wire in such a way that the current traverses all the carbons, the conductor of one pole being in communication with the first lamp and the conductor of the other pole in communication with the last lamp, or by subdividing the current—that is to say, the current of one pole is subdivided from one point and conducts the current by separate conductors to each lamp. The current of the other pole subdivided in the same way meets the current of the first pole in each lamp.

Having now described my said invention and the mode in
4408 which it may be carried out, I would observe, in conclusion, that I claim as the invention secured to me by the foregoing specification of letters patent—

First. Placing the carbons which are to be lighted on insulators in order that the metallic conductors of the electric current may not be used as supports, and to allow the said carbons a little space to move about in the hollow of the insulators, as hereinbefore described.

Second. Effecting the contact of the carbons with the metal by introducing the metal wire into the carbon and not by fixing or attaching the same outwardly to the carbon.

Third. Connecting the principal conductors with the wire introduced into the thick end of the carbon, and which are exposed to the heat in the lamp by hinges or fastenings of metal, which leave them a little space to move about, substantially as hereinbefore described.

Fourth. Producing nitrogen gas by rarifying the air in the globe by means of the lighted carbons by the electric current and transforming the remainder of oxygen into oxide of carbon by employing an hydraulic closing and valves through which the heated air would escape and which would not al-ow the outward air to introduce itself again into the lamp, all substantially as hereinbefore set forth.

Fifth. Introducing massive pieces or pieces in the shape of tubes closed at one end into the globe in order to retain a certain
4409 length of the globe indispensable for the closing and which at the same time afford the means of having the least possible air in the globe, substantially as set forth.

Sixth. The employment of an automatic mechanism for the passage of the electric current from the one carbon to the other in case of accident or breakage of one of the carbons in the lamp, substantially as hereinbefore described and shown.

In witness whereof I, the said Stephen Alexandrovitch Kosloff, have hereunto set my hand and seal this 13th day of August, in the year of our Lord one thousand eight hundred and seventy-five.

STEPHAN ALEXANDROVITCH KOSLOFF. [L. S.]

Signed by the within-named Stephan Alexandrovitch Kosloff, in my presence, this 1–13 day of August, 1875.

FRED'K LESLIE,
British Vice-consul.

[CONSULATE SEAL.]

4410 DEF'T'S EX. JENSEN (KONN'S) ENGLISH PATENT NO. 970 OF 1875. Mar. 13, '89. W. T. F., N. P. & S. E.

(Second edition.)

[British coat of arms.]

A. D. 1875, 16th March. No. 970.

Specification of Peter Jensen.

Electric light apparatus.

London: Published and sold at the patent office sale branch, 38 Cursitor street, Chancery lane, E. C. 1886. Price, 8d.

4411 (Second edition.)

A. D. 1875, 16th March. No. 970.

Electric Light Apparatus.

Letters patent to Peter Jensen, of Chancery lane, London, for the invention of "improvements in the construction of electric light apparatus." A communication from abroad by Stanislas Vikentievitch Konn, of St. Petersburg, in the Empire of Russia.

Dated the 16th March, 1875.

Provisional specification left by the said Peter Jensen at the office of the commissioners of patents with his petition on the 16th March, 1875.

I Peter Jensen of Chancery lane London do hereby declare the nature of the said invention for "improvements in the construction of electric light apparatus" (a communication to me from abroad by Stanislas Vikentievitch Konn of St. Petersburg in the Empire of Russia) to be as follows:

Onto a metallic base piece a metallic socket is screwed air-tight; the socket has a stuffing box with vulcanized India-rubber
4412 packing and with a gland, which receives an upright glass cylinder closed at the top. Inside this glass cylinder there are two upright copper conductors covered with glass tubing; one of these conductors is movable up and down in a metallic socket fastened to the aforesaid metallic base piece; the other conductor passes air-tight through the base piece which here is fitted above and below with a gland having an insulated horngum lining, the space between the two glands being filled with unvulcanized India-rubber washers. Under the aforesaid base piece there is a closed hollow metallic chamber, in which copper conducting connection is made between the bottom of the last named conductor, and an insulated binding screw in connection with the positive pole of an electric current, at its top this conductor is fastened to the bottom plate of the electric light apparatus proper, while the top plate of

the same is fastened to the top of the first named conductor. The electric light apparatus proper consists of say two rows of platina or silver studs resting in recesses in the aforesaid bottom plate, and corresponding rows of platina or silver studs passing through porcelain ferrules in the aforesaid top plate, but the studs all project unequally through the top plate; the bottoms of the upper studs fit into carbon or graphite sockets, and the tops of the lower studs fit in other carbon or graphite sockets; between these upper and lower sockets carbon or graphite stems are inserted in recesses. A contact plate, made of silver or thickly silvered copper is jointed to the first named conductor and rests on the longest of the platina studs; should this carbon stem break, the contact plate drops onto the next longest, and so on. The broken stems falling down are kept from contact with the glass cylinder by a circular metallic shield placed inside the glass cylinder in the lower part of the same. If the last stem should break, the extinguishing of other lamps in connection with the same current is prevented by the falling of the contact piece onto a copper stopping stem which is fastened by a set screw to the bottom plate and passes through a porcelain ferrule in the top plate.

A small tap in connection with the interior of the glass cylinder serves for pumping out the air.

The positive pole current entering the base piece by a binding screw passes through the metallic socket up to the contact piece at
the top thence to the carbon stem in contact therewith which
4413 stem is thereby heated to a white heat; the current then
descends through the conductor connected to the negative
poles.

Should the glass cylinders break, the entering air will cause the rapid *combination* of the carbon stem.

Specification in pursuance of the conditions of the letters patent filed by the said Peter Jensen in the Great Seal Patent Office on the 16th September, 1875.

To all to whom these presents shall come I, Peter Jensen, of Chancery lane, London, send greeting:

Whereas her most excellent majesty Queen Victoria by her letters patent bearing date the sixteenth day of March in the year of our Lord one thousand eight hundred and seventy-five in the thirty-eighth year of her reign did for herself her heirs and successors give and grant unto me the said Peter Jensen her special licence that I the said Peter Jensen my executors administrators and assigns or such others as I the said Peter Jensen my executors, administrators and assigns should at any time agree with and no others from time to time and at all times thereafter during the term therein expressed should and lawfully might make, use, exercise, and vend within the United Kingdom of Great Britain and Ireland, the Channel islands, and Isle of Man, an invention for "improvements in the construction of electric light apparatus" (a communication to me from abroad by Stanislas Vikentievitch

Konn of St. Petersburg in the Empire of Russia) upon the condition (amongst others) that I the said Peter Jensen my executors, or administrators by an instrument in writing under my or their or one of their hands and seals should particularly describe and ascertain the nature of the said invention and in what manner the same was to be performed and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said letters patent.

Now know ye that I the said Peter Jensen do hereby declare the
nature of the said invention, and in what manner the same
4414 is to be performed to be particularly described and ascertained in and by the following statement, reference being had to the accompanying drawings and to the letters of reference marked thereon that is to say:—

These improvements will be best understood by reference to the accompanying drawings Fig. 1 and Fig. 2 which are vertical sections at right angles to one another of an electric lamp constructed according to this invention.

On to a metallic base piece *a* a metallic socket *b* is screwed air-tight; the socket *b* has a stuffing box with vulcanized India-rubber packing *d* and with a gland *c* which receives an upright glass cylinder *v* closed at the top. Inside this glass cylinder *v* there are two upright copper conductors *f* and f^1 covered with glass tubing; one of these conductors *f* is movable up and down in a metallic socket *g* fastened to the aforesaid metallic base piece *a* the other conductor f^1 passes air-tight through the base piece *a* which here is fitted above and below with a gland *h* having an insulating horngum lining, the space between the two glands being filled with unvulcanized India-rubber washers *i*. Under the base piece *a* there is a closed hollow metallic chamber above the base or sole plate *l* in which chamber a copper conductor f^{11} forms connection between the bottom of the conductor f^1 and an insulated binding screw *k* in connection with the negative pole of an electric current, at its top this conductor f^1 is fastened to the bottom plate *p* of the electric light apparatus proper, while the top plate of the same *q* is fastened to the top of the first named conductor *f*. The electric light apparatus proper consists of say two rows of platina or silver studs *o* resting in recesses in the aforesaid bottom plate *p* and corresponding rows of platina or silver studs *o* passing through porcelain ferrules in the aforesaid top plate *q* but the studs all project unequally through the top plate *q*; the bottoms of the upper studs *o* fit into carbon or graphite sockets *n* and the tops of the lower studs fit in other carbon or graphite sockets *n*; between these upper and lower sockets carbon or graphite stems *m* are inserted in recesses. A contact plate *r* made of silver or thickly silvered copper is jointed to the first named conductor *f* and rests on the longest of the platina studs *o*; should this carbon stem break, the contact plate *r* drops on to the next longest stud *o* and so on; the broken stems *m* falling down are kept from contact with the
glass cylinder *v* by a circular metallic shield *w* placed inside
4415 the glass cylinder *v* in the lower part of the same. If the last
stem should break, the extinguishing of other lamps in con-

nection with the same current is prevented by the falling of the contact piece *r* or to a copper stopping stem *t* which is fastened by a set screw *u* to the bottom plate *p* and passes through a porcelain ferrule in the top plate.

A small tap *x* in connection with the interior of the glass cylinder serves for pumping out the air.

The positive pole current entering the base piece *a* by a binding screw passes through the metallic socket up to the contact piece *t* at the top thence to the carbon stem *m* in contact therewith which stem is thereby heated to a white heat; the current then descends through the conductor f^1 and f^{11} connected to the negative pole.

Should the glass cylinders break the entering air will cause the rapid combustion of the carbon stem.

And having thus fully described and ascertained the nature of this invention I declare that I claim as the aforesaid improvements in the construction of electric light apparatus:—

Firstly: The mode of mounting the carbon stems substantially as set forth.

Secondly: The guard plate or shield *w* in combination with a closed glass cylinder or chamber *v*.

Thirdly: The contact piece *t* in combination with two or more studs *o* of unequal lengths and with the stopping stem *t*.

And fourthly: The general arrangement of parts substantially as set forth.

In witness whereof I the said Peter Jensen have hereunto set my hand and seal this fifteenth day of September in the year of our Lord one thousand eight hundred and seventy-five.

PETER JENSEN. [L. S.]

London: Printed by Eyre and Spottiswoode, printers to the Queen's most excellent majesty, for her majesty's stationery office.
(24521.—50.—3 | 86.)

(Here follows diagram marked p. 4416.)

4417 DEF'T'S EX. WERDERMANN ENGLISH PATENT NO. 4805 OF 1876. Mar. 13, '89. W. T. F., N. P. & S. E.

(Third edition.)

[British coat of arms.]

A. D. 1876, 12th December. No. 4805.

Specification of Richard Werdermann.

Electric lighting apparatus.

Printed by order of the commissioners of patents for inventions.

London: Published and sold at the commissioners of patents' sale department, 38 Cursitor street, Chancery lane, E. C. 1883. Price, 6d.

4418 (Third edition.)

A. D. 1876, 12th December. No. 4805.

Electric Lighting Apparatus.

Letters patent to Richard Werdermann, of Princes street, in the county of Surrey, civil engineer, for an invention of "improvements in electric lighting apparatus."

Provisional specification left by the said Richard Werdermann at the office of the commissioners of patents on the 12th December, 1876.

Richard Werdermann, of Princes street, in the county of Surrey, civil engineer. "Improvements in electric lighting apparatus."

My said invention relates to improvements in electric lamps, carbon electrodes for the same, and in other apparatus for the production of electric light.

The carbon electrodes or carbons to be used in connection with the said electric lamps are coated with any suitable material which will protect the same from contact with air and which is volatile when exposed to the intense heat of the voltaic arc—I use by preference calcined magnesia, sulphate of magnesia, borax, sulphate of lime and other substances or bodies which in burning emit a great amount of light.

The principal advantages of such coating of the carbons are the following namely. First. The flame produced by the burning of the carbons which diminishes considerably the intensity of the light by covering the same is reduced to a minimum. Second. By excluding the air from contact with the carbons the heating of the electrodes is partly p-evented. Third. The coating material which is volatilised as the carbons are consumed produces a greater amount of light and reduces the resistance of the circuit

A.D. 1876. Dec. 12. Nº 4805.
WERDERMANN'S SPECIFICATION.
(3rd Edition)

FIG. 5.

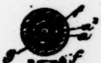


FIG. 5a.

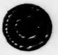


FIG. 4.

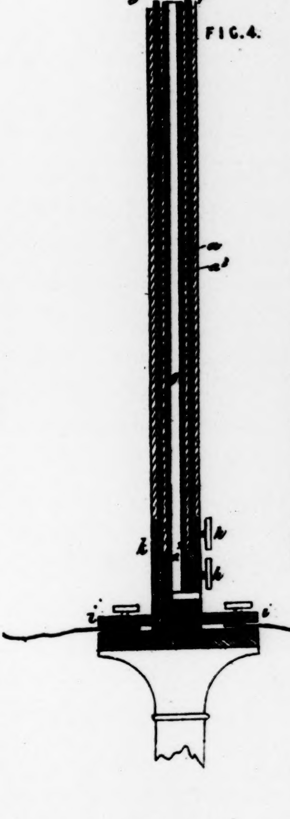


FIG. 2.

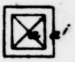


FIG. 1.

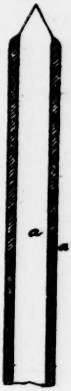


FIG. 6.

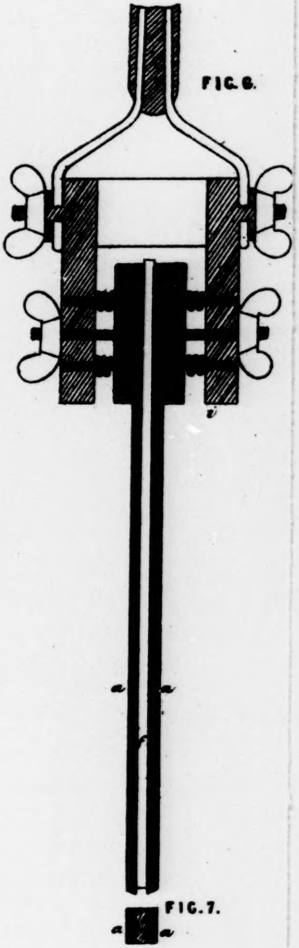


FIG. 7.

Lond

My invention relates partly to an electric lamp not designed to be used in connection with reflectors or holophotes

The carbon electrodes are supported in the required proximity to each other and are automatically adjusted in proportion to their combustion in the following manner that is to say. The carbon pieces are curved so as to form portions of a circle. One of these pieces is secured in a fixed arm or bar and the other is secured in an arm or beam pivoted to the said fixed bar. This pivoted 4419 arm is provided with a balance weight preferably containing sand or liquid which escapes and diminishes the weight, or with an arrangement of clockwork which regulates the action of the said arm or beam and always keeps the carbon points the proper distance apart—Or I may employ electro magnets or other suitable means for automatically regulating the distance of the carbon points from each other during their combustion.

Another part of my invention relates to carbon electrodes to be used without any lamps or regulator as follows, that is to say

Two concentric hollow cylinders of carbon are insulated from each other by any suitable insulating material which when exposed to the heat of the voltaic arc will be volatilized. The inner side of the inside carbon and the outer side of the outside carbon electrode are equally covered with the insulating material. A powerful current of air will pass through the hollow space as through a chimney and will accelerate the combustion of the carbon and of the insulating material. The said inner cylinder instead of being hollow may be solid The outer cylinder is about one inch shorter or longer than the inner one; both are fixed by screws in a holder consisting of two insulated metal cylinders which are connected with the two poles of the electric current generator.

Instead of using carbon cylinders rods of carbon of square, or oblong section may be placed parallel as set forth in the specification of my former letters patent, dated April 24th A. D. 1874 No 1438. It is advantageous to make the negative electrode only half as thick as the positive one, a very uniform consumption of the carbon being thereby obtained.

When the light is not required to illuminate in all directions but when it is desirable to obtain a very powerful point of light I place a rod of carbon in front of a plate of carbon parallel with and insulated from the same by mica or other suitable material.

(Here follows diagram marked p. 4420.)

4421 Specification in pursuance of the conditions of the letters patent filed by the said Richard Werdermann in the Great Seal Patent Office on the 12th June, 1877.

Richard Werdermann, of Princes street, in the county of Surrey, civil engineer. "Improvements in electric lighting apparatus."

My said invention relates to improvements in electric lamps and in carbon electrodes for the same and in other apparatus for the production of electric light.

Description of the Drawing.

Figure 1 is a longitudinal section and

Figure 2 is an end view of a carbon electrode covered or coated according to my invention as hereinafter described.

Figure 3 is a side elevation of an electric lamp constructed according to my invention.

Figure 4 is a longitudinal section and

Figure 5 a transverse section illustrating my improvements in carbon electrodes.

Figure 5^a is a transverse section shewing a modification of the same

Figures 6. 7. 8. 9 are similar views illustrating other modifications of this part of my invention.

Figure 10 shows in transverse section various forms of my improved carbons or carbon electrodes

Figure 11 is a perspective view illustrating a further modification in the construction of my carbon electrodes

Like letters indicate the same parts throughout the drawing

The improved carbon electrodes or carbons *a* to be used in connection with the said electric lamps are coated as shewn at a^1 figures 1 and 2 with any suitable material which will protect the same from contact with air and which is volatile when exposed to the intense heat of the voltaic arc. I use by preference either separately or two or more of them in combination the following materials, namely, calcined magnesia, sulphate of magnesia, borax, boracic acid, sulphate of lime, fire-clay, glass, alumina, or other substances or bodies which in burning emit a great amount of light

The principal advantages of this coating of the carbons are the following namely

1. The flame ordinarily produced by the burning of the carbons and which diminishes considerably the intensity of the light by covering or enveloping the same is reduced to a minimum.
2. By excluding the air from contact with the carbons the heating of the electrodes is partly prevented
3. The coating material which is volatilized as the carbons are consumed produces a greater amount of light and reduces the resistance of the circuit

The electric lamps constructed according to my invention are not designed to be used in connection with reflectors or holophotes. In these lamps the carbon electrodes or carbons are supported in the required proximity to each other and are automatically adjusted in proportion to their combustion in the following manner that is to say. The carbon pieces *a* are so curved as shown in figure 3 as to form portions of a circle. One of these pieces is secured in a fixed support *b* and the other piece is secured in an arm or beam *c* pivoted to the said fixed support. This pivoted arm may be provided with a balance weight preferably containing sand or liquid which escapes and diminishes the weight. But I prefer to provide the said apparatus with an arrangement of clockwork at *d*

which regulates the action of the arm or beam c and always keeps
the carbon points a the proper distance apart. Or I may employ
electro-magnets or other suitable means for automatically
4422 regulating the distance of the carbon points from each other
during their combustion.

My improved carbon electrodes to be used without any lamp or regulator are constructed as follows that is to say.

In figures 4 and 5 I have shewn two concentric hollow carbon cylinders a a^2 insulated from each other by any suitable insulating material as shewn at f and which when exposed to the heat of the voltaic arc will be volatilized. The inner side of the inside carbon cylinder a and the outer side of the outside carbon cylinder a^2 may be equally covered with the insulating material. A powerful current of air will pass through the hollow space g as through a chimney and will accelerate the combustion of the carbon and of the insulating material. The said inner cylinder instead of being hollow may be solid as shewn in figure 5^a. The outer cylinder of these electrodes is about one inch shorter than the inner one as shewn at a^3. Both cylinders are fixed by a screw h in a holder i. I prefer to use a holder consisting of two insulated metal cylinders j, k which are connected with the two poles of the electric current generator as shewn in figure 4.

Instead of using carbon cylinders, rods of carbon of square, oblong, or other suitable section may be placed side by side parallel with each other as set forth in the specification of my former letters patent dated 24th April A D 1874 No. 1438

Figures 6 and 7 shew one of my improved electrodes formed of flat bars or rods a of carbon insulated at f and suspended in the holder i. In figures 8 and 9 I have shown one of the said electrodes consisting of flat rods a secured together by clips l. Various sectional forms of my improved carbon rods are shewn at e figure 10.

When a continuous electric current is used it is advantageous to make the negative electrode only half as thick as the positive one, a very uniform consumption of the carbon being thereby obtained

When the light is not required to illuminate in all directions but when it is desirable to obtain a very powerful point of light I place a rod a of carbon in front of a plate of carbon a^4 parallel with and insulated from the said plate by mica or other suitable material as shewn at m figure 11.

Having thus fully described my said invention and the manner of performing the same I wish it understood that I claim for the purposes above specified.

First—The coating of carbons or carbon-electrodes with metallic oxides or salts for the purposes specified.

Second—The coating of carbons or carbon-electrodes with borax or with boracic acid mixed with, or in which are dissolved, metallic oxides, salts, or other suitable material, as above set forth.

Third—In an electric light or lamp the curved carbons arranged in the manner above specified

Fourth—In the construction of carbons or carbon-electrodes the carbon cylinders placed one within the other or side by side and parallel with each other as above set forth

Fifth—The modification of my invention in which I place the carbon or carbons in front of a carbon plate as above set forth.

Sixth—The employment of mica as an insulating material for carbons used for the production of electric light as above set forth.

In witness whereof I the said Richard Werdermann have hereunto set my hand and seal this twelfth day of June in the year of our Lord one thousand eight hundred and seventy-seven.

R. WERDERMANN. [L. S.]

London: Printed by Eyre and Spottiswoode, printers to the Queen's most excellent majesty. For her majesty's stationery office. (10204.—50.—9 | 83.)

4423 Def't's Exhibit English Patent No. 4905 of 1876. W. T. F., S. E.

A. D. 1876, 19th December. No. 4905.

Apparatus for Producing Electric Light, &c.

Letters patent to Samuel Alfred Varley, of Hertford, in the county of Hertford, telegraphic engineer, for the invention of "improvements in apparatus for producing the electric light, parts of which invention are applicable to other purposes."

Sealed the 23rd March, 1877, and dated the 19th December, 1876.

Provisional specification left by the said Samuel Alfred Varley at the office of the commissioner of patents on the 19th December, 1876.

Samuel Alfred Varley, of Hatfield, in the county of Hertford, telegraphic engineer, "improvements in apparatus for producing the electric light, parts of which invention are applicable to other purposes."

This invention is an improvement on previous inventions for which provisional protection was granted to myself in conjunction with Cornelius Varley, bearing date the 24th day of December, 1866, No. 3394, but which was not proceeded with and which was continued by a new application and for which letters patent were granted, bearing date the 15th day of June, 1867, No. 1755.

4424 In the before-mentioned provisional specification a method was described which may be said to have marked a new era in the construction of dynamo-electric machines used for producing the electric light.

Nearly all the subsequent machines which have been designed for this purpose depending for their action upon the principle first described in the provisional specification before referred to, which consisted in making electricity and magnetism developed by the expenditure of mechanical force to act and react on one another in the machine itself in such way as to develop a greatly increased amount of both these forces, the consumption of force giving motion to the machine increasing and having relation to the increased amount of magnetism and electricity produced.

The nature of my present improvement will be rendered more clear by a brief reference to the machine described in the provisional specification hereinbefore referred to, No. 3394, 1866.

The machine therein described consisted of a number of soft-iron cores or bobbins wrapped with insulated wire and mounted on an axle, by means of which they were revolved and to which was attached a reversing com-utator. These bobbins revolved between opposite poles of soft-iron magnets, which were also wrapped 4425 with insulated wire. The soft-iron magnets were so arranged that they presented north and south poles alternately and opposite to one another, and the bobbins, when revolved, were magn*a*tised first in one direction and then in the other, positive and negative electric currents being developed in the insulated wire of the bobbins alternately at each reversal of the magnetic polarity.

The commutator closed the electrical circuit through the insulated wire of the bobbins and the soft-iron magnets, the electricity passing round the soft-iron magnets in the direction to increase their magnetic polarity, which increased polarity reacted upon the bobbins, developing an increased amount of electricity.

Just previous to the reversal of the magnetic polarity the commutator connected the ends of the insulated wires both of the magnets and the bobbins together, and immediately afterwards the commutator reversed the ends of the insulated convolutions of the bobbins relatively to those of the soft-iron magnets and put them again in circuit with one another, so that the electricity now produced by the reversal of the magnetic polarity of the bobbins passed relatively to the magnets the same way as before and maintained their polarity always in one direction.

The capability of the machine just described and of all 4426 others of this class is limited to a considerable extent, from the fact that the force consumed in giving motion to the machine is being converted into magnetism and electricity at the same time. Not only is the magnetism produced less proportionately as electricity is being developed, but force is also wasted.

The electricity produced when the magnetic polarity is reversed neutralizes and lowers the magnetic potential of the bobbins; the consequence of this is when the next reversal takes place and the magnetic potential previously acquired becomes converted into electrical force the electricity produced is less than it would have been had the magnetic potential just previous to the reversal been higher.

My improvement consists in separating the development of the electrical and magnetic forces to a considerable extent, obtaining thereby a greatly increased magnetic potential in the bobbins, which at a later stage becomes converted into electricity of a correspondingly high potential. I effect this by what may be described as splitting up the bobbins; I divide the bobbins into groups, each group having nearly the same relation to the soft-iron magnets as one bobbin in my previous invention; in other words, the alternations of north and south poles between which the bobbins revolve correspond to the number of groups and not to the actual number of bobbins, so that if the machine has 6 groups of 4427 bobbins and each group consists of three bobbins there will be 6 pairs of soft-iron magnets presenting alternate north and south poles instead of eighteen, as would have been the case in my former invention.

The number of bobbins in each groop may be 2, 3, 4, or more. The number of commutators employed may correspond to the number of bobbins forming a group or they may be increased in number, and when electricity of a very high potential is desired the commutators may be increased to the same number as the bobbins.

I now proceed to describe what takes place in one of my improved machines when set in motion, and which for simplicity of description I will suppose to consist of two pairs of soft-iron magnets only and two groups of bobbins, each group consisting of three bobbins.

The first or advancing bobbin of the group when its magnetism is reversed by passing from between the poles of the magnets into those of opposite polarity develops electricity throughout the circuit after passing onward a certain determined distance. When all or a greater part of the electricity has been developed this bobbin is by the action of the commutator cut out of the circuit and receives magnetism only. A little further on the connections relatively to the electrical circuit are reversed, and this bobbin is then again thrown into the circuit. The polarity of the second and fol- 4428 lowing bobbins is now reversed, and the electricity developed thereby passes through the insulated wire of the first bobbin, which is now included in the electrical circuit, and raises its magnetic potential to a very high degree. The first bobbin now passes between the magnetic poles of the opposite polarity, and the high magnetic potential previously acquired develops a corresponding equivalent of electricity. In the same way as the electricity developed in the second bobbin raises the magnetic potential of the first one so does the electricity developed in each following bobbin raise the magnetic potential of the one preceding it.

What I have just described as taking place in the bobbin of one group is also taking place at the same time in the second group, the only difference being that the electricity developed in the bobbins of the one is opposite to that which is being developed in the corresponding bobbins of the other. The insulated wires of the bobbins of the two groups are, however, so connected that the electricity developed in both flows round the soft-iron magnets and through the electrical circuit in the same direction.

By my improved arrangement just described not only do I obtain a higher magnetic and consequently a higher electrical potential than could be obtained from any former inventions, but as the reversal of the bobbin connections takes place when they are receiv-

ing magnetism only and before the reversal of their mag-
4429 netic polarity the whole of the electricity which is produced
at the time of the reversal passes through the electrical circuit.

In my previous invention hereinbefore referred to and in all machines of this class a certain amount of loss occurs both of the magnetic and electrical forces when the insulated wires of the magnets and the bobbins are short-circuited, just previous to the magnetic polarity of the bobbins and during the time the reversal of the connections is being made.

I now proceed to describe the construction of the commutator of a machine having three bobbins to each group.

The ends of the insulated wires of the bobbins are connected to metal discs mounted on the axle of the machine, but electrically insulated from it and also from one another. There are usually three discs to each commutator, two of these discs being employed for changing the connections and one for cutting out the bobbins from the electric circuit.

When the number of commutators correspond to the number of bobbins forming a group the ends of the insulated wire of the bobbin of each of the groups are joined side by side and connected to their respective discs of the commutators. For example, if the machine consists of six groups, then the ends of the insulated wire of
the leading bobbins of each of the groups are joined side by
4430 side and connected to one commutator. The ends of the sec-
ond and following bobbins of each of the groups are joined in the same way together and connected to the second commutator, and the third and last bobbin of each of the groups are connected to one another and to the third commutator.

The springs which rest against the said commutators are so connected as to form a continuous electrical circuit from one to the other throughout the metal discs of the commutators.

The changing of the connections and the cutting out the bobbins from the electrical circuit at regular intervals is effected by dividing or cutting away portions of the discs, the number of divisions having relation to the number of groups in the machine; or, in other words, to the number of changes in the connections which have to be made in each revolution.

The inward motion of the springs which press against the periphery of the commutators is limited by stops of insulating material, so as to prevent the springs following and making contact with the metal discs when a space or a division is opposite to the springs.

By cutting away at regular intervals more or less of the metal discs all the necessary adjustments for reversing and cutting out the bobbins from the electrical circuit at determined positions can be effected.

The object of the commutator is simply to make the necessary
changes in the connections at regular intervals, and its con-
4431 struction admits of modifications.

The iron cores or bobbins may be made of soft iron and split on one side to prevent the development of electrical currents in the body of the iron, or they may be made of a bundle of iron wires or of sheet iron rolled up upon itself.

In some cases to prevent more completely the development of electricity at those periods when I desire magnetism only to be produced I wrap the bobbins with two insulated wires in the reverse direction, and at the time when the bobbins are cut out of the electrical circuit by a modification in the construction of the commutator the ends of the two insulated wires are connected together for a short interval, the effect of which is to more completely neutralize the development of electricity.

Part of the electricity developed by the machine is diverted to maintain the magnetism of the soft-iron magnets, and the remaining portion is used to produce the electric light. There are several well known ways of doing this, but the method I prefer is to wrap the soft-iron magnets with two insulated wires, one having a larger resistence than the other. The circuit of larger resistence is always closed and the circuit of less resistence is used for the electric light.

4432 When the electric light is being produced the greater portion of electricity passes through the circuit of less resistence, which I term the "electric light circuit," maintaining the magnetism of the magnets and producing the light; when the electric light circuit is open from any cause the electricity passes through the circuit of greater resistence only and maintains the magnetism of the magnets.

The electric light is produced by closing the "electric light circuit" through a carbon rod which rests on the periphery of a disc of carbon, usually bevelled on the edge; this disc may be made of what is termed "gas carbon" and which is deposited on the side of the retorts in the process of making coal gas, or they may be made of what is technically termed "moulded carbon."

Motion is given to the carbon disc. The carbon rod rests loosely on the disc, and the contact being imperfect the electric circuit is completed by an electric arc being formed, and a similar effect is produced as when carbon conductors are brought into contact and separated a short distance from one another.

In some cases I construct the carbon disc of segmental pieces of carbon, separating each segment with a suitable non-conducting substance. An electric arc is then formed when the carbon rod is passing over the space occupied by the non-conducting
4433 material.

When a solid carbon disc is used a slight joggling action may be communicated to the carbon rod by any of the well-known methods to insure actual separation. Two carbon rods may also be employed instead of one, the circuit being completed through the one to the carbon disc and through it to the second carbon rod.

I prefer to give rotation to the carbon disc by means of the electric force generated by the machine itself, and so avoid having to depend upon more or less complicated mechanism, which has to be wound up.

I communicate motion in the following way: Hollow helices of insulated wire are arranged end to end, each helix being separated by a space from one another. In these spaces iron discs, mounted on a soft iron spindle (which passes through the helices and runs in suitable bearings), move.

The iron discs are divided into teeth on their outer periphery, and the helices are encased with iron tubes or shells, divided at both ends into teeth, corresponding in number with those cut in the iron discs.

The insulated wire composing the helices is connected to the insulated wire surrounding the soft-iron magnets of the ma-
4434 chine and is usually inserted in the circuit of greater resistance.

When the machine is set in motion the soft-iron cylinder in the centre of the helices becomes pow-fully magnetic, and the teeth of the discs and those of the shells mutually attract one another, giving motion to the iron discs. There is a commutator attached to the soft-iron cylinder which closes and opens the electric circuit through the helices in succession, and the discs are arranged so that their teeth break joints one with the other.

When the machine is in action the helix in the electric circuit renders the portion of the iron cylinder enclosed by its magnetic, and the teeth of the iron discs are attracted by the teeth of the iron shell covering this helix. When the teeth of the disc, moved by magnetic attraction, are almost opposite the teeth of the shell the commutator closes the electric circuit through the 2nd helix and opens it with respect to the one previously polarized. The discs are now moved another step forward. In this way, with a suitable number of helices and divided discs, the electric circuit being closed and opened through the helices in succession, a rotary motion is given to the cylinder, which gives motion to the carbon disc.

The helices are wrapped with two wires, joined together
4435 at one end and insulated at the other. These wires are
wrapped in opposite directions. The electricity which gives motion to the discs passes through one of these wires only, say, for distinction, No. "1;" No. "2" being disconnected at one end, the commutator, just before it opens the circuit of the helix electrically polarized, connects the end of No. "2" to No. "1."

The secondary or extra current, as it is sometimes termed, which is generated when the circuit is opened, now passes into No. "2," which is wrapped in the opposite direction to No. "1," and the demagnetization of the part of the iron cylinder previously magnetized is very rapidly effected in consequence.

In order to ascertain the amount of electric force which is being produced at any time, I attach to the machine an electric gauge which I construct in the following way: I wrap a hollow bobbin, which may be made of brass, with a number of convolutions of soft-iron wire; in the center of this a permanent magnet is mounted in pivots, care being taken that the pivot holes are placed truly in the center so that the poles of the magnet may be as nearly as possible at an equal distance from the iron wire, whatever position the magnet may be in. Circular or segmental coils, usually 4436 made of insulated copper ribbon, are mounted above and below the poles of the magnet, allowing space sufficient for the magnets to pass freely between.

An index or pointer, moving over a divided scale, is connected by a spring to the upper pivot of the magnet and retains the magnet in the center of the circular coils when the machine is not in action.

The circular coils are placed in the electric light circuit and when the machine is in action the magnet is deflected. The index is then turned round until the tension of the spring is sufficient to bring the magnets back again into the center of the coils. The distance traveled by the index to effect this indicates the amount of electric force which is being developed.

Malleable cast iron may be used for the magnets in place of soft iron. Common cast iron may also be used, and permanent magnets may in some cases be substituted with advantage for the soft-iron magnets, but the coercitive force or the power of permanent magnets to resist depolarization is limited, and the development of electricity when the machine is in motion drives back the magnatism, temporarily depolarizing them to some extent, and, consequently, renders them less effective. To neutralize this effect when I use permanent magnets, I prefer to arm them with soft-iron 4437 poles, which I wrap with insulated wire. The electricity developed by the machine is made to pass through this insulated wire and develops sufficient magnetism to neutralize the depolarizing effect before referred to.

Those parts of my invention by which the electricity which produces the light is developed are applicable for nearly all purposes where electricity in large quantities is required.

The high electrical potential which can be readily obtained by my invention renders it, for example, very suitable for the production of ozone, as well as other purposes where electrical currents of high tension are wanted.

The electric gauge used in my said invention and the method of obtaining rotary motion are also applicable to electric currents obtained by chemical action or thermo-electric sources.

Specification in pursuance of the conditions of the letters patent filed by the said Samuel Alfred Varley in the Great Seal Patent Office on the 19th June, 1877.

Samuel Alfred Varley, of Hatfield, in the county of Hertford, telegraphic engineer, "improvements in apparatus for producing the electric light, parts of which invention are applicable to other purposes."

This invention is an improvement on a previous invention 4438 for which provisional protection was granted to myself in conjunction with Cornelius Varley, bearing date the 24th day of December, 1866, No. 3394, but which was not proceeded with, and which invention was made the subject of a second application and — which letters patent were granted to us, bearing date the 15th day of June, 1867, No. 1755.

In the before-mentioned provisional specification a method was described which may be said to have marked a new era in the construction of dynamo-electric machines used for producing the electric light.

Nearly all the subsequent machines which have been designed for this purpose depend for their action on the princip*al* first described in the provisional specification above referred to. This principle as set forth in the said specification consists in causing electricity and magnetism developed by the expenditure of mechanical force to act and react on one another in the machine itself in such a way as to develop a greatly increased amount of both these forces. Such increased amount of magnetism and electricity, as is well understood, involves an increase in the consumption of mechanical force for giving motion to the machine.

The nature of my present improvement will be rendered more clear by a brief reference to the machine described in the provisional specification hereinbefore referred to, No. 339,466.

4439 The machine therein described consisted of a number of soft-iron cores or bobbins wrapped with insulated wire and mounted on an axle, by means of which they were revolved, and to which was attached a reversing commutator. These bobbins revolved between opposite poles of soft-iron magnets, which were also wrapped with insulated wire. The soft-iron magnets were so arranged that they presented north and south poles alternately and opposite to one another, and the bobbins when revolved were magnetized first in one direction and then in the other, positive and negative electric currents being developed in the insulated wires of the bobbins alternately at each reversal of the magnetic polarity.

The commutator closed the electrical circuit through the insulated wire of the bobbins and the soft-iron magnets, the electricity passing round the magnets in their direction to increase their magnetic polarity, which increased polarity reacted upon the bobbins, developing an increased amount of electricity.

Just previous to the reversal of the magnetic polarity the commutator connected the ends of the insulated wires both of the magnets and the bobbins together, and immediately afterwards the commutator reversed the ends of the insulated convolutions of the bobbins relatively to those of the soft-iron magnets and put
4440 them again in circuit, one with another, so that the electricity
now produced by the reversal of the magnetic polarity of the bobbins passed relatively to the magnets the same way as before, and maintained their polarity always in one direction.

The capability of the machine just described and of others of its class as heretofore constructed is limited to a considerable extent, because the force consumed in giving motion to the machine is being converted into magnetism and electricity at the same time, and the magnetism produced is less proportionately as electricity is developed.

The electricity produced when the magnetic polarity is reversed partially neutralizes the magnetism of the bobbins. The consequence of this is that when the next reversal takes place and the magnetism previously acquired thus becomes converted into electrical force the electricity produced is less than it would have been had the magnetism been greater just previous to the reversal.

My improvement consists in separating the development of the electrical and magnetic forces to a considerable extent, obtaining thereby greatly increased magnetic potential in the bobbins, which at a later stage becomes converted into electricty of a correspondingly high potential. I effect this by what may be described as "splitting up" the bobbins—that is to say, I divide the bobbins into groups, each group having nearly the same relation 4441 to the soft-iron magnets as one bobbin had to the soft-iron magnets in my previous machine—that is, in a machine according to the former invention above referred to. In other words, the alternations of north and south poles, between which the bobbins revolve, correspond in my improved machine to the number of groups and not as in my old machine to the actual number of bobbins, so that if the machine has six groups of bobbins and each group consists of three bobbins there will be six pairs of soft-iron magnets presenting alternate north and south poles instead of eighteen, as would have been the case in my old machine.

The number of bobbins in each group may be 2, 3, 4, or more. The number of commutators employed may correspond to the number of bobbins forming a group or they may be increased in number, and when electricity of a very high potential is desired the commutators may be increased to the same number as the bobbins.

I now proceed to describe what takes place in one of my improved machines when set in motion, and which for simplicity of description I will suppose to consist of two pairs of soft-iron magnets only and two groups of bobbins, each group consisting of three bobbins:

The first or advancing bobbin of the group, when its magnetism is reversed by passing from between the poles of the magnets into those of opposite polarity, develops electricity throughout 4442 the circuit after passing onward a certain determined distance; when all or the greater part of the electricity has been developed this bobbin is by the action of the commutator cut out of the circuit and receives magnetism only. A little further on the connections relatively to the electrical circuit are reversed, and this bobbin is then again thrown into the circuit. The electricity developed in the bobbin of the group whose magnetic polarity is next reversed passes through the insulated wire of the first bobbin and raises its magnetic potential to a very high degree. The first bobbin then passes between the magnetic poles of the opposite polarity, and the high magnetic potential previously acquired develops a corresponding equivalent of electricity and raises the magnetic potential of the bobbin following it. In this way the magnetic potential of each of the bobbins is raised to a high degree just before the reversal of its polarity takes place.

What I have just described as taking place in the bobbins of one group is also taking place at the same time in the other group, the only difference being that the electricity developed in the bobbins of the one group is opposite to that which is being developed in the corresponding bobbins of the other. The insulated wires of the bobbins of the two groups are, however, so connected that the electricity developed in both flows round the soft-iron magnets and through the electrical circuit in the same direction.

4443 By my improved arrangement just described not only do I obtain a higher magnetic and consequently a higher electrical potential than could be obtained in my old machine, but, as the reversal of the bobbin connections takes place when they are receiving magnetism only and before the reversal of their magnetic polarity, the whole of the electricity which is produced at the time of the reversal passes through the electrical circuit.

Although for simplicity of description I have above referred to the use of only two groups of bobbins, in practice three or more groups may be used with advantage, the number depending upon the requirements of each particular application.

In my old machine hereinbefore referred to and in other machines of this class a certain amount of loss occurs, both of the magnetic and electrical forces, when the insulated wires of the magnets and the bobbins are short circuited, just previous to the reversal of the magnetic polarity of the bobbins and during the time the reversal of the connections is being made.

I now proceed to describe the construction of the commutators of a machine having three bobbins to each group:

The ends of the insulated wires of the bobbins are connected to metal discs mounted on the axle of the machine, but electrically insulated from it, and also from one another. There may be 4444 three discs to each commutator, two of these discs being employed for charging the connections, and one for cutting out the bobbins from the electrical circuit.

When the number of commutators corresponds to the number of bobbins forming a group the ends of the insulated wires of the bobbins of each of the groups are joined side by side and connected to their respective discs of the commutators; for example, if the machine consists of six groups, then the ends of the insulated wires of the leading bobbins of each of the groups may be joined side by side and connected to one commutator. The ends of the second and following bobbins of each of the groups may be joined in the same way together and connected to the second commutator, and the third and last bobbin of each of the groups may be connected to one another and to the third commutator.

The springs which rest against the commutators are so connected as to form a continuous electrical circuit from one to the other through the metal discs of the commutators.

The changing of the connections and the cutting out of the bobbins from the electrical circuit at regular intervals is effected by dividing or cutting away portions of the discs, the number of divisions having relation to the number of changes which have to be made in the connections during each revolution.

The inward motion of the springs which press against the
4445 peripheries of the commutators is limited by stops of in-
sulating material so as to prevent the spring following and making contact with the metal discs when a space or a division is opposite to the springs.

By cutting away at regular intervals more or less of the metal discs, all the necessary adjustments for reversing the cutting out the bobbins from the electrical circuit at determined positions can be effected.

The object of the commutator is simply to make the necessary changes in the connections at regular intervals, and its construction admits of modification.

The iron cores or bobbins may be made of soft iron and split on one side to prevent the development of electric currents in the body of the iron, or they may be made of bundles of iron wires or of sheet iron rolled up upon itself.

Part of the electricity developed by the machine is diverted to maintain the magnetism of the soft-iron magnets, and the remaining portion is used to produce the electric light. There are several well-known ways of doing this, but the method I prefer is to wrap the soft-iron magnets with two insulated wires, one having a larger resistance than the other. The circuit of larger resistance is always closed and the circuit of less resistance is used for the electric
light.

4446 When the electric light is being produced the greater por-
tion of electricity passes through the circuit of less resistance, which I term the "electric light circuit," maintaining the magnetism of the magnets and producing the light. When the electric light circuit is opened from any cause the electricity developed passes through the circuit of greater resistance only and maintains the magnetism of the magnets.

The electric light is produced by closing the "electric light circuit" through a carbon rod which rests on the periphery of a disc of carbon, usually bevelled on the edge. This disc may be made of what is termed "gas carbon," and which is deposited on the sides of the retorts in the process of making coal gas or they may be made of what is technically termed "moulded carbon."

Motion is given to the carbon disc. The carbon rod rests loosely on the disc, making imperfect contact, and the electric circuit is completed by the formation of an electric arc, a similar effect being produced as when carbon conductors are brought into contact and separated a short distance from one another.

In some cases I construct the carbon disc of segmental pieces of carbon, separating each segment with a suitable non-conducting substance. An electric arc is then formed when the carbon rod is pass-
ing over the space occupied by the non-conducting material.

4447 When a solid carbon disc is used a slight joggling action
may be communicated to the carbon rod by any of the well-known methods to insure actual separation. Two carbon rods may

also be employed instead of one, the circuit being completed through the one to the carbon disc and through it to the second carbon rod.

I prefer to give rotation to the carbon disc by means of the electric force generated by the machine itself and so avoid having to depend upon more or less complicated mechanism which has to be wound up.

I communicate motion in the following way: Hollow helices of insulated wire are arranged end to end, each helix being separated by a space from its neighbors; in these spaces move iron discs, which are mounted on a soft-iron spindle that passes through the helices and runs in suitable bearings.

The iron discs are formed with teeth on their outer peripheries, and the helices are encased with iron tubes or shells formed at both ends, with teeth corresponding in number with those on the iron discs.

The insulated wire composing the helices is connected to the insulated wire surrounding the soft-iron magnets of the machine, and is usually inserted in the circuit of greater resistance.

When the machine is set in motion the soft-iron cylinders in
4448 the centres of the helices become powerfully magnetic, and the
teeth of the discs and those of the shells mutually attract one
another, giving motion to the iron discs. There are commutators which close and open the electric circuit through the helices in succession, and the discs are arranged so that their teeth "break joint" or alternate one with the other, as hereinafter described.

When the machine is in action the helix in the electric circuit renders the portion of the iron cylinder enclosed by it magnetic, and the teeth of the iron discs are attracted by the teeth of the iron shell covering this helix. When the teeth of the discs, moved by magnetic attraction, are almost opposite the teeth of the shell a commutator closes the electric circuit through *the electric circuit through* the second helix and opens it with respect to the one previously polarized. The discs are now moved another step forward. In this way, with a suitable number of helices and divided discs, the electric circuit being closed and opened through the helices in succession, a rotary motion is given to the cylinder which gives motion to the carbon disc.

Each of the helices is wrapped with two wires joined together at one end and insulated at the other. These wires are wrapped in opposite directions. The electricity which gives motion to the discs passes through one of these wires only, say, for distinction, "No. 1,"
the other ("No. 2") being disconnected at one end. The com-
4449 mutator just before they open the circuit of the helix elec-
trically polarized connects the end of "No. 2" to the end of "No. 1."

The secondary current, or "extra current," as it is sometimes termed, which is generated when the circuit is opened, now passes into "No. 2," which is wrapped in the opposite direction to "No. 1," and the demagnetization of the part of the iron cylinder previously magnetized is very rapidly effected in consequence.

In order to ascertain the amount of electric force which is being produced at any time, I attach to the machine an electric gauge, which I construct in the following way: I wrap a hollow bobbin, which may be made of brass, with a number of convolutions of soft-iron wire; in the centre of this a permanent magnet is mounted on pivots, care being taken -at the pivot holes are placed truly at the centre, so that the poles of the magnet may be as nearly as possible at an equal distance from the iron wire, whatever position the magnet may be in. Circular or segmental coils, usually made of insulated copper ribbon, are mounted above and below the poles of the magnet, allowing sufficient space for the magnet to pass freely between the coils.

An index or pointer moving over a divided scale is connected by a spring to the upper pivot of the magnet, and when the machine is not in action retains the magnet in the centre of the circular coils. 4450

The circular coils are placed in the electric light circuit, and when the machine is in action the magnet is deflected. The index may be then turned round until the torsion of the spring is sufficient to bring the magnet back again into the centre of the coils, or the divided scale may be moved round, which is practically the same thing. The distance travelled by the index to effect this indicates the amount of electric force which is being developed.

In constructing the machines malleable cast iron may be used for the magnets in place of soft iron. Common cast iron may also be used, and permanent magnets may in some cases be substituted with advantage for the soft-iron magnets; but the coercitive force or the power of permanent magnets to resist depolarization is limited, and the development of electricity when the machine is in motion drives back the magnetism, temporarily depolarizing the magnets to some extent, and consequently renders them less effective. To counteract this action when I use permanent magnets I prefer to arm them with soft-iron poles, which I wrap with insulated wire. The electricity developed by the machine is made to pass through this insulated wire and develops sufficient magnetism to neutralize the depolarizing effect before referred to.

4451 Those parts of my invention by which the electricity which produces the light is developed are applicable for nearly all purposes where electricity in large quantities is required.

The high electrical potential which can be readily obtained by my invention renders it, for example, very suitable for the production of ozone, as well as for other purposes where electrical currents of high tension are wanted.

My method of obtaining motion is also applicable to electric currents obtained by chemical action or from thermo-electric sources.

Description of the Drawings.

Sheets 1 and 2 shew the apparatus by which the electrical force is produced.

Sheet 3 shows the apparatus by which the light is obtained and illustrates the way in which the electrical force developed by the machine is measured.

Fig. 1 is a general view of a machine, having four groups of revolving bobbins and three bobbins in each group. Fig. 2 is an end view of the same.

Fig. 3 is an end view, with parts of the machine removed to show how the bobbins revolve over the magnets.

Fig. 4 is a side view of the bobbins removed from the machine, shewing the way in which they are mounted on the axle. Fig. 5 is an end view of the same.

Fig. 6 is an end view of the bobbins, shewing the connections.

Fig. 7 is a side view of the commutator removed from the
4452 machine and shewing its general construction. Fig. 8 is a
sectional view of the same, shewing how the different parts are connected.

Fig. 9 is an end view of the commutator.

Fig. 10 is a sectional view, shewing the construction of parts of the commutator.

Fig. 11 (sheet 2) is a side view and Fig. 12 is an end view, shewing the general construction of a machine having two groups of bobbins only and three bobbins in each group, in which the magnets are arranged in line with the bobbins. The commutator is shown separately in Fig. 17 (sheet 3).

Fig. 13 (sheet 3) is a side view and Fig. 14 an end view of parts of a machine having two groups of bobbins with eight bobbins in each group and shows the form in which I prefer to make the electro-magnets when the construction of the machine admits of it. A sectional and an end view of the iron cores used for these magnets is shewn in Figs. 15 and 16, sheet 3.

Figs. 20 to 25 shew the construction of the apparatus for giving motion to the carbon disc used for producing the electric light.

Fig. 26 is a sectional view of the electric gauge, and Fig. 27 is a top view of the same with parts removed to shew the construction more clearly.

A A (Figs. 1 and 2) are two uprights, usually made of gun metal or other suitable non-magnetic substance, to which are attached the
iron blocks B, more clearly shown in Figs. 2 and 3, and
4453 which form extensions of the poles of the electro-magnets.
C are the electro-magnets attached to the iron blocks B. D is an axle which carries the bobbins E^1 E^2 E^3 F^1 F^2 F^3 G^1 G^2 G^3 H^1 H^2 H^3. I is a pulley attached to the axle by means of which motion is communicated to the machine. I^x is a pulley revolving loosely on the axle, onto which the band is shifted when it is desired to stop the machine. J J are bearings in which the axle runs. K is a cradle in which the bobbins lie. This cradle is attached to the axle and the bobbins are kept in their places by lashing them together by a cord or in any other suitable way. L are the commutators attached to but electrically insulated from the axle. M M^x are contact springs which rest on the commutator discs. When the machines are constructed with a large number of bobbins in each group the extensions of the magnet poles B, as shewn in Figs. 13

and 14, may be made of continuous circles instead of segmental pieces of iron, as the loss of magnetism arising from the opposite magnetic poles being connected by a bridge of iron is in such cases comparatively small.

The way in which the commutators are connected together is
shewn in Fig. 17 (sheet 3), which represents the commutators of a
machine having two groups of bobbins and three bobbins in each
group. The arrangement consists of nine metal discs, divided into
three sets, electrically connected together as indicated by the
4454 dotted diagonal lines; portions of the discs are cut away, as
shown in Fig. 18, which is an end view of one set. L^x L^1
are discs connected to the ends of the insulated wires of the bobbins.
L^2 are the discs through which the circuit is completed when the
bobbins are receiving magnetism only. M and M^x are the contact
springs which press against the metallic discs of the commutators.
L^3 L^4 are metallic discs mounted on but insulated from the axle
D against which contact springs M rest. These are connected to a
divided metallic ring, L^5 L^6, which is mounted on the axle, but insulated from it. An end view of this divided ring is shown in Fig.
19. When electricity in one direction only is required the circuit
is closed through the dotted lines M^2 M^{x2}; when alternate positive
and negative currents are desired the circuit is closed through M^{x2}
M^{x3}.

In Fig. 2 the bobbins E^1 F^1 G^1 H^1 are passing from between the
magnetic poles of one name into those of opposite polarity and are
developing electricity. I term this position of the bobbins "No. 1
position." The bobbins E^2 F^2 G^2 H^2 are disconnected from the
electrical circuit and are acquiring magnetism or magnetic potential
only. I term this "No. 2" position. The bobbins E^3 F^3 G^3 H^3 are
in what I term "No. 3" position—that is, the position where they
are again put into the electrical circuit, the ends of the insulated
wires of the bobbins relative to the general circuit being, however,
reversed to what they were when in "No. 1" position.

4455 The electricity developed in the insulated wires of the
bobbins in "No. 1" position passes through the bobbin in
"No. 3" position, through the insulated wire of the electro-magnets
and through the whole of the electrical circuit, magnetizing the
electro-magnets and increasing the magnetic potential of all the
bobbins in "No. 3" positions. The next reversal takes place during the passage of the bobbins from "No. 3" position to the succeeding "No. 1" position, the bobbins in "No. 2" position passing
on to "No. 3" position and having their magnetic potential raised,
as before described, by the bobbins which are now passing on to
"No. 1" position. In this way the magnetic potential of each of
the bobbins in its passage from "No. 2" position onwards until just
before it reaches the succeeding "No. 1" position is raised to a high
degree, and the magnetic potential thus acquired becomes converted
into electricity during the passage of the bobbin into "No. 1" position and onwards until it reaches "No. 2" position.

To avoid confusion the connections between the magnets, bobbins, and commutators are indicated only generally in the draw-

ings, but their arrangement will be generally understood by electricians from the description given, aided by reference to Figs. 17^{A},
which are theoretical diagrams, showing each of the bobbins
4456 of a single group in the three positions hereinbefore referred
to as "No. 1," "No. 2," and "No. 3."

N (Figs. 20 and 21) is a carbon disc mounted on the axle O, to which are attached the soft-iron cylinders P, with discs or flanges P^x, divided into teeth on their outer peripheries. The iron cylinders revolve in the helices of insulated wire. Q_x p are soft-iron shells surrounding the helices Q. The faces of these shells are divided into teeth corresponding to those of the iron discs. p^x q are helices of insulated wire, which are usually placed over the iron shells to further increase the development of magnetism.

The diagram-atic view, Fig. 22, shews the alternate positions of the teeth of the iron discs and shells. R R^1 are the commutator wheels electrically insulated from one another, and also from the axle. The teeth of these wheels "break joint" one with the other—that is to say, the teeth of one wheel are opposite the spaces between the teeth of the other wheel, as shown in Fig. 21. These wheels alternately close the circuit through the helices when the axle is rotated. r r^1 r^2 r^3 are the demagnetizing commutators, each of which is composed of two divided wheels, the teeth of which "break joint" with one another, the teeth of the one wheel being opposite the spaces between the teeth of the other wheel, as indicated in
Fig. 21. These wheels are insulated from the axle and from one
4457 another. S S^x S^1 S^2 S^3 S^4 are contact springs. S^x S^3 are in
electrical contact with each other. S^1 and S^2 are also electrically connected. S^x is in permanent electrical contact with R, and S^1 is always in contact with R^1. One end of the two insulated wires of which each helix Q q is composed is connected with the axle. The other ends of what I have termed for distinction the "No. 1" wires of the two helices are connected to R and R^1, and the other ends of the "No. 2" wires are connected to r^1 r^2. The electrical circuit is closed through the contact springs S S^4, and the current passes from the axle through the helices alternately and out at S, or *vice versa.*

The circuit is represented in Fig. 20 as closed through the "No. 1" wire of the helix connected to the communtator wheel R, and the Nos. "1" and "2" wires of the helix connected to R^1 are represented as connected together by the demagnetizing commutator r^2.

In Fig. 20 the rotary apparatus is represented as constructed with two hollow helices and revolving cylinders, but it will work better if constructed with three or more helices.

T, Fig. 23, is a carbon rod attached to the lever U and resting by gravity on the carbon block N.

The dotted lines V V, Fig. 26, represent the convolutions of iron
wire of the electrical gauge which insulate the magnets in-
4458 side from external magnetism. W are the circular coils. X
are the magnets working over the surfaces of and between the coils. X^x is an axle to which the magnets are attached. Y^1 is a torsion spring, one end of which is attached to the axle X^x and the

other end to the circle Z, whose surface has degrees marked on it. Z^1 is a handle by means of which the circle Z can be turned round. Y^1 is a pointer attached to the axle X^x and which is deflected when the circuit is closed through the coils of the electrical gauge. Y^x is a fixed pointer which shows the number of degrees *and* divided circle Z has been moved in bringing back the pointer Y^1 to zero and which measures the amount of force exerted by the current on the magnets.

The dotted lines and circles, Fig. 27, shew how the electrical gauge can be rendered much more sensitive to electric currents by increasing the number of coils and magnets as indicated by the dotted lines.

Having described the nature of my said invention and explained the mode of carrying the same into practical effect, I desire to have it understood that save and except as hereinafter mentioned I do not intend to claim any of the mechanical or electrical parts of the apparatus hereinbefore shewn and described when taken
4459 separately and apart from the combination or application
thereof in manner and for the purposes hereinbefore described, but what I consider to be novel and original and therefore claim as secured to me by the hereinbefore in part recited letters patent is—

First. The method hereinabove described of obtaining a high degree of "magnetic potential" in the bobbins by causing the insulated wires of the bobbins at certain determined positions to be cut out of and disconnected from the electric circuit, and whilst so disconnected to acquire magnetism only, and further increasing such magnetism by causing electricity developed in other parts of the machine to pass through the insulating wires of the said bobbins after they have been again put into the electric circuit, but before their magnetic polarity is reversed, the high "magnetic potential" so acquired being converted into electricity at the next reversal of the magnetic polarity of the said bobbins, as described.

Secondly. The method hereinbefore described of obtaining rotary motion by the use of iron discs provided with teeth in conjunction with iron shells or tubes also provided with teeth, the said discs being attached to or forming parts of iron cylinders, which are mounted on a common axle and revolve in helices of insu-
4460 lated wire, which helices by means of commutators are ren-
dered alternately active and inactive, and magnetize in succession the enclosed iron cylinders and shells, the said cylinders and shells being rapidly demagnetized in the manner described.

In witness whereof I, the said Samuel Alfred Varley, have hereunto set my hand and seal this nineteenth day of June, in the year of our Lord one thousand eight hundred and seventy-seven.

S. ALFRED VARLEY. [L. S.]

4461 Def't's Ex. Edison English Patent No. 2402 of 1879.

(Fourth edition.)

[British coat of arms.]

A. D. 1879, 17th June. No. 2402.

Specification of Thomas Alva Edison.

Electric lights and apparatus for developing electric currents, &c.

London: Published and sold at the patent office sale branch, 38 Cursitor street, Chancery lane, E. C. 1886. Price 1s. 1d.

4462 (Fourth edition.)

A. D. 1879, 17th June. No. 2402.

Electric Lights and Apparatus for Developing Electric Currents, &c.

Letters patent to Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, electrician, for an invention of "improvement in electric lights and in apparatus for developing electric currents and regulating the action of the same."

Provisional specification left by the said Thomas Alva Edison at the office of the commissioners of patents on the 17th June, 1879.

Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, electrician. "Improvement in electric lights and in apparatus for developing electric currents and regulating the action of the same."

I have ascertained that when wires or sheets of platina, iridium or other metallic conductors of electricity, which fuse at a high temperature are exposed to a high temperature, near their melting point in air for several hours by passing a current of electricity through them and then are allowed to cool, the metal is found to be ruptured, and under the microscope there is revealed myriads of cracks in every direction, many of which are seen to reach nearly to the centre of the wire. I have also discovered that contrary to the received notion, platinum, and iridium alloy loses weight when exposed to the heat of a candle, that even heated air causes it to lose weight, that the loss is so great that it tinges a hydrogen flame green, and under the influence of an electric current and at a yellow white heat the loss is very great. After a time the metal falls to pieces, hence wire or sheets of platinum, or platinum or iridium alloy as now known in commerce are useless for giving light by incandescence.

First: Because its loss of weight makes it expensive and unreliable and causes the burner to be rapidly destroyed.

Second: Because its electrical resistance changes by loss in weight

and its light giving power by the cracks, or ruptures, the melting point being determined by the weakest spot where the greatest difference of potential of the electric current is present which causes this point to be brought to a higher heat than the rest of the surface of the wire; again as it is essential to obtain a steady light
4463 the platinum burner must be screened from the air, and when thus screened, by being placed in a glass vessel, the glass soon becomes coated with a black deposit of platinum.

A platinum spiral brought to incandescence under these conditions may be made to give a light of three standard candles, when near its melting point, and when the radiating surface is $\frac{3}{16}$ of an inch, but this amount of light will be rapidly reduced as before described.

From my researches and experiments I am led to believe that the cause of the rupturing of the metal when brought to incandescence, is due to the action of the gases contained in the pores of the metal. These gases are probably compressed within the pores during the rolling or drawing of the sheet or wire.

These gases, or air, when subjected to high heats are greatly expanded and rupture the metal and it cannot be driven out by slowly heating the metal.

I have also discovered that the loss of weight and apparent vola*ta*lization of the metal is due to the action of the air or gases against the highly heated surface. Having thus ascertained the cause of fracture and loss of weight I have conducted experiments to obviate these defects and have succeeded by the following method. A spiral of platinum wire is placed in a glass bulb, with its ends passing through and sealed in the glass, and the air exhausted from the bulb by a Sprengel pump, until the discharge from a three-inch induction coil, will not pass between two subsid*a*ary wires in the bulb, the ends of which are four millimetres apart; the wires of the spiral are then connected to a magneto-electric machine or battery whose current can be controlled by the addition of resistance. Sufficient current is allowed to pass through the wire, to bring it to about 150° Fahrenheit it is allowed to remain at this temperature for 10 or 15 minutes while thus heated, the air or gases in the pores of the metal is expelled by the action of the heat and the expansion of the gases which tend to pass outward in consequence of the vacuum. While this air or gases is passing out of the metal, the mercury pump is kept continuously working. After the expiration of about 15 minutes the current passing through the metal is to be augmented so that its temperature will be about 300 degrees Fahrenheit and it is allowed to remain at this temperature for another 10 or 15 minutes. If the mercury pump be worked continuously and the temperature of the spiral raised at intervals of 10 or 15 minutes, until it attains to vivid incandescence, and the bulb be then sealed, the metallic wire is then in a state heretofore unknown for it may have its temperature raised, to the most dazzling incandescence emitting a light of 25 standard candles.

Whereas before the treatment, the same spiral would only emit a light equal to three candles, before attaining the melting point.

The wires subjected to the process of freeing them from air and gases, are found after the process, to have a polish exceeding that of silver, and obtainable by no other means, no cracks can be seen even after the spiral has been raised suddenly to incandescence many times by the current, and no volat*a*lization takes place as there is no deposit upon the glass bulb, nor does a delicate balance show any loss of weight in the spiral after burning for many hours continuously, because the spiral is in a vacuum, that is so nearly perfect that the action of the gaseous molecules is reduced to the minimum and were it possible to obtain an absolute vacuum, there would be no loss whatsoever and the total loss after a year's use, would scarcely be noticed. I have further discovered that if an alloy of platinum and iridium or even platinum be coated with the oxide of magnesium, in the manner hereafter stated, and subjected to the vacuum process described that combination takes place between the metal, and the oxide, giving the former remarkable properties. With a spiral having a radiating surface of $\frac{3}{16}$ of an inch, light equal to that given by 40 standard candles may be obtained, whereas the same spiral not passed through my process, would melt before giving a light of 4 candles.

The effect of the oxide of magnesia is to harden the wire to a surprising extent and render it more refractory. A spiral spring made of the wire is as elastic and springy when at dazzling incandescence as when cold.

4464 I have found that chemically pure iron and nickel, drawn in wires and subjected to the vacuum process may be made to give a light equal to that of platinum in the open air.

Carbon sticks may be also freed from air, in this manner and be brought to a temperature, that the carbon becomes pasty and if then allowed to cool is very homogeneous and hard rods or plates made of mixtures of finely divided conducting and non-conducting materials may thus be freed from air. It is also obvious that the metal might be heated by subjecting the containing bulb to a considerable temperature, but this only partially frees the wire from its air or gases.

I will now describe the form of burner or lamp which I employ.

To operate several hundred electric lights practically each equal to an ordinary gas jet, upon one circuit, it is essential for many reasons both on the score of economy, facility and reliability to place them all in multiple arc, and to prevent the combined resistance of several hundred lamps from falling to such a low point, as to require main conductors of immense dimensions, with low resistance, and generating machines of corresponding character, it is essential to reverse the present and almost universal practice of using lamps which have but one or two ohms resistance and construct lamps which shall have when giving their proper light a resistance of several hundred ohms, because the more lamps there are in circuit, the less will be the resistance. I have ascertained by experiment that the loss of energy is in proportion to the extent of the radiating surface, independent of the resistance of the conductor, hence we have 1,000 lamps each of $\frac{1}{4}$ of an inch radiating surface and each of

1 ohm resistance, or 1,000 lamps having the same radiating surface and 1,000 ohms resistance each, the loss of energy from each lamp when giving each a light of 15 candles will be nearly the same, but the combined resistance of the 1 ohm lamps will be $\frac{1}{1000}$ of an ohm requiring an enormous main conductor, whereas the combined resistance of the 1,000 ohms lamp will be 1 ohm requiring a conductor of very moderate dimensions. In practice a resistance of 200 to 300 ohms in the burner will be sufficient.

Again with lamps of low resistance the lamp connections and leading wires must be large to prevent great loss of energy by resistance, the leading wires from the main conductors, are large, expensive, and bulky to handle, the low resistance of the burner, or incandescent conductor requires large terminals to convey the current and these offer by their conduction a medium for the rapid dissipation of energy without producing any effect whereas with a lamp of high resistance all these objections are obviated.

My burner consists of a bobbin composed of an infusible oxide, such as oxide of calcium, cerium, zirconium magnesium freed from silica and turned in a lathe from sticks moulded by hydraulic pressure, in a manner hereinafter set forth.

These wires serve to hold the bobbin in the centre of the sealed glass vacuum bulb, and at the same time serve as conductors of the electric current to the wire coiled upon the bobbin.

The two platinum wires are first passed through small tubes of glass which are melted around the wires. The burner is introduced into the bulb and the wires are passed out through the sides of the narrow neck leading from the bulb and the glass is melted around them to prevent leakage, the glass of the neck being melted to the small glass tube around the wires.

Before the burner is permanently sealed at the neck, the air pump is connected therewith and the wire upon the bobbin is subjected to the vacuum process heretofore described and the electric current is used to produce incandescence for about one hour to heat the bobbin and thereby expel the air and gases, after which the bulb is permanently sealed by melting the glass of the neck, and it is ready to be used as a lamp.

The method which I adopt for regulating the light radiated from the burner, consists in a small rotating magnet provided with a governor which serves to open the lamp circuit when the 4465 strength of the current is greater than is necessary to produce the proper light in the bobbin. This apparatus is very reliable and although the current supplied is not perfectly continuous, the total energy passing to the lamp in one hour is nearly the same, no matter what the strength of the current may be. The magnets are so arranged that the continuous metallic circuit cannot be broken by the commutator of the revolving magnet and the extra current produced by the reversal of the current in the revolving magnet is short circuited by the fixed magnet, hence the sparks which would occur at the break points of the governor are prevented.

The rotating magnet is upon a vertical shaft supported in suitable bearings, and immediately over the rotating magnet is the fixed magnet, the cause of which are in the path described by the rotating magnet. Upon the shaft is a reversing commutator formed of an insulated ring, the periphery of which is faced with platina, and cut in two parts, one part being connected by a wire to one helix of the revolving magnet, and the other part to the other helix of said magnet, the two helices being connected. Rubbing on this ring are two contact springs which serve to convey the currents to the revolving magnet.

The current passes through the fixed magnet thence through the revolving magnet, the rotation of the magnet being kept up by the reversal of the direction of flow of the currents through the revolving magnet.

When the cores of the revolving magnet are nearest the cores of the fixed magnet the direction of the flow of current is reversed by the action of the commutator springs and commutator and the polarity changed, hence the attraction ceases, but the momentum of the revolving magnet carries said magnet forward and mutual attraction again takes place as the revolving cores approach the stationary cores the current is reversed and the revolution continued.

Connected to the revolving shaft is a governor which consists of two collars connected together by two springs: one collar is secured to the shaft while the other is free to slide thereon.

Upon each spring a weight is secured and the rotation of the shaft causes these to act centrifugally and bow outward the springs and raise the sliding collar upward more or less in proportion to the speed of the shaft.

The sliding collar is made with a groove to receive the end of the circuit opening lever which lever is moved by the rise and fall of the collar. The other end of the lever has an insulated cross bar which is in contact with two circuit breaking springs and serves to disconnect the springs simultaneously from their contact points or blocks when the shaft has reached a certain velocity.

The object of using two springs is to open the circuit at two places simultaneously and thus reduce the spark, which it does in the ratio of the number of simultaneous breaks.

One of the two springs is connected by a wire to one of the commutator springs and the other is connected to the wire leading from the main conductor, or a branch therefrom. This method of breaking the circuit simultaneously in many places is applicable to all kinds of electrical apparatus where large and powerful sparks occur, as for instance if it is desired to transfer electric energy from one point to another by dynamo electric machines operating upon a magneto electric motor to a distant station. If four springs are employed, and the circuit opened at the four places simultaneously the spark will be reduced to $\frac{1}{16}$ of what it would be if it was opened at but one place.

The block to which the two circuit breaking springs are secured is connected to a screw so that said block and springs can be positioned or adjusted with reference to the cross bar on the governor lever.

By turning this screw to the right the block and springs are moved until the cross bar moves the springs away from their contact points or bars and disconnects the lamp from the circuit: the reverse movement places the lamp in circuit, and according to the proximity of the springs to the cross-bar of the governor lever so the amount of current to the burner is regulated. A stop is applied to the screw so that it can be turned only to a determined
4466 point which limits the amount of current passing to the
burner. I prefer that each burner shall give a light equal to 16 candles the burner being capable of giving 35 candle power without fusion.

As there may be a point where the revolving magnet after being at rest will not start when the current is put on, I use an automatic starter which consists of a light lever and thin armature turned edgewise which is attracted by the fixed magnet at the moment the current is put on. The movement of this lever which carries upon its end a click serves to give a sudden motion to the shaft of the revolving magnet by the click engaging in a ra*ck*et or toothed wheel secured to the shaft.

The click after making this movement passes beyond the ratchet and does not come in contact again until the magnet is stopped and the current is broken.

In the specification of my British patent No. 5306 of 1878, I have described the manner of coating the wire with pyroinsulating material. I employ that mode in coating the wire after which a coil of said wire is wound upon one or more li*me* supports and placed in a sealed bulb that is connected to a spengel vacuum apparatus and by gradually increasing the heat of the wire by the gradual rise in the strength of the current as described in the first part of this specification the wire is not only freed from air and rendered more refractory but the oxide is vitrified and shrinks upon the wire from which it cannot be detached.

The coil after passing through this process may be wound upon the lime bobbin of the lamp without breaking the pyroinsulation.

After the bobbin is wound and placed in the final bulb it has any air which may have passed into the oxides expelled by a gradual accession of current in the manner heretofore described and the bulb is then sealed.

The oxides of the alkaline material which are infusible attack the platina to a slight extent and as herewith greater tenacity to it than the oxides which do not attack it such as cerium or zirconium but the compound thus formed renders the wire more refractory.

It is not essential that the oxide should be in the form of a soluble salt as it may be put on the wire directly by mechanically mixing the oxide with water, alcohol, or other liquids, but special devices are requisite to keep the mixture in constant agitation to prevent settling.

It has been found very difficult to mould slender sticks of the oxides enumerated on account of the bending and breaking of the plunger of the mould which owing to the pulverulent nature of most of the oxides must be long and slender.

I have obviated this difficulty by devising a mould and plunger by which pressures to the crushing point of steel may be concentrated upon one quarter of an inch surface.

This apparatus is applicable to the moulding of any substance.

The block that receives the mould is of cast iron with a taper hole in the centre. The mould is made of three pieces and has the same taper as the hole in the block.

The object of the taper and split mould is to allow the pressed piece to be taken out without injury which it would receive were it forced out of the mould endwise.

The plunger is upon the end of a sliding stock and said plunger is only about $\frac{1}{4}$ of an inch long and about $\frac{3}{8}$ of an inch in diameter and it is adapted to pass downwardly into the hole in the centre of the split mould.

After the mould has been filled to the top with the pulverulent oxide a steel washer or punch section is placed upon the oxide and forced into the mould by the plunger. Afterward another punch section is placed upon the first one and forced into the mould in the same manner, thus sections may be added until the desired pressure is obtained without any disarrangement of the apparatus. So powerful is the pressure which may be obtained by this means that cylinders of the oxide of magnesium are rendered semi-transparent.

The cylinder of oxide thus obtained is placed on a lathe and the bobbin turned with a cutting tool without fear of breaking.

The electric generating machine which I propose to use consists of a powerful field magnet between the poles of which rotate an induction bobbin.

The cores of the field magnet are each three feet in length
4467 and about six inches in diameter and wound with a helix of
insulated copper wire having a resistance of about one ohm.

The number of coils and the resistance of the wire may of course be varied to meet various conditions. By the use of large masses of iron I am enabled to reduce the resistance of the magnetic circuit to a very low point and at the same time by reason of this large mass of iron of great magnetic conductivity, the use of a single layer of wire is possible thus obtaining the maximum economy.

The back or bar that connects the two cores of the magnet is of iron and is greater in mass than in the same length of core. The surface of both the back and the end of each core are ground together and are permanently secured by bolts and nuts. By thus employing a large mass of iron for the back and grinding the faces of contact to a point where air suction becomes powerful I reduce the resistance of this point to a minimum and prevent the appearance of free magnetic poles.

There are iron poles bolted to the cores the surfaces being ground together.

Between the two poles there is a circular aperture in which the induction cylinder rotates.

The cylinder may be of wood upon a shaft and at each end of the cylinder there is a wrought iron head.

This cylinder or bobbin is wound with fine wire until the wire is flush with the edge of the iron heads.

Over this cylinder is wound longitudinally the insulated induction wire the ends of which are connected to the commutator. The wire of the parallel induction helix is substantially endless and it is wound with reference to obtaining a continuous current.

The number of parallel coils may be more or less in number but I find the desired object can be obtained by using an even number of parallel coils longitudinally of the cylinder and an odd number of commutator plates.

There are two insulated disks upon the shaft of the field magnet and a metallic brush or spring is in contact with each disk, the line wires are connected to these disks. One end of the wire of the field magnet is connected to one disk and the other end of the wire is connected with one of the commutator brushes, the other commutator brush is connected with the second insulated disk.

The path of the current is through one insulated disk to the field magnet through it to one commutator block then through the induction coil to the opposite block on the commutator and by brush and wire the second insulated disk and thence to the line.

The current will be continuous or nearly so and travel in one direction there will however sometimes be a spark between the commutator bars when the circuit of the parallel induction coil is interrupted but this will be lessened by having the commutator springs bent to rest on more than one commutator bar.

It will be apparent that the shell and parallel induction coil may be revolved if the magnet cylinder remains stationary and I remark that the cylinder supporting the parallel induction coil may be of any suitable material but I prefer vulcanized fibre.

The parts of this machine are not liable to become heated under ordinary circumstances of use, because the wires are not wound one on the other and the atmosphere has an opportunity to circulate.

I however apply a fan in some instances upon the shaft of the field magnet within a case communicating with the internal portions of the machine so as to induce a current of air through the same.

As I have heretofore set forth the maximum economy of illuminating by electricity when using a great number of light giving points is only obtainable by working the resistance in multiple arcs, hence it is also necessary that the generating machines should also be worked in multiple arc.

To work a great number of machines in multiple arc with economy and reliability it is essential that all should have the same electro motive force and that means must be devised to prevent the insulating covering of the induction bobbin of any 4468 machine being burned should the same stop for any reason such as by the breaking of a belt, because if the wire of the bobbin cease to be the seat of an electro motive force the current from the other machines pass through it and tend to produce sufficient heat to destroy the insulation and at the same time cause a loss of available energy.

I prevent any such action by the use of a polarized magnet which prevents the electric circuit being opened by the direction of the flow of the current from the machine when in action tending to hold its tongue strongly against a contact point, but if the machine should stop and cease to be the seat of an electro motive force, a current from the other machines passes through the machine in a contrary direction whereupon the tongue of the polarized magnet is attracted from its contact point and the circuit opened.

Each machine being provided with this apparatus, it is freed from the danger aforementioned.

An ordinary magnet with its armature lever provided with a retractile spring might replace the polarized magnet but the margin for adjustment would be very small.

The resistance of the polarized magnet is made an exceedingly small fraction of the resistance of the machine to prevent loss of energy.

The field magnets of the machine are energized by supplying their helices with electricity from thermo-electric piles.

Compound condensing steam engines are employed at the large central stations to drive the magneto-electric machines and the heat given off from the surface condensers acts upon thermo electric piles to produce an electric current and the same is passed through the field of force helices.

The field magnets may all be connected in multiple arc and the thermo electric piles arranged in the same manner with appliances whereby the strength of all the field may be increased or decreased at pleasure, thus increasing or decreasing the electro motive force of the induction bobbins thus making it easy and convenient by the aid of electro meters at the central stations to counteract the rise and fall in the electro motive force on the main conductors when the maximum and minimum number of lamps may be working.

I will mention that the electro motive force of the machines is analogous to the pressure in the system of gas lighting and at dusk when the lamps are being rapidly connected to the circuit, the electro meter will show a slight drop on the electro motive force or pressure and this may be increased by increasing the speed of the prime mover or increasing the power of the field magnets, the later method is the one I prefer.

The surface condensers which I employ consists of a great number of iron pipes whose surfaces are painted with a thick coating of a non-conducting substance. The pipes after painting are about five inches in diameter.

Over these pipes are slipped rings of the double sulphide of lead and copper. These rings are cast in a mould and both the inner and outer edges are either covered or plated with copper.

The inner copper ring of one disk connects with the outer copper ring of the adjoining disk throughout the entire series of disks.

Owing to the exceedingly low resistance of these disks and the considerable electro motive force which they give between low range of temperature, very powerful currents are obtained and nearly as much energy is thus obtained in the form of an electric current from the waste heat of the engine as can be obtained from the engine itself through the medium of the Faradic machines.

In British letters patent No. 4226 of 1878 granted to me, a method is described and shown for measuring the total energy passing into the house of the consumer during a given period of time, the same consisting of a depositing cell or cells in which the weight of copper deposited by the current gives the indication.

Instead of the cell or cells shown two cells connected by a syphon may be used.

4469 In one cell is a solution of cupric sulphite and a copper electrode and in the other cell sulphuric acid and a copper electrode. No polarization takes place; the liquid of the syphon tube offers the requisite resistance.

The cells are sealed from the air to prevent loss by evaporation.

Any loss by this means may be made good by adding water, the results are nearly independ*a*nt of the strength of the solution.

The central stations are intended to light an area of $\frac{1}{4}$ of a mile in every direction. The method which I propose to adopt for conveying the current from the central station to various points consists in laying double wrought pipes lined with vulcanized rubber known as ebonite side by side under the flagging stones near the edge of the sidewalk. The pipes are to be in 20 feet lengths, the four ends passing into a cast iron box.

The pipes and box are water-tight.

The top of the box which is detachable has its upper surface even or flush with the walk, from the same box small tubes serve to convey wires from the main conductors to the houses of the consumers.

The wires forming the main conductors are small and may either be insulated and laid loosely together or insulated with a thin layer of cotton. In this case each consumers wire will be independent, but the economy is greater when the wires are all in contact, as then when few lamps are in use the resistance of the main conductor is relatively small as compared to the lamps.

The practice of causing the total resistance of the circuit extraneous to the generator to be equal to that of the generator and by which the maximum effect*s* is obtained from the machine, is very wasteful of energy, for by thus arranging the resistance fifty per cent. of the energy is lost in the machine itself, whereas if the exterior resistance is four times greater than the machine, the capacity of the machine to translate energy from one to the other is lessened, but of what is translated owing to the changed conditions 80 per cent may be utilized.

For this reason I so arrange the resistance of the main conductors that they should be but $\frac{1}{10}$ of the total resistance of all the lamps, and the resistance due to the *the* generating machines is kept down by keeping in multiple arc a greater number of machines than is necessary to supply all the lights which may happen to be in circuit at the time.

4470 Specification in pursuance of the conditions of the letters patent filed by the said Thomas Alva Edison in the Great Seal Patent Office on the 17th December, 1879.

Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, electrician. Improvements in electric lights and in apparatus for developing electric currents and regulating the action of the same.

I have ascertained that when wires or sheets of platina, iridium or other metallic conductors of electricity which fuse at a high temperature are exposed to a high temperature near their melting point in air for several hours by passing a current of electricity through them and then are allowed to cool, the metal is found to be ruptured and under the microscope there is revealed myriads of cracks in every direction many of which are seen to reach nearly to the center of the wire.

I have also discovered that contrary to the received notion, platinum, or platinum and iridium alloy loses weight when exposed to the heat of a candle, that even heated air causes it to lose weight, that the loss is so great that it tinges a hydrogen flame green, and under the influence of an electric current and at a yellow white heat, the loss is very great. After a time the metal falls to pieces, hence wire or sheets of platinum or platinum and iridium alloy as now known in commerce are useless for giving light by incandescence, 1st because its loss of weight makes it expensive and unreliable and causes the burner to be rapidly destroyed. 2nd because its electral resistance changes by loss in weight and its light giving power by the cracks or ruptures, the melting point being determined by the weakest spot where the greatest difference of potential of the electric current is present which causes this point to be brought to a higher heat than the rest of the surface of the wire. Again as it is essential to obtain a steady light the platinum burner must be screened from the air and when thus screened by being placed in a glass vessel, the glass soon becomes coated with a black deposit of platinum. A platinum spiral brought to incandescence under these conditions may be made to give a light of three standard candles when near its melting point and when the radiating surface is $\frac{3}{16}$ of an inch, but this amount of light will be rapidly reduced as before described.

From my researches and experiments I am led to believe that the cause of the rupturing of the metal when brought to incandescence is due to the action of the gases contained in the pores of the metal. These gases are probably compressed within the pores during the rolling or drawing of the sheet or wire. These gases or air when subjected to high heat are greatly expanded and rupture the metal and it cannot be driven out by slowly heating the metal

I have also discovered that the loss of weight and apparent volatilization of the metal is due to the action of the air or gases against the highly heated surface.—Having thus ascertained the cause of fracture and loss of weight I have conducted experiments to obviate these defects and have succeeded by the following method:—

A spiral of platinum wire is placed in a glass bulb with its ends passing through and sealed in the glass and the air exhausted from the bulb by a Sprengel pump until the discharge from a three inch induction coil will not pass between two subsid*u*ary wires in the bulb the ends of which are four millimetres apart: the wires of the spiral are then connected to a magneto electric machine or battery whose current can be controlled by the addition of resistance. Sufficient current is allowed to pass through the wire to bring it to about 150° Fah: it is allowed to remain at this temperature for 10 or 15 minutes. While thus heated the air or gases in the pores of the metal are expelled by the action of the heat and the expansion of the gases which tend to pass outward in consequence of the vacuum.

While the air or the gases are passing out of the metal
4471 the mercury pump is kept continuously working. After the
expiration of about fifteen minutes the current passing through the metal is to be augmented so that its temperature will be about 300° Fahr. and it is allowed to remain at this temperature for another ten or fifteen minutes. If the mercury pump be worked continuously and the temperature of the spiral raised at intervals of ten or fifteen minutes until it attains vivid incandescence and the bulb be then sealed the metallic wire is then in a state heretofore unknown for it may have its temperature raised to the most dazzling incandescence emitting a light of twenty five standard candles, whereas before treatment the same spiral would only emit a light equal to three candles before attaining the melting point.— The wires subjected to the process of freeing them from air and gases are found after the process to have a polish exceeding that of silver and attainable by no other means, no cracks can be seen even after the spiral has been raised suddenly to incandescence many times by the current and no volatilization takes place as there is no deposit upon the glass bulb, nor does a delicate balance show*n* any loss of weight in the spiral even after said spiral has been burning for many hours continuously because the spiral is in a vacuum so nearly perfect that the action of the gaseous molecules is reduced to the minimum and were it possible to obtain an absolute vacuum there would be no loss whatever.

I have further discovered that if an alloy of platinum and iridium or even platinum be coated with the oxide of magnesium in the manner hereafter stated and subjected to the vacuum process described, that combination takes place between the metal and the oxide giving the former remarkable qualities. With a spiral having a radiating surface of $\frac{3}{16}$ of an inch, light equal to that given by forty standard candles may be obtained whereas the same spiral not passed through my process would melt before giving a light of four candles. The effect of the oxide of magnesia is to harden the wire to a surprising extent and render it more refractory.

A spiral spring made of the wire is as elastic and springy when at dazzling incandescence as when cold.

I have found that chemically pure iron and nickel drawn in wires and subjected to the vacuum process may be made to give a light equal to that of platinum in the open air.

Carbon sticks may be also freed from air in this manner and be brought to a temperature that the carbon becomes pasty and if then allowed to cool is very homogeneous and hard. Rods or plates made of mixtures of finely divided conducting and non conducting materials may thus be freed from air.—It is also obvious that the metal might be heated by subjecting the containing bulb to a considerable temperature but this only partially frees the wire from its air or gases.

I will now describe the form of burner or lamp which I employ:—To operate several hundred electric lamps practically, each equal to an ordinary gas jet, upon one circuit, it is essential for many reasons both on the score of economy, facility and reliability, to place them all in multiple arc, and to prevent the combined resistance of several hundred lamps from falling to such a low point as to require main conductors of immense dimensions with low resistance and generating machines of corresponding character, it is essential to reverse the present and almost universal practice of using lamps which shall have but one or two ohms resistance and construct lamps which shall have when giving their proper light, a resistance of several hundred ohms, because the more lamps there are in the circuit the less will be the resistance. I have ascertained by experiment that the loss of energy is in proportion to the extent of the radiating surface independent of the resistance of the conductor, hence we have 1,000 lamps each of $\frac{1}{4}$ of an inch radiating surface, and each of one ohm resistance, or 1,000 lamps having the same radiating surface and 1,000 ohms resistance each, the loss of energy from each lamp when giving each a light of 15 candles will be nearly the same, but the combined resistance of the one ohm lamps will be $\frac{1}{1000}$ of an ohm, requiring an enormous main conductor,
4472 whereas the combined resistance of the 1,000 ohm lamps will be one ohm, requiring a conductor of very moderate dimensions—In practice a resistance of 200 to 300 ohms in the burner will be sufficient—Again with lamps of low resistance the lamp connections and leading wires must be large to prevent great loss of energy by resistance, the leading wires from the main conductors are large expensive and bulky to handle, the low resistance of the burner or incandescent conductor requires large terminals to convey the current and these offer by their conduction a medium for the rapid dissipation of energy without producing any effect, whereas with a lamp of high resistance all these objections are obviated.

My burner *b*, consists of a bobbin composed of an infusible oxide such as oxide of calcium, cerium, zirconium, magnesium, freed from silica and turned in a lathe from sticks molded by hydraulic pressure in a manner hereinafter set forth, and upon this bobbin fine wire of platinum or platinum-iridium alloy is coiled. This bobbin is shown in Fig. 1. It is secured to two platinum wires 1. 2. as in Fig. 2. These wires serve to hold the bobbin in the center of the sealed glass vacuum bulb and at the same time serve as conductors of the electric current to the wire coiled upon the bobbin.—Fig. 3. shows the manner of connecting the wire upon the bobbin to the platina supports. The two platina wires 1. 2. are first passed through a small tube *a*. of glass and the glass melted around the wires: the burner *b* is introduced into the bulb *c*. and the wires 1. & 2. are passed out through the sides of the narrow neck leading from the bulb and the glass is melted around them to prevent leakage; the glass of the neck is melted to the small glass tube *a*. Before the burner is permanently sealed at the neck, the air pump is connected therewith and the wire upon the bobbin is subjected to the vacuum process heretofore described and the electric current is used to produce incandescence for about one hour to heat the bobbin and thereby expel*l* the air and gases after which the bulb is permanently sealed by melting the glass of the neck and it is ready to be used as a lamp as represented in Fig. 4.

The method which I adopt for regulating the light radiated from the burner consists in a small rotating magnet provided with a governor which serves to open the lamp circuit when the strength of the current is greater than is necessary to produce the proper light in the bobbin. This apparatus is very reliable and although the current supplied is not perfectly continuous the total energy passing to the lamp in one hour is nearly the same, no matter what the current strength may be, the magnets being so arranged that the continuous metallic circuit cannot be broken by the commutator of the revolving magnet and the extra current produced by the reversal of the current in the revolving magnet is short circuited by the fixed magnet hence the sparks which would occur at the break-points of the governor are prevented. Referring to Fig. 4. *b*. is the bobbin with the platinum iridium wire which forms the electric lamp. *c* is the sealed glass bulb. *f*. and *g*. are supports to hold the bulb in position; these are insulated from each other.—The platinum wires 1. and 2. from the bulb are connected to these supports.

m. is a box for supporting the lamp and enclosing the governor. *n*. is the back of the fixed magnet consisting of the spools o. o^1. p. p.^{1} are the spools of the revolving magnet: *r*. is the back of the same which is secured permanently to the shaft *q*. upon which is a revolving commutator *s*. This commutator consists of a ring of insulating material whose periphery is faced with platina and cut in two parts, one part being connected by the wire 5. to the magnet p^1. and the other part by the wire 4. to the magnet *p*. The wire 65. connects the two spools *p*. and p^1, together.

Rubbing on this ring are two contact springs s^1. t^1. which serve to convey the currents to the revolving magnet The current passes through the fixed magnet o. o^1. see diagram Fig. 5. thence by wires 4. 5. springs s^1. t^1. through the revolving magnet p. p^1. The rotation of the magnet is kept up by the reversal of the direction of the flow of the currents through the revolving magnet.—When the cores of the revolving magnet are nearest the cores of the fixed magnet, the direction of the current through the former is reversed by the action of the springs s^1. t^1. upon the commutator and
4473 the polarity changed hence the attraction ceases, but the

momentum of the magnet *p*. p^1 carries it forward and mutual attraction again takes place as the revolving cores approach the stationary cores, the current is reversed and the revolution continued.

Connected to the revolving shaft *q*. is the governor which consists of two collars *v*. *w*. connected by springs 6 & 7: the collar *v*. is permanently secured to the shaft while the collar *w*. is free to slide up and down upon it.—Each spring is provided at its center with a weight and these weights act centrifugally to bow outwardly the springs and raise the collar *w*. upwardly more or less in proportion to the speed of revolution. Connected to *w*. by a sleeve is another collar 19. upon the surface of which rests the end of the circuit opening lever *l*. which rises and falls by the action of the governor. A spiral spring l^1. see Fig. 5. on the axis of the lever *l*. serves to keep *l*. in contact with 19. Upon the exetrme end of the lever *l*. is a block 18. in juxtaposition to circuit breaking springs 8 & 9. and serves to disconnect the springs simultaneously from the metallic block 10. when the governor and shaft has reached a certain velocity.—The block 10. is insulated from the frame 11. and serves to keep the circuit closed between the springs.

The current passes by wire 84. to the spring 8. thence across the block 10. to the spring 9. thence to the magnet and lamp by wire 85.

The object of employing two springs is to open the circuit in two places simultaneously and thus reduce the spark which it does in the ratio of the square of the number of simultaneous breaks.—This method of breaking the circuit simultaneously in many places is applicable to all kinds of electrical apparatus where large and powerful sparks occur as for instance if it is desired to transfer electric energy from one point to another by dynamo electric machines. The distant machine which serves to give out the power for driving machinery may be provided with a governor the same as herein shown and the circuit may be opened in several places simultaneously by the action of the governor shown in Fig. 6. *l*. is the lever operated by the governor. 12 and 13. are contact springs which rest upon the bar 43. 14. and 15. are also contact springs which rest on the bar 44. The current passes by wire 84. to spring 12. across the bar 43. to spring 13. thence by wire 45. to spring 14. across bar 44. to spring 15. to wire 85. When the governor reaches a certain velocity, the insulated piece 18. of the lever *l*. comes in contact with all the springs simultaneously and separates them from the bars 43. & 44. thus opening the circuit in four places simutaneously the spark is reduced to $\frac{1}{16}$ of what it would be if a single break was used. Having shown the importance of breaking the circuit simultaneously in many places, I will now describe how the illumination of the burner *b*. may be increased or decreased or stopped entirely.

Referring to Figs. 4. & 5. *t*. is the thumb nut for regulating the speed of the revolving magnet and consequently the amount of energy which passes to the burner. The nut 22. is provided with a slot or groove containing a stationary pin p^2. and into the nut 22. the screw 20. passes and by turning this screw the block 10. may be drawn inwardly or forced outwardly, said block running on two guide pins 23. 24. which prevent the block from turning, thus the block 10. may be made to approach or recede from the lever *l*.

If it is desired to turn off the light and disconnect the lamp altogether from the circuit, the screw is turned to the right until the block 18. separates the springs 8. & 9. from the block 10 and opens the circuit. In this position the circuit is broken and the lamp and magnets are entirely disconnected from the circuit.

If it is desired to have the lamp give light the screw is turned to the left: when the springs 8 & 9. come in contact with the block 10. and close the circuit, the magnets immediately revolve and if the parts are left in such a position that the piece 18. is in close proximity to the springs, the rotation of the magnet will operate the governor and lessen the pressure of 8. and 9. on 10. and hence the speed will be comparatively slow and the electricity passing to the light will be very small and but little light will be given
4474 out, but by causing the block 18. to further recede from 8 &
9. the speed of the magnet will increase and more energy will pass to the lamp in a given time.

By continued turning of the screw 20 a point may be reached where the governor lever *l*. will not separate the springs 8 & 9. from 18; in this case the entire electric energy passes through the bobbin *b*. but in practice limiting stops are applied so that when the screw has been turned a certain distance the further movement will be prevented by the action of the stops, thereby determining the maximum light which the consumer can obtain from the burner. In practice this will be about sixteen candle power, the burner being capable of giving thirty-five candle power without fusion.

As there may be a point where the revolving magnet after being at rest will not start when the current is put on, I use an automatic starter which consists of a light lever and thin armature turned edgewise which is attracted by the fixed magnet at the moment the current is put on. The movement of this lever which carries upon its end a click serves to give a sudden motion to the shaft *q*. by the click engaging in a ratchet or toothed wheel which is secured to it. The click after this movement passes beyond the ratchet and does not come in contact again until the magnet is stopped and the current is broken.

In the specification of my British patent No. 5306 of 1878, I have described the manner of coating the wire with pyroinsulating material: I employ that mode in coating the wire after which a coil of said wire is wound upon one or more bobbins and placed in a sealed bulb and connected to a vacuum apparatus and by gradually increasing the heat of the wire by the gradual rise in the current strength as described in the first part of this specification, the wire is not only freed from air and rendered more refractory but the oxide is vitrified and shrinks upon the wire from which it cannot be detached. The coil after passing through this process may be wound upon the lime bobbin of the lamp without fear of breaking the pyroinsulation. After the bobbin is wound and placed in the final bulb any air which may have passed into the oxides is expelled by a gradual accession of current in the manner heretofore described and the bulb is then sealed. The oxides of the alkaline materials which are infusible attack the platina to a slight extent and adhere with greater tenacity to it than the oxides which do not attack it, such as cerium or zirconium but the compound thus formed renders the wire more refractory.

It is not essential that the oxide should be in the form of a soluble salt as it may be put on the wire directly by mechanically mixing the oxide with water, alcohol or other liquids, but special devices are required to keep the mixture in constant agitation to prevent settling.

It has been found very difficult to mold slender sticks of the oxides spoken of on account of the bending and breaking of the plunger of the mold, which owing to the pulverulent nature of most of the oxides, must be long and slender.

I have obviated this difficulty by devising a mold and plunger by which pressures to the crushing point of steel may be concentrated upon one quarter of an inch surface. This apparatus is applicable to the molding of any substance and it is shown by a vertical section in Fig. 7. Fig. 8, is a plan of the divided mold. a^2. is the plunger; upon the extreme end is the part d^2. which enters the die or mold. This is only about one-quarter of an inch long and about three eighths of an inch in diameter and it is adapted to pass downwardly into the mold.

e^2 is a solid block of cast iron with a taper hole in its center and into this the divided steel mold f^2. is forced; this mold is made of three pieces and has the same taper as the hole in the block e^2. The object of the taper and divided mold is to allow the pressed piece to be taken out without the injury it would receive were it forced out of the mold endwise.—After the mold has been filled to the top with the pulverulent oxide, a steel washer or plunger section h^2. is placed upon the oxide and forced into the mold by the plunger; afterwards another plunger section is placed upon the first one and forced into the mold in the same manner. Thus sections
may be added until the requisite pressure is obtained with-
4475 out any disarrangement of the apparatus. So powerful is
the pressure which may be obtained by this means that cylinders of the oxide of magnesium are rendered semi-transparent.—The cylinder of oxide thus obtained is placed in a lathe and the bobbin turned with a cutting tool without fear of breaking.

The electric generating machine which I propose to use consists of a powerful field magnet between the poles of which rotate an induction bobbin. This apparatus is shown by a vertical section in Fig. 9, and sectional plan Fig. 10. F. is the field magnet the cores of which are about three feet in length and the diameter about six inches wound with a helix of insulated copper wire having a resistance of about one ohm.—The number of coils and the resistance of the wire may of course be varied to meet various conditions.—By the use of large masses of iron I am enabled to reduce the resistance of the magnetic circuit to a very low point and at the same time by reason of this large mass of iron of great magnetic conductivity, the use of a single layer of wire is possible, thus obtaining the maximum economy. a^3. is the back of the magnet and the mass of iron is greater than in the same length of core. The surface of both the back and the end of each core are ground together and are permanently secured by bolts and nuts. By thus employing a large mass of iron for the back and grinding the faces of contact to a point where air suction becomes powerful, I reduce the resistance of this point to a maximum and prevent the appearance of free magnetic poles.—a^4. a^5. are iron poles bolted to the cores, the surfaces being ground together. Between the two poles there is a circular aperture in which the induction cylinder rotates. The cylinder b^3. is preferably of wood upon the shaft b^4, and has wrought iron heads b^5. This cylinder is wound with fine iron wire b^6. until the wire is flush with the edge of the iron heads b^5. Over this cylinder is wound longitudinally the insulated induction wire in sections, the ends of which are connected to the commutator i^4. as in Fig. 11. There are heads e^3. of hard rubber, vulcanite fiber or equivalent material secured to the shaft b^4. see Figs. 16. and 17, outside the heads b^5. and are of larger diameter so that the induction wires e^4. that are wound longitudinally may be kept from contact with the iron helix b^6. or heads b^5. so that the current may not be short circuited even if the insulation of the induction wires e^4. is imperfect.—e^5. is a pulley for driving the machine. e^6. is a loose pulley upon which the belt from the driving shaft is thrown by a shifter when the machine is to be stopped.

d^3. is a switch by means of which the circuit from the Faradic machine may be opened—d^4 and d^5. are the commutator springs. h^3. is a polarized magnet included in the circuit which serves automatically to open the circuit should a reverse current be sent through the machine. The connections are as follows:—From the post i^3. to the commutator i^4 thence through the induction helix e^4. to the opposite side of the commutator and by the brush d^5. to the switch d^3. thence to the tongue of the magnet h^3. if the switch lever is in contact with i^5. thence through the tongue of h^3. to the point i^5. and through the magnet h^3, to the post h^6. The wire upon the field magnet is connected to the clamping posts l^3. and l^4. I will now describe the method of winding the induction cylinder and the direction of the current relative to the commutator brushes.—The wire of the parallel induction helix is substantially endless and it is wound with reference to obtaining a continuous current: the diagram Fig. 11. illustrates the manner of winding the wires; the number of parallel coils may be more or less than that shown, but I find the object desired can be attained the best by using an even number of parallel coils longitudinally of the shaft and an odd number of commutator plates. Starting say from the part b. of the commutator the wire passes to the space 4. on one head e^3. to the same space on the other head, then across the head to the space 11. and to the same space on the other head, then across the head to the space 4. and so on until the spaces 4 and 11 are filled with the

wire and when the last turn in 11. has been laid, the wire is led to
the plate *c.* and then the spaces 2. and 9. are filled and the wire
4476 from 9. led to *d;* then 14, and 7. and a connection made with
e; then 12. and 5. connecting with *f.* then 10. and 3. connecting with *g.* then 8. and 1. connecting with *a.* then 6 and 13. connecting with *b.* the place of beginning.

I wind the wires in such a manner that while the current is continuous and the current flowing through the whole of it, the current will pass by two wires of the induction coil to one commutator plate and then away and will enter by an opposite commutator plate and pass by two wires out into the coil and circulate through the same to the other commutator plate. Suppose the springs to rest upon commutator plates *a.* and *e.* the current will flow towards *a.* from wires 1. and 6. and away from *e.* by wires 12. and 7. By following the arrows it will be found that the entire coil is a complete circuit in which the parallel portions of the wires in the south field of magnetic influence have a current energized in one direction and in the north field in the other direction, thus obtaining the dynamic effect, and there is no break or pulsation of the current, the springs touch one commutator before leaving another.

As I have heretofore set forth the maxim economy of illuminating by electricity when using a great number of light-giving points is only obtainable by working the resistance in multiple arc, hence it is essential that the generating machines should also be worked in multiple arc. To work a great number of machines in multiple-arc with economy and reliability it is essential that all should have the same electro motive force and that means must be devised to prevent injury, by burning, to the insulating covering of the induction coil of any machine, should said machine stop for any reason such as by the breaking of a belt, because if the wire of the induction coil ceases to be the seat of an electro-motive force, the current from the other machines pass through it and tend to produce sufficient heat to destroy the insulation and at the same time cause a loss of available energy.

I prevent any such action by the use of the magnet h^3. Fig. 10. which being polarized is prevented from opening the electric circuit by the direction of the flow of current from the machine when in action, tending to hold its tongue strongly against the contact point i^5. but if the machine should stop and cease to be the seat of an electro-motive force, a current from the other machine tends to pass through the machine in a contrary direction, whereupon the tongue h^3. is detached from the point i^5. and the circuit opened. Each machine being provided with this apparatus is thus freed from the danger described. An ordinary magnet might replace the polarized one and a retractile spring used but the margin for adjustment would be very small.

The resistance of the magnet h^3. is made an exceedingly small fraction of the resistance of the machine to prevent loss of energy.

The field magnets of the machine are energized by supplying them with electricity from thermo electric piles.

Compound condensing steam engines are employed at the large central stations to drive the magneto electric machines and the heat given off by the surface condensers act upon the thermo electric piles to produce an electric current and the same is passed through the field of force helices.

The field magnets may all be arranged in multiple arc and the thermo electric piles arranged in the same manner with appliances whereby the strength of all the field magnets may be increased or decreased at pleasure, thus increasing or decreasing the electro motive force of the induction bobbins, thus making it easy and convenient by the aid of electrometers at the central stations to counteract the rise and fall in the electro motive force on the main conductors when the maximum and minimum number of lamps may be working.

I will mention that the electro-motive force is analogous to the pressure in the system of gas lighting and at dusk when the lamps are rapidly being connected to the circuit, the electrometer will show a slight drop on the electro-motive force or pressure, and this may be increased either by increasing the speed of the prime mover or an increase in the power of the field magnets; the latter method is the one I prefer.

4477 The surface condensers which I employ consist of a great number of iron pipes whose surfaces are painted with a thick coating of a non-conducting substance. The pipes after painting are about five inches in diameter. Over these are slipped rings of the double sulphide of lead and copper. These rings are cast in a mold and both the inner and outer edges are either covered or plated with copper. In Figs. 12. and 13. m^3. is the ring or disk of double sulphide m^4. the copper ring fitted in the hole of m^3. m^5 is a copper ring which fits over the circumference of m^3. to this ring a binding post and strip or wire m^6. is secured, the latter to connect to the next disk. m^7 represents one of the condensing pipes.

m^8. m^9. m^{10} & m^{11} a series of disks arranged to give a current. The inner copper of m^8. connects to the outer copper of m^9 and in this manner to many hundreds of disks. Owing to the exceedingly low resistance of these disks and the considerable electro motive force which they give between low ranges of temperature, very powerful currents are obtained and nearly as much energy obtained in the form of an electrical current from the waste heat of the engine as can be obtained from the engine itself through the medium of the Faradic machines.

The central stations are intended to light an area of $\frac{1}{4}$ of a mile in every direction. The method which I have adopted for conveying the current from the central station to various points, consists in laying double wrought pipes lined with vulcanized rubber known as ebonite, side by side under the flagging stones near the edge of the sidewalk.—The pipes are to be in twenty feet lengths, the four ends passing into a cast iron box.—The pipes and box are water tight. Fig. 14. is a vertical section of one line of pipe and Fig. 15. is a perspective view representing the box and two lines of conductors.

For electric lighting purposes I employ a main conductor M composed of many wires uninsulated from each other but insulated as a whole from the earth by the ebonite coating of the pipe P. but for telegraphic purposes each of the small wires instead of acting as parts of one main conductor are to be insulated from each other by being coated with cotton and afterwards passed through an insulating substance such as resin, tar, paraffine or other non-conductor.

By first putting down pipes P. in sections of say twenty or twenty five feet and boxes B. between the sections, wires may be introduced sufficient for the purpose at the time, and in the future the number of wires may be increased by drawing others through the pipes. The boxes B. allow for introducing or guiding the wires by hand. In practice it will be preferable to employ small pulleys in each box with a stout cord running backward and forward through the line of pipe, for drawing the wire through each section.—The box has a cover *c.* which is bolted to it, and soft rubber, or oiled leather washers are placed between the top and the box to prevent air or water leaking into the box. The inside of the box and cover is to be lined with ebonite or other non-conducting and water proof material. One end of the system of tubes passes into the central station and if the other ends are closed a vacuum may be produced within the whole system of pipes: this will promote the evaporation of any moisture which may have passed into the pipes but the vacuum will only be required periodically. If the two ends pass into central stations warm dry air may be passed through occasionally to prevent dampness.—In the system of electric lighting two lines of pipes are employed on each side of the street but these may be separate and have independent boxes; I prefer that both lines of pipes on each side of the street should be connected to one range of boxes as illustrated in Fig. 15. A small pipe *s.* insulated with rubber is connected at right angles to the main pipes and passes from one of the boxes into the house to be illuminated and carries the conductor which may be made of one or more wires: from the other main conductor another small tube *s.* serves to carry the second wire to the house. These wires entering the house through the meter are carried into various rooms and the electric lamps connected in multiple arc between the two. The wires forming the main conductors are small and as mentioned previously may be uninsulated and laid loosely together or insulated with a thin layer of cotton. In the latter case each consumer's wire would be independent but the economy is greater when the wires are all
4478 in contact as then when few lamps are in use the resistance
of the main conductor is relatively small as compared to the lamps. The practice of causing the total resistance of the circuit extraneous to the generator to be equal to that of the generator almost universally prevails, and by which the maximum effect is obtained is very wasteful of energy, for by thus arranging the resistances fifty per cent. of the energy is lost in the machine itself, whereas if the exterior resistance is four times greater than the machine the capacity of the machine to translate energy from one to the other is lessened, but of what is translated, owing to the

changed conditions, eighty per cent. may be utilized.—For this reason I so arrange the resistance of the main conductors that they should be but one tenth of the total resistance of all the lamps, and the resistance due to the generating machines is kept down by keeping in multiple arc a greater number of machines than is necessary to supply all the lights which may happen to be in circuit at the time.

I claim as my invention

First. The combination with a sealed vacuum chamber made of a glass vessel, of a continuous incandescent conductor wound upon a bobbin of infusible material, substantially as set forth.

Second. The method herein described of preparing metals and metallic conductors for electric lamps or burners, consisting in freeing the metallic conductors of gases in a vacuum and then hermetically sealing the surrounding air tight transparent case, substantially as specified.

Third. In an electric lamp, the combination with a sealed transparent vacuum case of a bobbin of pyroinsulated wire wound upon an infusible substance substantially as specified.

Fourth. In combination with an electric light and the circuits thereof, two electro-magnets one of which is caused to revolve, a governor operated by the speed, and a circuit regulator controlled by the governor, whereby the uniformity of the current passing to the light is maintained, substantially as set forth.

Fifth. In combination with an electric light, an adjustable circuit regulator composed of the insulated springs connected with the circuit wires, a contact block upon which said springs rest, and a governor lever l to regulate the pressure of the contact springs upon the contact block, substantially as set forth.

Sixth. The process of molding sticks of pulverulent material consisting in filling the mold with the material to be compressed and then compressing the mass by successive operations by means of a plunger and plunger sections, substantially as described.

Seventh. The divided mold f^2 and block e^2 in combination with the plunger a^2 and plunger sections h^2 substantially as and for the purposes set forth.

Eighth. The combination in a magneto electric machine of the helix of wire b^6 and the wires e^4 wound and connected to the commutator blocks i^4 as described and forming a parallel induction coil that occupies the space and revolves between the poles of the field magnet, substantially as set forth.

Ninth. The combination in a magneto electric machine of the magnetic cylinder composed of the helix b^6 surrounded by the parallel induction coil e^4 and revolving between the poles of the field magnet, the commutator i^4 springs d^4 and d^5 and circuit connections substantially as set forth.

Tenth. In a magneto electric machine, a parallel induction coil the wires of which are wound substantially as shown in Fig. 11, and commutator connections to the wires whereby the current is taken off from the parallel induction coil at two points in opposite directions, substantially as set forth.

A.D. 1879. June 17. Nº 2402.
EDISON'S SPECIFICATION.
(4th Edition)

FIG.1.

FIG.2.

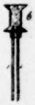


FIG.3.

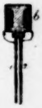


FIG.4.

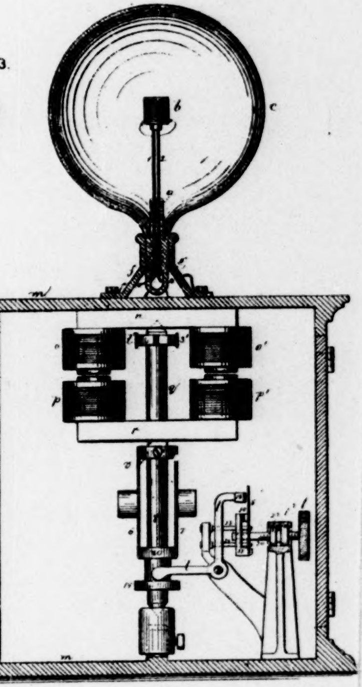

b
c
m
n
o
o'
p
p'
r
m

FIG.6.

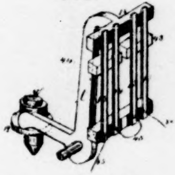
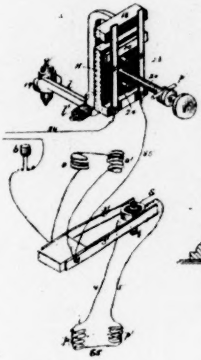


FIG.5.



Eleventh. The cylinder b^3 of wood or similar material with the iron heads b^5 and intervening helix of wire b^6 in combination with the disks e^3 of non-conducting material and the induction helix e^4 wound lengthwise and into notches in the edges of the insulating disks, substantially as set forth.

Twelfth. A polarized electro-magnet in the multiple arc circuit of the magneto electric machine for opening the circuit to the machine to which it is connected in case of dera-gement of said machine.

4479 Thirteenth. The thermo-electric piles connected as set forth upon the condensing pipes of an engine in combination with the magneto-electric machine substantially as set forth.

Fourteenth. The combination with the electric conductors M. of metallic tubes lined with hard rubber or similar non-conducting substance, substantially as set forth.

Fifteenth. The metallic tubes lined with non-conducting material such as hard rubber, in combination with metallic boxes B lined with similar material, and uniting the tubes and the conductors passed through such tubes substantially as set forth.

Sixteenth. An induction bobbin nearly surrounded by the poles of the field magnet and the combination therewith of an abnormally large field magnet which shall be in proportion to the size of the pole-pieces as described, for obtaining a powerful electro-motive force in the wires of the revolving bobbin without great loss of energy as set forth.

In witness whereof I have hereunto set my hand and seal this twenty-fifth day of November, A. D. 1879.

THOMAS ALVA EDISON. [L. S.]

Witnesses:

S. L. GRIFFIN, of Menlo Park, N. J.
WM. CARMAN, of Menlo Park, N. J.

London: Printed by Eyre and Spottiswoode, printers to the Queen's most excellent majesty. For her majesty's stationery office.

(2867.—100.—5 | 86.)

(Here follows diagram marked p. 4480.)

4481

MINISTÈRE DU COMMERCE.

Brevets d'Invention.

Mémoire descriptif annexé au brevet d'invention de quinze ans pris, le 18 Décembre, 1872, par la compagnie d'éclairage électrique Lodyguine et Cie et qui lui a été delivré par arrête du Ministre de l'Agriculture et du Commerce, en date de 19 Mars, 1873, pour un mode d'éclairage électrique et les appareils y employés.

Brevet No. 97583.

Le nouveau mode de éclairage électrique que nous avons inventé et que nous exposons ici diffère essentiellement de ceux connus et employés jusqu'a ce jour.

La lumière électrique obtenue à l'aide des appareils actuellement en usage, est due à la translation, de particules incandescentes d'un conducteur à l'autre et à la réaction chimique produite par une température élevée entre ces particules et l'oxygène de l'air ambiant Cette haute température se produit lorsque les bouts des conducteurs se trouvent placés à une certaine distance l'un de l'autre. L'éclat de la lumière obtenue est d'autant plus grand que les corps employés connue conducteurs de l'électricité.

4482 Notre nouveau mode d'éclairage électrique repose sur le propriété que possède le courant d'échauffer et de porter à la température rouge les corps mauvais conducteurs de l'électricité.

La figure (1) du plan, que nous joignons à cet exposé, montre la difference qui existe entre les appareils employés jusqu'à ce jour et ceux dont nous sommes les inventeurs.

A représente les conducteurs d'un appareil ordinaire, *a a* sont les extrémités taillées en point de ces conducteurs. C'est entre ces extrémités que se produit l'arc lumineux.

La figure B représente les conducteurs dans notre nouvel appareil. Il est formé d'un corps mauvais conducteur de l'électricité. C'est la parte qui dans ce conducteur s'échauffe sous l'influence du courant électrique, arrivé à la température rouge et devient par suite lumineuse.

Dans les appareils employés actuellement la production de la lumière électrique est due à la combustion des extrémites des conducteurs qui pour cela même se détériorent promptement et qui doivent être remplacés souvent.

4483 Dans nos nouveaux appareils et d'après notre nouvelle méthode, le conducteur est plongé dans un gas avec lequel il ne reágit pas; il n'est soumis à aucune combustion et cependant il y a production de lumière.

Cette Lumière est obtenue non par une réaction chimique, mais par une action mécanique, par le passage d'un courant électrique d'une grande puissance à travers notre conducteur, qui est alors porté au rouge et devient lumineux.

Il n'est d'ailleurs nullement détérioré par la haute température à laquelle il est soumis, et ne demande pas par conséquent à être renouvelé fréquemment.

Avec les appareils employés actuellement pour produire la lumière électrique, l'on ne peut obtenir par le passage d'un courant que quatre points lumineux. D'après notre méthode et avec nos appareils on peut en obtenir plusieurs milliers. Ainsi, augmentation du nombre des points lumineux obtenus, conservation intégrale des conducteurs, telles sont les différences qui existence entre un éclairage électrique coûteux et un autre très bon marché, celui- là même dont nous sommes les inventeurs.

La lumière obtenue avec les appareils actuels a un tel éclat que la vue peut à peine la supporter. D'après notre nouveau mode
d'éclairage, cet éclat peut être diminué a volonté de 10
4484 à 15 fois, lumière produite par les appareils ordinaires est
inégale et vacillante, inconvénient des plus graves pour la vue.

Au contraire la lumière électrique produite par nos nouveaux appareils peut par son bon marché, par la douceur et la fixité absolue de son éclat rivaliser avec tous les modes d'éclairage actuellement employés.

Afin d'obtenir un courant électrique d'une grande puissance, nous employons les machines électro-magnétiques de Ledda Wilda Nolle et autres beaucoup moins coûteuses que les batteries galvaniques et produisent en outre un courant d'uen intensité bien plus grande.

Les lanternes que nous avons imaginées pour utiliser notre nouveau mode d'éclairage électrique sont représentées par les figures 2 et 3 de la planche ciannexée.

La figure 3, se compose d'un manchon en verre terminé à ses deux extremités par des montures métallique t'' t''', que traversent les conducteurs F^2 F^3 F^4 F^5. Le mauvais conducteurs m' m' communique avec la machine electro-magnetique par un fil metallique f^2. L'autre m'' m'' est mis en communication avex m' m' par le monture t''' même de la lanterne. Le courant amené par le fil
metallique F^2 passe par le conducteur m' m' qu'il porte au
4485 rouge traversé par F^3, la monture t''', arrive par F^4 dans le
conducteur m'' m'' qu'il porte également au rouge et passe
ensuite dans la lanterne suivante par le fil de fer F^5.

La seconde lanterne Fig. 2, se compose comme la première d'un manchon en verre, terminé aussi a ses extremites par des montures metalliques.

Cette lanterne ne possède qu'un seul conducteur m m. Le courant entrant par le conducteur m m qu'il porte au rouge et ressort par le fil de fer F^1.

Les pièces métalliques q et q' (figures 2 et 3) fixées la première par la charnière 1 au couvercle t', la seconde au fil de fer F^2 par la charnière l', serviraîent a intercepter le courant, dans le cas où une ou plusieurs lanternes ne devraient pas être utilisées.

En effet, si F^2 n'est pas mis en communication avec F^5 par la pièce q', le courant forcée de passer par le conducteur m' m' le portera au rouge. Si au contraire la pièce q' se trouve abaissée sur le crochet r', le courant la suivra et sortira par le fil métallique F^5.

En effet la pièce en métal est un meilleur conducteur de l'électricité que les conducteurs m' m', m'' m''.

Il en serait de même pour la lanterne représentée par la
4486 figure 2. Si la piece metallique q fixée à la monture t' par
la charnière l, s'appuie sur la crochet r, le courant ayant à

choisir entre le conducteur m m et la pièce métallique q, qui est un meilleur conducteur de l'électricité, suivra évidemment. Cette dernière m m se trouvant donc plus sur le passage du courant ne sera pas porté au rouge et par suite ne deviendra pas lumineux.

Dans le cas où l'on ne voudrait utiliser aucune des lanternes, il suffirait évidemment d'arrêter le mouvement de la machine électromagnétique.

Les conducteurs m, m', m'', doivent être en coke, en graphite ou toute autre substance qui pourrait servir au même but et qui remplirait les mêmes conditions.

Les lanternes elles-mêmes formées comme nous l'avons dit de manchons en verre n, n'' fermées à leurs extrémités par des montures métallique t, t', t'', t''', forment réservoirs n^2 n^3, qui sont remplis d'azote ou d'un autre gaz inerte et ne pouvant donner lieu à aucune combinaison chimique avec les conducteurs m, m', m''.

Les réservoirs n^2 n^3 peuvent être cylindriques prismatiques ou avoir toute autre forme. Il en est de même des conducteurs m, m', m''. En outre chaque lanterne peut contenir un ou plusieurs de ces conducteurs.

4487 Les lanternes ou reservoirs n^2 n^3 doivent être fermées hermêtiquement. Comme nous l'avons déjà dit les montures sont métalliques. Elles se composent de disques. C'est en outre dans ces rebords que vient s'emboiter le manchon de verre n.

Le fils de fer F, F', F^2 F^5 passent par des ouvertures f, f' f^2 pratiquées dans les montures métalliques t, t', t''.

Dans la lanterne représentée par la figure 3 le fil de fer F^2 se trouve isolé de la monture t'' par un manchon e, en verre ou en toute autre substance isolante.

(Signé) LODYGUINE ET CIE.

Compagnie d'éclairage électrique, Paris, 46 Rue Neuve St. Augustin, le 18 Décembre, 1872.

Paris, le 8 Fevrier, 1886. Pour expédition certifiée conforme.

Le Chef du Bureau de la Propriété Industrielle.
CH. DESTREM. [L. S.]

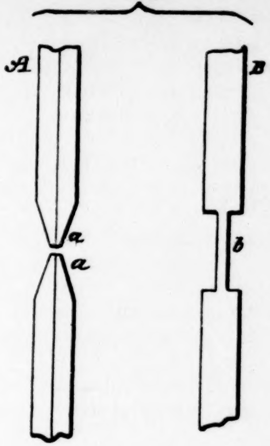
Légation des Etats Unis d'Amerique, Paris, le 2 Mars, 1886. Bon pour légalisation de la signature de Mr. E. Corpel, le 1er secretaire. [L. S.]
HENRY VIGNAUD.

Vu pour la légalisation de la signature de M. Ch. Destrem, sous-chef du bureau de la Propriété Ind'elle, Paris, le 8 Fevrier, 1886. Pour le Ministre du Commerce et par autorisation, le Directeur du Sécrétariat de la Comptabilité. [L. S.]
G. GRISON.

Le Ministre des Affaires Etrangeres certifie véritable la signature de Mr. Grison, Paris, le 19 Fev'r, 1886. Pour le Chef de Bureau Délégue. [L. S.]
E. DORPE.

(Here follow diagrams marked pp. 4488 & 4489.)

Fig. 1



No. 256.
C. L. Light Co. v. M. G. Light Co. } p. 4488

Fig. 2

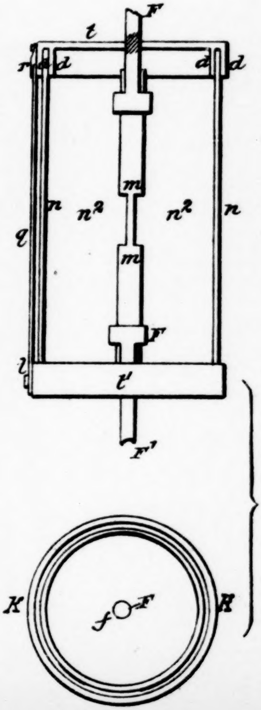
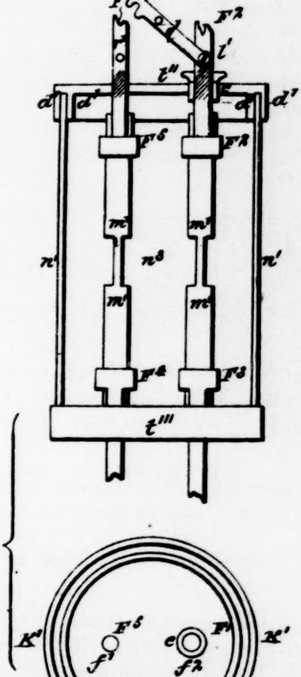
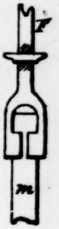

F
t
r
d
d
d
d
n
n^2
n^2
n
q
m
m
F
l
t'
F'
K
f
F
R

Fig. 3


F^1
F^2
l'
t''
d'
d'
d'
d'
F^6
F^2
m'
n^3
m'
n'
n'
m'
m'
F^4
F^3
t'''
K'
F^5
f^1
c
F^1
f^2
K'



Complainant's Exhibit Cut of King Lamp

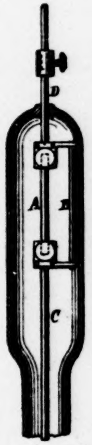


FIG. 45
King's Lamp.

No. 286.
C.E. Light Co.
v.
McK. Light Co. } p. 4489

U. S. Circuit Court,
Western District of Pennsylvania.

Consolidated Electric Light Co.
vs.
McKeesport Light Co.

In Equity.

It is agreed that the above is a correct copy of the Complainant's Exhibit Cut of King Lamp and may be used in place of the original which has been mislaid.

Thomas B. Kerr
Complts Solicitor

Magnus Pflaum
Defendants Solicitor

4490 *Stipulation as to the Omission of Certain Exhibits from the Record on Appeal.*

Circuit Court of the United States, Western District of Pennsylvania.

CONSOLIDATED ELECTRIC LIGHT COMPANY *vs.* MCKEESPORT LIGHT COMPANY. } No. 5, May Term, 1888. In Equity.

It is stipulated by and between the counsel for the respective parties that the following exhibits offered by the defendants in connection with the cross-examination of complainant's witness, Albon Man, need not be filed or printed:

Baldwin-Cheever Telegram, January 6, 1880.
2d Baldwin-Cheever Telegram of January 6, 1880.
Baldwin, Hopkins & Peyton-Cheever Telegram of January 7, 1880.
Baldwin-Cheever Telegram of January 5, 1880.
Cheever-Baldwin Telegram of January 6, 1880.
Baldwin-Cheever Telegram of January 7, 1880.
Horseshoe-Cheever Bill of February 1st, 1880.
Hopkins, Baldwin and Peyton-Cheever Bill.
Baldwin-Cheever Letter of April 27, 1880.
Baldwin-Cheever Letter of April 27, 1880.
Baldwin-Cheever Letter of April 17, 1880.
Pope-Cheever Letter of May 12, 1880.
Baldwin-Man Letter of September 27, 1880.
Dynam*e* Bill.
Accounts and Jay Lease.
Flanagan Agreement, December 16, 1887.
Accounts of Flanagan's Disbursements, December 16, 1887.
Sawyer-Man-Keith Record, April 26, 1888.
Sawyer-Man-Maxim Record, April 26, 1888.
Sawyer-Man-Westen Record, April 26, 1888.
4491 Man-Cheever Letter of December 12, 1880.

It is further stipulated that the copies (attached to the record) of the following exhibits, to wit:

Defendant's Exhibit Baldwin-Wallace Letter of January 8, 1880, and Defendant's Exhibit Memorandum of Agreement of January 8, 1880, being a memorandum signed by Charles A. Cheever and witnessed by William D. Baldwin and dated January 8, 1880, shall be received and filed in lieu of the originals, production of which is hereby waived.

Dated Sept. 24, 1890.

MAGNUS PFLAUM,
Solicitor for Defendant.
THOMAS B. KERR,
Solicitor for Complainant.

Filed Oct. 10, 1890.
H. D. GAMBLE, *Clerk.*
349—286

4492 Circuit Court of the United States for the Western District of Pennsylvania.

THE CONSOLIDATED ELECTRIC LIGHT COMPANY, Complainants,
vs.
MCKEESPORT LIGHT COMPANY, Defendants.
} On Bill and Final Hearing.

Opinion of the Court.

BRADLEY, *Circuit Justice:*

This is a bill for the alleged infringement of a patent, filed December 8th, 1887, and the patent alleged to be infringed is dated May 12th, 1885, and is for improvements in electric lamps. It was granted upon the application of William E. Sawyer and Albon Man, of New York, to their assignee, the Electro-Dynamic Light Company, and by mesne assignments was transferred to the complainant, whose title commenced in October, 1882, before the patent was issued. The application for the patent was filed January 9th, 1880, and the issue was delayed by various proceedings in the Patent Office, including an interference with an application of Thomas A. Edison, which had been filed a month earlier, to wit, December 11th, 1879. Various defences were set up in the answer, such as anticipation by prior inventions, vagueness of description, want of novelty and utility, undue change of specification 4493 after filing, surreptitious claim of an invention made by Edison, &c. It is conceded that the defence of the suit is conducted by Edison Electric Light Company, a corporation of New York, which sells the lamps complained of as infringements of the patent and is interested as assignee in the patents for electric light formerly owned by "The Edison Electric Light Company" and in the question of interference between Edison and the complainants.

In the specification of the patent sued on, called Sawyer & Man's patent, the invention is described as relating to that class of electric lamps employing an incandescent conductor inclosed in a transparent hermetically sealed vessel or chamber from which oxygen is excluded, and constituting an improvement upon the apparatus shown in a previous patent granted to the same parties (Sawyer and Man) June 18th, 1878, and numbered 205,144.

It is further stated in the specification that the invention relates more especially to the incandescing conductor, its substance, its form, and its combination with the other elements composing the lamp, and that the improvement consists, first, of the combination, in a lamp chamber composed wholly of glass, as described in the said former patent, of an incandescing conductor of carbon made from a vegetable fibrous material, in contradistinction to a similar conductor made from mineral or gas carbon, and also in the form of such conductor combined in lighting circuit within the exhausted chamber of the lamp.

The construction of the lamp is then described, reference being made to the drawings for illustration. The lamp, as described

and shown in the drawings, is a glass cylinder with
4494 rounded top cemented at the bottom to a glass disk or plate
ground to fit closely to the cylinder, and the whole bottom enclosed in a cup filled with wax or suitable cement to prevent, as far as possible, the access of atmospheric air. Two holes are made in the bottom of the lamp for the passage of the wires which convey the electric current into and out of the lamp. The carbon conductor within the glass cylinder is connected by its extremities to these two wires respectively in a mode specified in another patent of Sawyer & Man, dated December 10th, 1878, and numbered 210,809, so as to constitute a part of the circuit, and, having a low conductivity and presenting a certain amount of resistance to the current of electricity, it becomes incandescent and highly luminous. If the carbon, in this condition, were exposed to atmospheric air—that is, to oxygen—it would be consumed by combustion; hence another part of the combination necessary to the result consists in filling the lamp with nitrogen gas or other gas which prevents combustion, to the exclusion of atmospheric air. The mode of doing this is pointed out in the patent No. 205,144, before referred to.

It is further stated in the specification that in the practice of the invention the applicants had made use of carbonized paper and also wood carbon; also that they had used conductors of different shapes, such as V-shaped and with rectangular corners, but preferred the arch shape, as shown in the drawings. It is added that a description of the mode of making the illuminating carbon conductors described "and making the subject-matter of this improvement" was unnecessary, as they could be made by any one skilled
in the art by the ordinary, well-known methods in practice.

4495 The specification then states the proposed practical advantages of the arched form of the conductor by its permitting the carbon to expand and contract and casting less shadow and the advantage of making the wall of the lamp wholly of glass by its preventing oxidation, leakage, &c., and states particularly the advantages resulting from the manufacture of the carbon from vegetable fibrous or textile material instead of mineral or gas carbon. "Among them," it says, "may be mentioned the convenience afforded for cutting and making the conductor in the desired form and size, the purity and equality of the carbon obtained, its susceptibility to tempering, both as to hardness and resistance, and its toughness and durability." "We have used," it is added, "such burners in closed or hermetically sealed transparent chambers, in a vacuum in nitrogen gas, and in hydrogen gas; but we have obtained the best results in a vacuum or an attenuated atmosphere of nitrogen gas, the great desideratum being to exclude oxygen or other gases capable of combining with carbon at high temperatures from the incandescing chamber, as is well understood."

The patent has four claims:

"1. An incandescing conductor for an electric lamp of carbonized fibrous or textile material and of an arch or horseshoe shape, substantially as hereinbefore set forth.

"2. The combination, substantially as hereinbefore set forth, of an electric circuit and an incandescing conductor of carbonized fibrous material included in and forming part of said circuit and a hermetically sealed chamber in which the conductor is enclosed.

4496 "3. The incandescing conductor for an electric lamp formed of carbonized paper, substantially as described.

"4. An incandescing electric lamp consisting of the following elements in combination: First, an illuminating chamber made wholly of glass, hermetically sealed, and out of which all carbon-consuming gas has been exhausted or driven; second, an electric circuit conductor passing through the glass wall of said chamber and hermetically sealed therein, as described; third, an illuminating conductor in said circuit and forming part thereof within said chamber, consisting of carbon made from a fibrous or textile material having the form of an arch or loop, substantially as described, for the purpose specified."

The great question in the suit is whether the patent sued on is valid so far as it involves a general claim for the use in electric lamps of incandescing carbon conductors made of fibrous or textile substances. If it is, the complainants must prevail. If it is not, the bill must be dismissed.

The claims of the patent (excluding the third claim, which the defendants do not use and which is not involved in the case) may be summarized as follows: (1) a conductor of carbon made of fibrous or textile material and of an arched form; (2) a conductor of carbon made of fibrous material, in a hermetically sealed chamber, without regard to form; (3) the combination of a conductor of carbon made of fibrous or textile material in an arched form and the glass chamber hermetically sealed and deprived of carbon-consuming gas. The claim of the combination last named may be dismissed from consideration as a separate claim, because a glass chamber hermetically sealed for holding the light has always been used and must necessarily be used in all incandescing carbon
4497 electric lamps. It was used by King in 1845, by Greener & Staite in 1846, by Roberts in 1852, by Konn in 1872, by Kosloff in 1875, and by others. Unless the patent is valid for the conductor of carbon made from fibrous or textile material in an arched form it cannot be made valid by combining such conductor with a glass chamber hermetically sealed.

We are equally of opinion that the giving of an arched form to the conductor was not new and could not give to the claim any validity which it would not have as a broad claim of the conductor itself made of carbon produced from a fibrous material. The arched or bent shape in incandescent conductors was applied in 1848 by Staite to an iridium conductor; in 1858 by Gardiner & Blossom to a platinum conductor, and in 1872 by Konn to a carbon conductor. In the last case the conductor was enclosed (as it had to be) in a glass lamp or case filled with nitrogen or other gas incapable of supporting combustion. The carbon, it is true, is presented in a V-shaped form, but in a similar patent, applied for a few weeks afterward, claiming the same apparatus for the production of heat, the patentee very properly says "it is evident that stems of other shapes may be used." If the U or V shaped form had not been given to carbons made of fibrous material for incandescent light before Sawyer & Man adopted that form it was merely an application by them of an old device to a new and analogous use; but the carbons used by Konn included charcoal, as well as other carbons. He mentions graphite as preferable, but he claims the use of carbons generally.

As before stated, therefore, the patent must be construed as making the broad claim to the use in electric incandescing 4498 lamps of all carbons made of fibrous or textile substances. Is the patent valid for such a broad claim? The defendants contend that it is not—first, because no such invention was set forth in the original application, but was introduced for the first time more than four years after it was filed and after the same material had been used by Edison and claimed by him in an application for a patent; secondly, because Edison, and not Sawyer and Man, was really the original and first inventor of an incandescent conductor made of fibrous or textile material for an electric lamp; thirdly, because, if Edison was not the first inventor, the thing claimed as an invention was old and neither of the parties was entitled to a patent for it.

The whole vegetable kingdom is composed of fibrous material, and all carbon or charcoal made therefrom comes within the scope of the complainant's claim. Silk is fibrous or textile, and carbon made from silk thread is therefore within the claim. Mineral coals and the carbon produced in gas retorts are not included. Can it possibly be said when we look at the history of the art of electric lighting that carbon made from fibrous or textile material was never used for that purpose until Sawyer & Man used it in 1878? We think not. We do not propose to describe in detail the various English patents of prior date which have been adduced in evidence. The word charcoal, as well as carbon, is constantly used to define the material from which the conductors were made, and that word in the English language, *prima facie*, refers to carbon or coal made of wood. We cannot yield our assent to the ingenious 4499 theory of the complainant's counsel and of some of their witnesses that the word has come to have an artificial or technical meaning in this particular art, signifying gas or mineral carbon. We think that carbon made from wood or other vegetable material is generally intended. In King's patent of 1845 he says, "The nature of the invention consist in the application of continuous metallic and carbon conductors intensely heated by the passage of a current of electricity to the purpose of illumination." * * * "When carbon is used it becomes necessary, on account of the affinity this substance has for oxygen at high temperature, to exclude from it air and moisture. To accomplish this in the most perfect manner it should be enclosed in a Torricellian vacuum." He does not confine himself to any particular kind of carbon. It is true he does afterwards say, "That form of carbon found on the

interior of coal-gas retorts which have long been used is well suited for this purpose," but his claim is general for "the application of metallic and carbon conductors intensely heated," &c., and the use of wood carbon would have infringed the patent. Greener and Staite, in their patent of 1840, in describing how they prepared the carbor for the incandescing stems in their lamps, say, "We take a quantity of lamp-black or of charcoal reduced to powder or of coke also reduced to powder, which has been purified, &c. The carbon thus highly purified we next bring into a state of great dryness, and then convert it into solid prisms or into cylinders both solid and hollow," &c. The charcoal here referred to is clearly wood charcoal. Roberts, in his patent of 1852, says, "Another part of my invention consists of a mode of obtaining electric light
by passing a current of electricity through a thin piece of
4500 graphite, coke or charcoal, or other infusible body being a
conductor of electricity, whilst it is inclosed in a vacuum or space not containing any oxygen or other matter which can cause the combustion or destruction of it when brought into an incandescent state by the action of the current of electricity. This certainly refers to wood charcoal. We have already alluded to Konn's patent of 1872, in which he claims carbon stems generally, arranged as specified in the patent for giving incandescent light. We may add that, in the earliest experiments of Sir Humphrey Davy and others on the effects of the electric current in producing light in various substances, charcoal was one of the most frequent articles used for that purpose. Long prior to 1878 it was a well-known fact in science and the arts that the transmission of the electric current through a pencil of charcoal interposed in a metallic circuit would produce intense light, and that when this charcoal was guarded from contact with oxygen in a vacuum or otherwise it would not be consumed. This is fully verified not only in scientific writings, but by the statements found in several of the patents referred to. The great desideratum was to construct an apparatus and to discover a process which would make the light economical and convenient of use for ordinary domestic purposes. We are clearly of opinion, therefore, that neither Sawyer and Man nor Edison can maintain any just claim to the exclusive use of charcoal generally in any form as an incandescing conductor in an electric lamp. This view of the subject is sufficient to decide the present case against the complainants. But there are other considerations which go to corroborate the conclusion to which we have come, which, however, we shall only cursorily examine.

4501 It is very clear to us that in the original application for the patent sued on the applicants had no such object in view as that of claiming all carbon made from fibrous and textile substances as a conductor for an incandescing electric lamp. Nothing on which to base any such claim is disclosed in the original application. We have carfully compared it with the amended application on which the patent was issued, and are fully satisfied that after Edison's inventions on this subject had been published to the world there was an entire change of base on the part of Sawyer &

Man, and that the application was amended to give it an entirely different direction and purpose from what it had in its original form. It is true that the last claim of the original was for "an illuminating arc made of carbonized fibrous or textile materials." But this claim had special reference to the arched form of the conductor rather than to the material of which it was composed; and this claim is the only expression in the application which even suggests any exclusive right to all vegetable carbons or any invention or discovery in relation thereto. No advantage in the use of said carbons is anywhere alleged. The whole scope and purpose of the application related to the arched form of the conductor. A subsidiary purpose was to claim carbon made from paper or pasteboard. They say distinctly "our improvement consists in the employment of an incandescent arc of carbon in the circuit as the light-giving medium;" "carbon" generally, not any particular carbon. By an adroit amendment made in 1885 they say: "Our improvement relates more especially to the incandescing conductor, its substance, its form, and its combination with the other elements
4502 composing the lamp." The purpose of this amendment is obvious and needs no comment. After explaining the drawings, the original application goes on to say: "Our improved burner or incandescent arc consists of an arch-shaped or semi-cylindrical piece of carbon, A, mounted in its clamps or supports in the usual well-known ways. We have tried carbonized paper covered with powdered plumbago, wood carbon or charcoal, and ordinary gas carbon. We have also used such arcs or burners of various shapes, such as pieces with their lower ends secured to their respective supports, and with their upper ends united so as to form an inverted V-shaped burner. We have also used arcs of varying contours—that is, with rectangular bends instead of curvilinear ones—but prefer the arch shape, as the shadow cast by such a burner is less than that produced by other forms of burners. We have used such burners in close transparent chambers in a vacuum, in nitrogen gas and in hydrogen gas, but have attained the best results in a vacuum or attenuated atmosphere of nitrogen, the great desideratum being to exclude oxygen from the combustion chambers, as is well understood. The operation of our improved apparatus will readily be understood from the foregoing description." Then come the claims, as follows: "First. Incandescing arcs for electric lights made of carbon, substantially as hereinbefore set forth. Second. Incandescing arcs of carbon in combination with the circuit of an electric light. Third. The combination, substantially as hereinbefore set forth, of the circuit of an electric light, an incandescing arc of carbonized paper included in the circuit, and a close transparent chamber in which the arc is enclosed. Fourth. An incandescing arc made of carbonized fibrous or textile material."

4503 This is the whole of the original application except the formal introduction. The arc is everything; the changes are rung on the arc. The fact is that Sawyer and Man were unconscious that the arc was not new, and supposed that they could get a patent for it; but as their eyes were opened they changed about and amended their application and made the material of the conductor the great object—carbon made from fibrous or textile material. Compare the original with the amended application as first stated in this opinion and this purpose most obviously appears. The carbons mentioned in the original application are merely mentioned, by the way, to show that the arched form would apply to all kinds of carbon—"We have tried carbonized paper covered with powdered plumbago, wood carbon, and ordinary gas carbon." This is changed in the amended application to the words, "In the practice of our invention we have made use of carbonized paper and also wood carbon." The object of this change is manifest. In other parts of the amended specification the importance of vegetable carbon as distinguished from gas carbon is dwelt upon. Thus they say in a former paragraph: "Our improvement consists, first, of the combination in a lamp chamber composed wholly of glass, and described in patent No. 205,144, of an incandescing conductor of carbon made from a vegetable fibrous material, in contradistinction to a similar conductor made from mineral or gas carbon, and also in the form of such conductor so made from such vegetable carbon, and combined with lighting circuit within the exhausted chamber of the lamp."

The fact that the whole object of the application was changed is evinced by the correspondence of the parties. In a
4504 letter from Wm. D. Baldwin, one of the attorneys of the applicants for the patent, to his clients, the Electro-Dynamic Light Company (who then owned the interest in the invention), dated January 8th, 1880, he says: "I have this day prepared an application for patent of arched form of incandescent carbon electric lamp made by William E. Sawyer and Albon Man, as joint inventors, containing a request for the issuing of such patent to your company, &c. * * * I will not make any alteration in the claims or specification of said patent enlarging its scope beyond its intended purpose of covering the arched or angular form of the carbon used for incandescent electric light." In a letter from Albon Man, one of the applicants for the patent, to a Mr. Cheever, dated Dec. 12th, 1880, he says: "I have received your two notes of 11th inst., enclosing the letter from the Patent Office advising Messrs. Baldwin, Hopkins & Peyton of substitution of Mr. Broadnax as attorney in carbon arch matter. This had relation to the application in question, Baldwin, Hopkins & Peyton being the solicitors in the case and Mr. Broadnax being substituted in their place. "Carbon arch matter" are words that could hardly be more suggestive.

As before stated, Edison had filed an application for a patent in December, 1879, about a month prior to the application in question, and in September, 1880, an interference was declared between the two applications. The controversy raised on this interference related principally to carbon made from paper, which Edison claimed in his application. The case was not finally decided until the beginning of 1885. Mr. Broadnax was examined as a witness in this suit and testified as follows: "After the decision of the Com-
4505 missioner of Patents of the interference awarding priority of

invention to Sawyer and Man, I resumed the prosecution of the application, insisting upon our right to the claims that had been once rejected by the examiner, among which was one for the U-shaped or loop carbon illuminant. My attention was then called for the first time by the examiner to the British patent of Konn, in which is shown an arch-shaped carbon illuminant, and which, as I thought, anticipated broadly, the claim for the U-shaped or arch-shaped carbon illuminant, and then in the discussion of the case with the examiner my attention was called to the patentability of the fibrous carbon illuminant as such on account of the properties such carbon possessed, which made it available for electric lighting above all other carbons." Being asked when this was, he said it followed soon after the decision of the Commissioner of Patents upon the question of priority or as soon as he could in the ordinary course get the case before the primary examiner again. His best recollection was that it occurred in February, 1885.

This testimony of Mr. Broadnax, which is undoubtedly to be relied on in connection with the letters just quoted, shows that the idea of claiming carbons made from fibrous and textile materials was an afterthought and was no part of the purpose of the original application. The amendments relating to this new and broad claim were made afterwards, in February and March, 1885.

We are of opinion that the changes made in the application in this regard were not justifiable, and that the claim in question cannot be sustained.

There are other aspects of the case to which we might refer
4506 which operate strongly against the claim of the complainants.

We are not at all satisfied that Sawyer and Man ever made and reduced to practical operation any such invention as is set forth and claimed in the patent in suit. Their principal experiments were made in 1878 and perhaps the beginning of 1879. The evidence as to what they accomplished in the construction of electric lamps is so contradictory and suspicious that we can with difficulty give credence to the conclusions sought to be drawn from it. We are not satisfied that they ever produced an electric lamp with a burner of carbon made from fibrous material or any material which was a success. During the year referred to, 1878, and the beginning of 1879 they applied for and obtained ten different patents (besides an English patent) on the subject of electric lamps, but not one of them contains a suggestion or a hint of any such invention as is claimed in the patent in suit, which was not applied for until 1880. They all relate to lamps with straight-pencil burners, generally of carbon, but without any preference given to one kind of carbon over another. The application for the patent in suit was not made until January, 1880, nearly or quite a year after their experiments had ceased and after the inventions of Edison had been published to the world. One cannot read the patents before applied for by Sawyer & Man, with all their detail of apparatus and process for constructing and managing the straight-stem conductors, without distinction of carbons, apparatus and processes, many of which would be needless in the lamp now claimed, without in-

dulging some degree of astonishment at the pains and ingenuity gratuitously expended or wasted if it was true that all the
4507 time they had in their possession a secret invention which would take the place of those complicated contrivances. The explanations made by the complainants for the delay in applying for the patent in suit fail to satisfy our minds that Sawyer and Man, or their assignees for them, have not sought to obtain a patent to which they were not legitimately entitled.

But suppose it to be true, as the supposed inventors and some of the other witnesses testify, that they did in 1878 construct some lamps with burners of carbon made of fibrous material and of an arched shape which continued to give light for days or weeks or months, still were they a successful invention? Would any one purchase or touch them now? Did they not lack an essential ingredient which was necessary to their adoption and use? Did they go any farther in principle, if they did in degree, than other lamps which had been constructed before? It seems to us that they were following a wrong principle—the principle of small resistance in an incandescing conductor and a strong current of electricity—and that the great discovery in the art was that of adopting high resistance in the conductor with a small illuminating surface and a corresponding diminution in the strength of the current. This was accomplished by Edison in his filamental, thread-like conductors, rendered practicable by the perfection of the vacuum in the globe of the lamp. He abandoned the old method of making the globe in separate pieces, cemented together, and adopted a globe of one entire piece of glass into which he introduced small platinum conductors fastened by fusion of the glass around them, thus being able to procure and maintain perhaps the most perfect vacuum known in the arts.

4508 In such a vacuum the slender filaments of carbon, attenuated to the last degree of fineness, may be maintained in a state of incandescence without deterioration for an indefinite time and with a small expenditure of electric force. This was really the grand discovery in the art of electric lighting, without which it could not have become a practical art for the purpose of general use in houses and cities.

It is unimportant to trace the various steps by which this great discovery was arrived at. It is well indicated and shown in Edison's patent, applied for in April, 1879, and issued May 4th, 1880, number 227,229, and is more fully described in that which he applied for November 4th, 1879, and issued January 27th, 1880, number 223,898. An extract from the latter will serve to explain the principles of this invention. Edison there says:

"Heretofore light by incandescence has been obtained from rods of carbon, of one to four ohms resistance, placed in closed vessels in which the atmospheric air has been replaced by gases that do not combine chemically with carbon. The vessel holding the burner has been composed of glass cemented to a metallic base. The connection between the leading wires and the carbon has been obtained by clamping the carbon to the metal. The leading wires have

always been large, so that their resistance shall be many times less than the burner, and, in general, the attempts of previous persons have been to reduce the resistance of the carbon rod. The disadvantages of following this practice are tha*n* a lamp having but one to four ohms resistance cannot be worked in great numbers in multiple arc without the employment of main conductors of
4509 enormous dimensions; that owing to the low resistance of
the lamp the leading wires must be of large dimensions and good conductors, and a glass globe cannot be kept tight at the place where the wires pass in and are cemented. Hence the carbon is consumed, because there must be almost a perfect vacuum to render the carbon stable, especially when such carbon is small in mass and high in electrical resistance.

"The use of a gas in the receiver at the atmospheric pressure, although not attacking the carbon, serves to destroy it in time by 'air washing,' or the attrition produced by the rapid passage of the air over the slightly coherent highly heated surface of the carbon. I have reversed this practice. I have discovered that even a cotton thread properly carbonized and placed in a sealed glass bulb exhausted to one millionth of an atmosphere offers from 100 to 500 ohms resistance to the passage of the current, and that it is absolutely stable at very high temperatures; that if the thread be coiled as a spiral and carbonized, or if any fibrous vegetable substance which will leave a carbon residue after heating in a closed chamber be so coiled, as much as 2,000 ohms resistance may be obtained without presenting a radiating surface greater than three-sixteenths of an inch; that if such fibrous material be rubbed with a plastic composed of lamp-black and tar its resistance may be made high or low according to the amount of lamp-black placed upon it; that carbon filaments may be made by a combination of tar and lampblack, the latter being previously ignited in a closed crucible for several hours and afterward moistened and kneaded until it assumes the consistency of thick putty. Small pieces of this material
4510 may be rolled out in the form of a wire as small as seven
one-thousandths of an inch in diameter and over a foot in length, and the same may be coated with a non-conducting noncarbonizing substance and wound on a bobbin or as a spiral and the tar carbonized in a closed chamber by subjecting it to high heat, the spiral after carbonization retaining its form.

"All these forms are fragile and cannot be clamped to the leading wires with sufficient force to insure good contact and prevent heating. I have discovered that if platinum wires are used and the plastic lamp-black and tar material be moulded around it in the act of carbonization there is an intimate union by combination and by pressure between the carbon and platina and nearly perfect contact is obtained without the necessity of clamps; hence the burner and the leading wires are connected to the carbon ready to be placed in the vacuum bulb. When fibrous material is used the plastic lamp-black and tar are used to secure it to the platina before carbonizing.

"By using the carbon wire of such high resistance I am enabled to use fine platinum wires for leading wires, as they will have a small resistance compared with the burner and hence will not heat and crack the sealed vacuum bulb. Platina can only be used, as its expansion is nearly the same as that of glass.

* * * * * * *

"I have carbonized and used cotton and linen thread, wood splints, papers coiled in various ways, also lamp-black, plumbago, and carbon in various forms mixed with tar and kneaded so that the same may be rolled out into wires of various lengths and
4511 diameters. Each wire, however, is to be uniform in size throughout."

The first claim of this patent is for an electric lamp for giving light by incandescence, consisting of a filament of carbon of high resistance, made as described, and secured to metallic wires as set forth. The second claim is the combination of such filaments with the receiver made entirely of glass.

Of course, the form of the filament in the receiver or globe may be varied at pleasure. It may be in the shape of a coil or of a horseshoe or it may be wound on a bobbin. All these forms are old. The principal and great thing described is the attenuated filament and its enclosure in a perfect vacuum. There may be a preference of materials from which the filament is made. Practice will evolve all these collateral advantages.

We think we are not mistaken in saying that but for this discovery electric lighting would never have become a fact. We have supposed it to be the discovery of Edison, because he has a patent for it. This may not be the case; it may be the discovery of some other person; but whoever discovered it, it is undoubtedly the great discovery in the art of practical lighting by electricity. We have given a more detailed account of it in order to illustrate what we mean when we raise the question whether the claimed inventions of Sawyer and Man were ever successful. They may have made a lamp that would burn, but was it a success or was it a failure? Did it ever go into use? What was the object of all the experiments made by them and others? Was it not to make an electric lamp that could be successfully used by the public and have a com-
4512 mercial value? Did they succeed in making such a lamp or in finding out the principle on which it could be made? We do not so read the evidence.

The bill must be dismissed.

Filed October 5, 1889.

H. D. GAMBLE, *Clerk.*

4513 *Final Decree.*

In the Circuit Court of the United States for the Western District of Pennsylvania.

THE CONSOLIDATED ELECTRIC LIGHT COMPANY *vs.* McKEESPORT LIGHT COMPANY.	No. 5. May Term, 1888. In Equity.

And now, to wit, October 10th, 1890, this cause having come on to be heard on bill, answer, replication, and proofs, and having been argued by counsel of the respective parties, it was ordered, adjudged, and decreed that the complainant's bill of complaint be dismissed at the cost of the said complainant.

BY THE COURT.

Filed October 10, 1890.

H. D. GAMBLE, *Clerk.*

4514 *Appeal.*

Circuit Court of the United States, Western District of Pennsylvania.

THE CONSOLIDATED ELECTRIC LIGHT COMPANY, Complainant, *vs.* McKEESPORT LIGHT COMPANY, Defendant.	In Equity. No. 5. May Term, 1888.

The above-named complainant, The Consolidated Electric Light Company, conceiving itself aggrieved by the order entered on October 10th, 1890, in the above-entitled proceeding, doth hereby appeal from said order to the Supreme Court of the United States, and it prays that this its appeal may be allowed, and that a transcript of the record and proceedings and papers upon which said order was made, duly authenticated, may be sent to the Supreme Court of the United States.

KERR & CURTIS,
Attorneys for Complainant and Appellant.

Pittsburgh, October 10th, 1890.

And now, to wit, on October 10, 1890, it is ordered that the appeal be allowed as prayed for.

By the court:

M. W. ACHESON, *Judge.*

Filed Oct. 10, 1890.

H. D. GAMBLE, *Clerk.*

4515 *Bond on Appeal.*

Circuit Court of the United States, Western District of Pennsylvania.

The Consolidated Electric Light Company, Complainant, vs. McKeesport Light Company, Defendant. } In Equity. No. 5. May Term, 1888.

Know all men by these presents that the Consolidated Electric Light Company, of the city, county, and State of New York, and George Westinghouse, Jr., of the city of Pittsburgh, county of Allegheny and State of Pennsylvania, are held and firmly bound unto the above-named McKeesport Light Company in the sum of five thousand dollars, to be paid to the said McKeesport Light Company; for the payment of which, well and truly to be made, the Consolidated Electric Light Company, its successors and assigns, and George Westinghouse, Jr., his heirs, executors, and administrators, and each of them, are, jointly and severally, firmly bound by these presents.

Executed and sealed with the seal of the said Consolidated Electric Light Company and of the said George Westinghouse, Jr., and dated the tenth day of October, in the year of our Lord one thousand eight hundred and ninety.

Whereas the above-named The Consolidated Electric Light Company has prosecuted an appeal to the Supreme Court of the United States to reverse the decree rendered in the above-entitled suit by the judges of the circuit court of the United States for the western district of Pennsylvania:

Now, therefore, the condition of this obligation is such that if the above-named The Consolidated Electric Light Company shall prosecute said appeal to effect and answer all damages and costs if it fail to make its said appeal good, then this obligation shall be void; otherwise the same shall be and remain in full force and virtue.

[SEAL.] THE CONSOLIDATED ELECTRIC LIGHT CO.,
By HUGH R. GARDEN, *Pres.*
GEO. WESTINGHOUSE, JR. [SEAL.]

4516 Sealed by the Consolidated Electric Light Company aforesaid and acknowledged before me — Hugh R. Garden, president of said company, this sixth day of October, 1890.

[SEAL.] JOSEPH A. WELCH,
U. S. Commissioner, Southern District of New York.

Sealed and acknowledged before me by the said Geo. Westinghouse, Jr., this 7th day of October, 1890.

[SEAL.] LORENZO C. CARUANA,
Notary Public, Kings County.

Certificate filed in New York Co.

And now, October 10th, 1890, the within bond approved.

M. W. ACHESON, *Judge.*

Filed October 10, 1890.

H. D. GAMBLE. *Clerk.*

4517 *Substitution of Solicitors for Complainants.*

United States Circuit Court, Western District of Pennsylvania.

THE CONSOLIDATED ELECTRIC LIGHT COMPANY
vs.
THE MCKEESPORT LIGHT CO.
} In Equity. No. —.

We hereby consent to the substitution of Messrs. Kerr & Curtis as solicitors for complainant in the above-entitled suit.

BROADNAX & BULL,
Solic. for Comp't.

New York, July 30, 1890.

Filed Oct. 10, 1890.

H. D. GAMBLE, *Clerk.*

4518 In the Circuit Court of the United States for the Western District of Pennsylvania.

CONSOLIDATED ELECTRIC LIGHT COM- COMPANY
vs.
THE MCKEESPORT LIGHT CO.
} No. 5. May Term, 1888.

WESTERN DISTRICT OF PENNSLYVANIA, *ss:*

Seal of the U. S. Circuit Court, W. D. Penna.

I, H. D. Gamble, clerk of the circuit court of the United States for the said district, do hereby certify that the annexed and foregoing pages contain a true copy of the record and proceedings in the above-entitled case so full and entire as the same remains of record and on file in my office.

In testimony whereof I have hereunto signed my name and affixed the seal of the said court, at Pittsburgh, this 13th day of October, A. D. 1890.

H. D. GAMBLE, *Clerk.*

WESTERN DISTRICT OF PENNSLYVANIA, *ss:*

I, Marcus W. Acheson, judge holding the United States circuit court for said district, do hereby certify that H. D. Gamble, above named, was at the time of making the above certificate and is now clerk of the said court, and that the said certificate made by him is in due form of law.

M. W. ACHESON,
Judge Holding U. S. Circuit Court.

Pittsburgh, October 13th, 1890.

4519 Circuit Court of the United States, Western District of Pennsylvania.

THE CONSOLIDATED ELECTRIC LIGHT COMPANY, Complainant, *vs.* MCKEESPORT LIGHT COMPANY, Defendant.	In Equity. No. 5. May Term, 1888.

UNITED STATES OF AMERICA, *ss:*

To McKeesport Light Company:

You are hereby cited and admonished to be and appear at a Supreme Court of the United States, to be holden at Washington on the second Monday of October, 1890, pursuant to an appeal filed in the clerk's office of the circuit court of the United States for the western district of Pennsylvania, wherein The Consolidated Electric Light Company is appellant and McKeesport Light Company is repondent, to show cause, if any there be, why the judgment in the said writ of error mentioned should not be corrected and speedy justice should not be done to the parties on that behalf.

Seal of the U. S. Circuit Court, W. D. Penna.

Witness Hon. Melville W. Fuller, Chief Justice of the United States, this 10th day of October, in the year of our Lord one thousand eight hundred and ni-ety.

M. W. ACHESON,
U. S. Judge.

Attest: H. D. GAMBLE, *Clerk.*

4520 [Endorsed:] No. 5. May term, 1888. Equity. Consolidated Electric Light Co. *vs.* McKeesport Light Co. Citation. I hereby accept service of the within citation this 11th day of October, A. D. 1890. Magnus Pflaum, of counsel for defend'ts.

And now, October 11, 1890, service of the within writ accepted for the defendant company by Magnus Pflaum, Esq., of counsel for defendant, as endorsed hereon.

So ans.—

J. R. HARRAH,
U. S. Marshal.

Endorsed on cover: Case No. 14,326. W. Pennsylvania C. C. U. S. No. 286. The Consolidated Electric Light Company, appellant, *vs.* The McKeesport Light Company. Filed October 17, 1890.